CHRISTIAN-ALBRECHTS-UNIVERSITÄT ZU KIEL

Diploma Thesis

Statechart Style Checking

Automated Semantic Robustness Analysis of Statecharts

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Eidesstattliche Erklärung
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Abstract

Software for safety-critical systems is nowadays often *graphically modeled*, using what has come to be known as *statecharts*. In collaborative, complex software development projects, code efficiency, readability, and maintainability are particularly important issues. Especially, since humans tend to digress, err, and diversify, error prevention, as well as the provision of solutions for reoccurring tasks are of paramount importance. Hence, this diploma thesis focuses on the definition and automated compliance check of so-called *robustness rules* for statecharts. By these means, a *subset* of the statechart programming paradigm is specified, which is considered to be less error-prone.

Keywords: statecharts, error prevention, style checking, style guide, syntactic robustness, semantic robustness, automated theorem proving

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List of Acronyms and Abbreviations

API application programming interface

ATP automated theorem proving BDD binary decision diagram

CASE computer-aided software engineering

CNF conjunctive normal form

CVC Cooperating Validity Checker

CVCL Cooperating Validity Checker Lite

DNF disjunctive normal form
DP Davis-Putnam (algorithm)

DPLL Davis-Logemann-Loveland (algorithm)

FSM finite state machine GUI graphical user interface

IDE integrated development environment

JAR Java Archive

JNI Java Native Interface JVM Java Virtual Machine

KIEL Kiel Integrated Environment for Layout

MISRA Motor Industry Software Reliability Association NASA National Aeronautics and Space Administration

OCL Object Constraint Language
OMG Object Management Group
SAT boolean satisfiability problem
SMT satisfiability modulo theories

SSM Safe State Machines

SUD system under developmentSVC Stanford Validity CheckerUML Unified Modeling Language

χv

VHDL Very High-Level Design Language

XMI XML Metadata InterchangeXML eXtensible Markup Language

w. r. t. with respect to

Chapter 1

Introduction

Computer-controlled electronic devices, so-called embedded systems, have long become part of our everyday life. Their presence has evolved from abundance to ubiquity. Even many safety-critical systems—those where human life or at least great financial values are at stake—are controlled by software. It is, therefore, all the more important that this software does exactly what it is supposed to do. Prominent examples of safety-critical systems failure are the Therac-25 radiation therapy (1985–1987) [62], the Space Shuttle *Challenger* (1986) [105], Lufthansa Flight 2904 (1993) [60], and Ariane 5 Flight 501 (1996) [63].

The software for such safety-critical (embedded) systems is nowadays oftentimes realized without using "standard" programming languages such as C or Java. Instead, behavior is either expressed in a specialized programming language, such as Esterel [16], or graphically modeled at various levels of abstraction, using what has come to be known as statecharts [44]. According to Harel, their inventor, statecharts "constitute an extensive generalization of state-transition diagrams. They allow for multilevel states decomposed in an and/or fashion, and thus support economical specification of concurrency and encapsulation. They incorporate a broadcast communication mechanism, timeout and delay operators for specifying synchronization and timing information, and a means for specifying transitions that depend on the history of the system's behavior" [46, page 10]. With these specialized features—hierarchy, concurrency, broadcastcommunication, and history—statecharts constitute a much more powerful and intuitive modeling paradigm than ordinary textual programming. Using a specialized modeling environment, e.g., Esterel Studio or MATLAB Simulink/Stateflow, such a system model may be used to generate program code. Moreover, the modeled system may also be simulated by injecting events into the model, which then reacts according to its behavior. Thus, statecharts in conjunction with a powerful modeling and simulation environment serve as specification and design language, graphical programming language, and test suite. Today, statecharts are used in the software development of such complex endeavors as the Airbus A380 and the Eurofighter.

Although utilizing statecharts for system development makes life easier, they are—by far—no magic bullet. When modeling systems graphically, certain aspects regarding quality need to be kept in mind, just as in textual computer programming:

Good programming style begins with the effective organization of code. By using a clear and consistent organization of the components of your programs, you make them more efficient, readable, and maintainable.

- Steve Oualline, C Elements of Style [85, page 1]

Code efficiency, readability, and maintainability are particularly important issues in collaborative, complex software development projects. Especially, since humans tend to digress, err, and diversify, common appearance and style, error prevention, as well as the provision of solutions for reoccurring tasks are of paramount importance in large programming projects. Hence, appropriate guidelines and an automated abidance check are indispensable. This diploma thesis focuses on the definition and automated check of so-called *robustness rules*, *i. e.*, rules that limit or even prevent the use of error-prone expressions.

The developed robustness checker is integrated in the statechart modeling and simulation tool *KIEL* [55]. A screenshot of *KIEL* is shown in Figure 1.1. In the broad context of computer aided software engineering (CASE), *KIEL* is currently being developed by the *Real-Time and Embedded Systems Group* at the Department of Computer Science, Christian-Albrechts-University of Kiel, Germany. Accordingly, the recursive acronym *KIEL* stands for "Kiel Integrated Environment for Layout." The tool's main goal is to enhance the intuitive comprehension of the behavior of the system under development (SUD). While most available statechart development tools merely offer a static view of the SUD during simulation, *KIEL* provides a more dynamic visualization [89]. At each simulation step, a new view of the chart is shown with the currently active states expanded and highlighted. The inner states of nonactive hierarchical states are collapsed to hide less important, potentially distracting details. Fundamental components of *KIEL* are a tree data structure that represents the topology of a statechart and an automatic layout mechanism that generates graphical representations of statecharts. *KIEL* also features import functionality for models of various statechart dialects, *e. g.*, Safe

State Machines and Stateflow, as well as for system descriptions written in Esterel via a transformation to Safe State Machines [90].

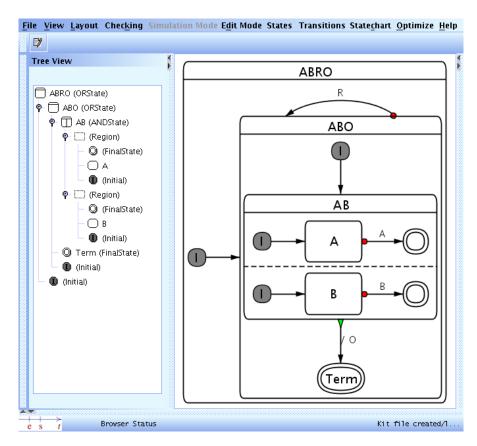


Figure 1.1: Screenshot of *KIEL* showing the example statechart ABRO. The tree data structure is shown on the left, the classical statechart view on the right.

This thesis is organized as follows: A thorough introduction of statecharts is given in Chapter 2. Thereafter, as the developed statechart checking framework is based on automated theorem proving, particularly the *satisfiability modulo theories* problem, Chapter 3 presents the respective theoretical background and an overview of available solving tools. Chapter 4 discusses automated software error prevention, focussing on the theoretical foundation and the practical state-of-the-art. In doing so, the particulars of style checking in textual computer programming (Section 4.2) as well as style checking in statecharts (Section 4.3) are addressed. Next, the definition of a comprehensive statechart style guide is presented in Chapter 5. Implementation details of the corresponding automatic checking framework as a plug-in for *KIEL* are described in Chapter 6. Finally, Chapter 7 concludes this thesis by critically discussing its results.

Chapter 2

Statecharts

Much has happened in the world of software and systems engineering since Harel introduced statecharts in 1987 in his seminal publication *Statecharts: A Visual Formalism for Complex Systems* [44]. Harel begins by recognizing "the existence of a major problem in the specification and design of large and complex reactive systems." The problem, as he points out, originates from "the difficulty of describing reactive behavior in ways that are clear and realistic, and at the same time formal and rigorous" [44, page 231]. Although specialized programming languages, *e. g.*, Esterel, are forthcoming in the field of reactive systems, a gap between specification and design aims on one side and available methods on the other side exists. This gap stands in contrast to the development of transformational systems, for which excellent methods of decomposition, both coherent and rigorous have long existed.

Unlike a transformational system, which essentially computes a function, transforming input data into output data, a *reactive system* is characterized by continuously interacting with its environment, *i. e.*, responding to external and internal stimuli. In essence, Harel defines the behavior of a reactive system as "the set of allowed sequences of input and output events, conditions, and actions, perhaps with some additional information such as timing constraints" [44, page 232]. The fact that this set of sequences, which is often large and complex, could not be elegantly decomposed using traditional methods, hindered the systematic and efficient development of reactive systems. Here, statecharts, which are described in the following, using a bottom-up approach, enter the picture.

2.1 Emergence of Statecharts

A priori, the concept of states and events suggests itself as a rather natural medium for capturing the dynamic behavior of complex systems. A state transition, which takes the general form "when event E occurs while the system is in state X, if condition C is true at the time, the system transfers to state Y," constitutes the basic element of this description. The systematic aggregation of such state-transitions forms a finite state machine.

2.1.1 Finite State Machines

A *finite state machine* (*FSM*), first introduced in the early 1950s by Rabin and Scott [92], is the oldest known formal, technical model of sequential behavior. It is based on the conjunction of Turing machines [106] and McCulloch's and Pitts' neural-network models [70]. Built on these concepts, FSMs are composed of states and transitions. "A state is a distinguishable, disjoint, orthogonal ontological condition that persists for a significant period of time" [30, page 50]. This means that a state can be clearly distinguished from other states, a system must be in exactly one state at all times, and states do not overlap. Transitions indicate a state change in response to an event of interest.

An FSM can be represented by a *state-transition diagram* (or *state diagram*, for short), as illustrated in Figure 2.1. State diagrams are directed graphs, with nodes representing states and edges labeled with *triggering* events and *guarding* conditions representing transitions.

A pure FSM, also called *acceptor* or *recognizer*, is defined as a quintuple $(Q, \Sigma, \delta, q_0, F)$, where

$$Q$$
 is a finite set of *states*,
 Σ is the *input alphabet*,
 $\delta: Q \times \Sigma \to Q$ is the *transition function*,
 $q_0 \in Q$ is the *initial state*, and
 $F \subseteq Q$ is the set of *final states*.

There are two basic ways to extend the above model into a *transducer* with an output capability:

According to the Moore model [73], output is associated with states. A *Moore machine* is a septuple $(Q, \Sigma, \Delta, \delta, \lambda, q_0, F)$, where $Q, \Sigma, \delta, q_0, F$ remain as defined above,

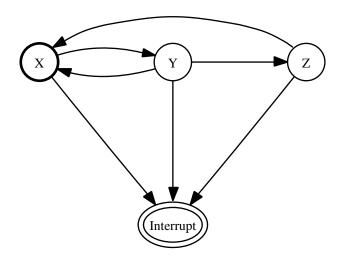


Figure 2.1: State transition diagram representing a simple finite state machine, with initial state "X" and final state "Interrupt."

 Δ is the *output alphabet*, and $\lambda: Q \rightarrow \Delta$ is the *output function*.

According to the Mealy model [71], output is associated with transitions. A *Mealy machine* is also a septuple $(Q, \Sigma, \Delta, \delta, \lambda, q_0, F)$, where $Q, \Sigma, \Delta, \delta, q_0, F$ are defined as for Moore machines, but

$$\lambda: Q \times \Sigma \to \Delta$$
 is the *output function*.

Output generally takes the form of an uninterruptible activity, called an action, to be performed before the system will react to any new events.

2.1.2 Application of FSMs: Shortcomings and Desiderata

Finite state machines, as presented above, have several critical shortcomings when employed for modeling complex reactive systems. Following a naïve approach of describing such systems, one would be faced with an unmanageable, exponentially growing multitude of states, as noted by Parnas as early as 1969 [86]. This is due to the "flat," unstratified nature of state diagrams, making them uneconomical concerning the number of transitions, *e. g.*, required for a high-level interrupt (cf. Figure 2.1), and even more uneconomical concerning the number of states w. r. t. parallel composition. Furthermore, state diagrams are inherently sequential, so that parallelism cannot be represented in a natural way [cf. 44].

To avoid the explicit representation of all combinations of states and transitions, a modular, hierarchical, and well-structured modeling strategy seems highly desirable. This strategy should provide more general and flexible concepts, including (1) a bottom-up aggregation of states into super-states as well as a top-down refinement of states into sub-states, which together results in a hierarchical organization of super-states, states, and sub-states; (2) the identification of independence or orthogonality of states; and (3) a generalization of single-event transitions into condition-guarded boolean multi-event ones.

To illustrate these concepts, consider the following example of a television set (numbers refer to the points mentioned above): (1) in all on-states (TV-program or videotext), when the power-button is pressed, the television switches off, and conversely, the television's on-state consists of TV-program and videotext; (2) the television's volume (or mute) is independent of the channel; (3) the device can be turned on by pressing either one of the channel buttons or the power button.

2.1.3 Harel Statecharts

Built on these desiderata, *i. e.*, enriching a combination of Moore and Mealy machines with hierarchy (depth) and orthogonality (parallelism), Harel developed an innovative visual formalism, introduced as statecharts [44]. *Statecharts* constitute an extension of conventional state diagrams by and/or decomposition of states, additionally including inter-level transitions and broadcast-communication between concurrent components, as well as encouraging 'zoom' capabilities for varying levels of abstraction—or, putting it in Harel's words.

```
"statecharts = state-diagrams + depth + orthogonality + broadcast-communication" [44, page 233].
```

In addition, the modeled system may hold and modify data and also exchange this data with its environment. In statecharts, this data is represented by events and condition variables. Thus, Harel's original definition should be augmented to read

```
statecharts = state-diagrams + depth + orthogonality + broadcast-communication + data [46].
```

The central components of this formalism are state-transitions, which model possible pathways to transfer from a current state into a next state under certain conditions, so-called transition predicates. There may be several outgoing transitions from one state, which are evoked in each case by their own predicates.

2.2 Statechart Dialects

Harel's original semantics is implemented in Statemate [45]. Besides, many different so called statechart *dialects* have evolved. In 1994, von der Beeck compared 21 of these dialects [12], each with somewhat different syntax and semantics. The Object Management Group (OMG) has incorporated an implementation-independent, overarching definition of statecharts into the UML specification [82]. In addition to this specification, the following three statechart implementations are considered in this thesis:

Statechart Dialect	Product Name	Product Vendor
Stateflow	MATLAB Simulink/Stateflow	The MathWorks
Statemate	Statemate	I-Logix
Safe State Machines	Esterel Studio	Esterel Technologies

All statechart dialects exhibit their own syntactic and semantic peculiarities of which the system modeler must be aware, especially since even identical syntax may have different semantics in different dialects. One of the most profound distinguishing characteristics of a particular statechart dialect is its notion of time. Essentially, two distinct models of time exist: The *synchronous* model of time assumes that a system executes a single step every instant or time unit, reacting to all external changes that have occurred since the completion of the previous step. The *asynchronous* model of time, on the other hand, assumes that a system reacts whenever an external change occurs, allowing several steps to take place within a single time unit [12].

The most prominent characteristics of the aforementioned dialects are described below:

UML state machines

Currently, no immediate implementation of UML state machines exists.
 However, a growing group of UML modeling tools has committed itself to partial, but expanding implementations.

In terms of syntactic scope, UML state machines represent a superset of a
variety of statechart dialects. Conversely, many statechart implementations
claim UML conformance. The semantics, on the other hand, are in many
cases merely sketched in the UML standard.

Stateflow

- Stateflow charts are always embedded within a Simulink model. The charts
 may be run synchronously at the same rate as the surrounding Simulink
 model or asynchronously by selectively injecting events from Simulink when
 required [68].
- Stateflow provides a rudimentary static checking functionality.

Statemate

- Statemate was the first executable implementation of statecharts, adhering closely to Harel's original semantics.
- Statemate's micro-step semantics is a variant of the asynchronous model of time [45].

Safe State Machines

- Safe State Machines are built on a perfectly synchronous framework, *i. e.*, conceptually, concurrent processes perform computation and exchange information in zero time [14]. On the physical target-platform, this abstraction is translated into the guaranteed keeping of deadlines.
- Safe State Machines do not allow inter-level transitions, as they tend to disturb the desired encapsulation.
- Safe State Machines feature clear and explicitly defined semantics, facilitating strictly formal behavioral descriptions.
- A non-commercial, but slightly limited variant of Safe State Machines, named SyncCharts, has been developed by André [1].

2.3 Graphical Notation of Statecharts

So far, the theoretical concepts of statecharts have been introduced. To complete the formalism, we will now turn to the equally important aspect of visualization. In order

Table 2.1:	Basic	statechart	elements:	state and	transition.

Statechart Element	Notation	Remarks
State	State	This most basic element, in unison with its name, represents the current state of the system. Moore-like actions, to be performed while entering, residing in, or exiting a state, may be specified.
Transition	e [c] / a	A transition models a possible pathway to transfer the system from the current state into a next state, given the presence of an event of interest and the adherence to a certain condition. Taking the transition also triggers a specified action.

to avoid showing the graphical notation of all aforementioned statechart dialects, the notation of the UML specification [82] is shown. Additionally, the notation of Safe State Machines [35], which is used in the examples in Chapter 5, is given for elements that differ considerably from the UML standard.

Traditionally, trees and other line-graphs have been used for capturing depth and hierarchy. In these, however, the geometrical features of lines and points contribute no additional meaning. Drawing from the more general concepts of Euler circles, Venn diagrams, and hypergraphs, Harel suggested the use of rounded rectangles to represent states at any level, *i. e.*, (simple) states that have no sub-states as well as hierarchical (or composite) states [44]. The hierarchical relation is expressed using encapsulation of states within higher-level states. In Harel's notation, arrows, representing transitions, are allowed to originate and terminate at any level and are labeled with a triggering event and a parenthesized guarding condition. In most statechart dialects, both transition events and conditions are optional. Table 2.1 illustrates the notation of states and transitions.

As shown in Table 2.2, two distinct types of composite states, facilitating the specification of hierarchy, exist: XOR as well as AND. Within an XOR-state, exactly one of the contained states is active at any given time—still, such states are commonly referred to as OR-states. In contrast, within an AND-state, all orthogonal components are ac-

Table 2.2: Statechart elements: composite states.

Statechart Element	Notation	Remarks
OR-State	ORState	Exactly one of the contained states is active at any given time. In general, transitions originating from encapsulating states have higher priority.
AND-State	ANDState	Each orthogonal component is called a region and has the semantics of an OR-state. All regions are active simultaneously.

tive simultaneously. AND-states constitute Harel's desired "natural way" to represent the decomposition of a system into its physical subsystems [44]. In general, transitions originating from encapsulating states have higher priority.

In addition to these basic statechart elements, final states and various pseudo-states are described in Table 2.3. Here, the notation of the UML standard as well as that of Safe State Machines (SSM) is shown. Pseudo-states are different from the previously introduced "normal" states in that a system can never actually reside in a pseudo-state.

The UML standard further defines Fork, Join, and Synch pseudo-states, shown in Figure 2.2. The exact semantics of these constructs are, however, beyond the scope of this paper.



Figure 2.2: Additional pseudo-states defined in the UML standard.

Moreover, as Safe State Machines do not allow inter-level transitions, alternative means for termination are required. These are illustrated in Table 2.4. For instance, an AND-state is exited by "normal termination" when all parallel components have reached their respective final states. Additionally, the relative priorities are given for the three types of transitions.

Table 2.3: Advanced statechart elements: final state and selected pseudo-states.

Statechart Element	Notation		Remarks
	UML	SSM	
Final State		Final	Identifies the termination of the encapsulating composite state.
Initial Connector	•		Typically, when any composite state becomes active, the mandatory initial connector within is activated (see History Connector below for exceptions).
Choice Connector/ Conditional Connector/ Junction Connector	•	©	These pseudo-states are meant for uncluttering and economizing statecharts. Variying nomenclature, notation, and semantics exist in different statechart dialects.
History Connector	(H)	(H)	When a composite state is re-entered through its History Connector (H), the previous inner state is restored. Deep History Connectors (H*) even restore the states within all contained hierarchical levels.

2.4 Suitability of Statecharts for Modeling Reactive Systems

System modeling can be considered as a transition from ideas and informal descriptions to concrete descriptions that use fixed concepts and predefined terminology. Statecharts are embedded within such a description, capturing the system specification organized into three views, or projections, of the system [46]: (1) the *functional view*, encompassing the "what" of the system's capabilities, including its processes, inputs, and flow of information; (2) the *behavioral view* (statecharts), capturing the "when", *i. e.*, the system's behavior over time, including the control and timing behavior and thus providing

Table 2.4: Safe State Machines extensions of the statechart notation.

Statechart Element	Notation	Remarks
Normal Termination		Lowest priority; automatically enabled when the originating composite state terminates. For an OR-state this is the case when an encapsulated final state is reached; for an AND-state it is the case when final states are reached in all encapsulated regions. Normal terminations do not support triggers or conditions.
Weak Abort		Medium priority; when enabled, the originating state is left after it has completed all its activities associated with the current instant.
Strong Abort	•	Highest priority; when enabled, the originating state ist left immediately.
Suspend Connector	S	"Always-active" pseudo-state; when one of the departing, actionless transitions is enabled, the composite target state is immediately (strongly) suspended, <i>i. e.</i> , execution within the state is paused for the current instant.

insight into causality, concurrency, and synchronization; and (3) the *structural view*, depicting the "how" of the system's structure in terms of subsystems, modules, or objects, and its communication links. While the former two views provide the *conceptual model* of the system, the structural view is considered to be its *physical model*, because it is concerned with the various aspects of the system's implementation. As a consequence, the conceptual model usually involves terms and notations borrowed from the problem domain, whereas the physical model draws more upon the solution domain.

Statecharts are well-fit for modeling reactive systems, as they emphasize not only "good" modeling in system development but also "easy" execution, debugging, analysis of the resulting models, and translation into working code for software and/or hard-

ware [46]. With the support of a specialized modeling environment, such as Esterel Studio or MATLAB Simulink/Stateflow, a model can be executed, *i. e.*, simulated, by emulating the environment of the system under development and letting the model react accordingly. In particular, a model can be simulated interactively (step-by-step) or by batch execution. The modeling environment generates an animation of the diagrams by highlighting currently active states and activities. The possibility to simulate only part of a model allows for early testing. Furthermore, external code may be attached to a model to produce input stimuli or simply to augment the model. After a model has been constructed, successfully simulated, and satisfactorily tested, it can be translated automatically—with help of the development environment—into high-level programming language code (*e. g.*, C, Ada) or into a hardware description (*e. g.*, VHDL).

In summary, statecharts provide a powerful set of communication and abstraction mechanisms for structuring a reactive program as a well-scaling collection of interacting components [2]. In conjunction with a progressive development environment, they also permit to simulate the modeled system behavior. Due to the overarching development process as well as their strong intuitiveness, statecharts certainly surpass textual reactive system descriptions.

Chapter 3

Automated Theorem Proving

From the ancient Greek philosophers' syllogisms to present-day automated theorem proving, the field of logic and reasoning has undergone a significant development. Hence, the chapter is commenced by a historical introduction, which traces automated theorem proving back to its mathematical roots at the early beginning of the 20th century. This is followed by a detailed presentation of the validity problem and its dual, satisfiability. The satisfiability problem is then generalized to yield the satisfiability modulo theories (SMT) problem. After a presentation and characterization of several SMT solvers, the chapter is concluded by the selection of a tool, most suitable for solving SMT problems arising from the semantic robustness analysis of statecharts.

3.1 Historical and Introductory Remarks

As part of automated reasoning, the area of *automated theorem proving (ATP)* deals with the development of efficient algorithmic methods for finding proofs for mathematical formulae that are true and providing a counterexample for those that are not true. This problem of proving the *validity* of a theorem or formula traces back to Hilbert's *tenth of 23 mathematical problems*, which he originally presented at the International Congress of Mathematicians in Paris in 1900 [47]. The *tenth problem* addresses whether or not all Diophantine problems¹ have a solution. Seventy years later, Matiyasevich proved that this is not the case [69].

¹A *Diophantine equation* is a polynomial equation that only allows integer-variables. *Diophantine problems* have fewer equations than unknown variables and involve finding integers that satisfy all equations.

Depending on the underlying logic, the problem of deciding the validity of a theorem varies from trivial to impossible. For propositional logic², the problem is decidable, but NP-complete, *i. e.*, only exponential-time algorithms are believed to exist. When dealing with first-order logic³, there are two historical results of central importance: Gödel's completeness theorem [39] and Church's undecidability of validity [23].

Gödel's completeness theorem asserts that there are logical calculi in which every true formula is provable. An example of this is Presburger's first-order theory of the natural numbers⁴, which was introduced in 1929. It is a model of arithmetic containing addition, but not multiplication [88]. Presburger-arithmetic is sound and complete, *i. e.*, it does not contain contradictions and every statement can either be proven or disproven. This is in contrast to, *e. g.*, Peano's undecidable first-order theory of the natural numbers, which also includes multiplication.

Church's undecidability of validity theorem was formulated in 1936 and solved the famous *Entscheidungsproblem*, a generalization of Hilbert's *tenth problem*. Church's theorem asserts that there is no decision procedure (that always terminates) for deciding whether a formula in first-order logic is valid. In the same year, Turing independently also proved the *Entscheidungsproblem* undecidable [106]. While Church's proof received less attention, Turing's approach, solving the halting problem for Turing machines along the way, became highly influential. Still, both proofs separately imply that the general first-order theory of the natural numbers expressed in Peano's axioms cannot be decided with any algorithm.

Combining Gödel's and Church's theorems, it follows that any valid first-order theorem can eventually be proven, given unbounded resources. Invalid statements, on the other hand, cannot always be recognized. In these cases, first-order theorem provers fail to terminate. Nevertheless, first-order theorem proving is one of the most mature subfields of

²Propositional logic is a logic in which the only objects are propositions, *i. e.*, objects which themselves have truth values. Variables represent propositions, and there are no relations, functions, or quantifiers except for the constants *true* and *false*. Typically, the connectives are \land , \lor , \neg , and \rightarrow (representing negation, conjunction, disjunction, and implication, respectively) [38].

³First order logic, also referred to as predicate logic or predicate calculus, is an extension of propositional logic with separate symbols for predicates, subjects, and quantifiers (\forall and \exists). For example, where propositional logic might assign a single symbol P to the proposition "All men are mortal," predicate logic can define the predicate M(x), which asserts that the subject x is mortal and bind x with the universal quantifier: $\forall x, M(x)$.

⁴With the tools of first-order logic it is possible to formulate a number of theories, with explicit axioms or by rules of inference, that can themselves be treated as logical calculi. Arithmetic is the best known of these; another example is set theory.

automated theorem proving, as the logic is expressive enough to allow the specification of arbitrary problems, often in a reasonably natural and intuitive way. Despite its limited decidability, practical theorem provers can solve many hard problems in first-order logic. Moreover, fully automated systems can be constructed for a number of sound and complete calculi, *e. g.*, the abovementioned Presburger-arithmetic. However, rather than proving a formula's validity directly, the undermentioned most influential and powerful ATP algorithms have always sought after determining a formula's *satisfiability*—a dual problem [38].

Since the 1994 Pentium FDIV-bug⁵, automated theorem proving has become a significant part of industrial integrated circuit design and verification. Industry leaders such as AMD, IBM, Intel, Motorola, and Sun use automated theorem proving to verify the operations of their modern microprocessors [54]. Program analysis through theorem proving has also become part of the development of large-scale safety-critical systems, *e. g.*, designed for the Airbus A380 or Ariane 5 [51].

3.2 Satisfiability: Theory and Algorithms

Two distinct forms of the satisfiability problem are presented below: the classic *boolean* satisfiability problem and the more recent and more general satisfiability modulo theories problem. In both cases, it is true that a proposition A is satisfiable, iff (if and only if) $\neg A$ is not valid. This was formally proven by Gallier [38, page 43].

3.2.1 Boolean Satisfiability Problem

As the dual of propositional theorem proving, the *boolean satisfiability (SAT)* problem is the simplest form of theorem proving. It holds an important place in various areas of computer science, including artificial intelligence, automatic verification of programs, and hardware circuit synthesis [110]. Alongside, SAT is the first problem which has been shown to be *NP*-complete [53, original proof in 24]

Boolean satisfiability is the problem of determining whether there is an assignment of truth values to the variables of a formula of propositional logic for which that formula

⁵FDIV is the x86 assembly language instruction for floating point division. Intel officially refers to the bug as the "Floating Point Flaw in the Pentium Processor" [see 50, the official Intel white paper on the "Statistical Analysis of Floating Point Flaw"].

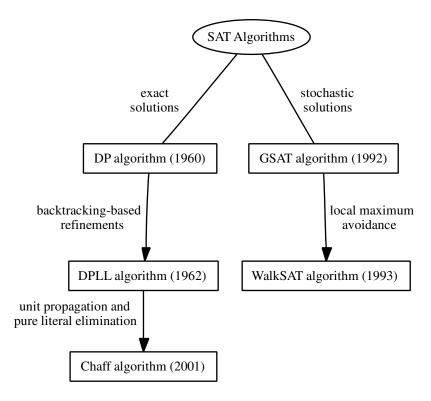


Figure 3.1: Historical overview of algorithms for solving the boolean satisfiability problem.

evaluates to *true*. More formally: Let P be a fixed finite set of propositional symbols; a truth assignment M is a set of literals such that $\forall p \in P, \{p, \neg p\} \subseteq M$. A clause C is true in M if at least one of its literals is in M. Then a formula F is satisfied or modeled by M, denoted by $M \models F$, if all of F's clauses are true in M. F is unsatisfiable iff it has no models [81]. Formulae are generally required to be in conjunctive normal form (CNF), i.e., a conjunction of clauses, where a clause is a disjunction of literals⁶.

As shown in Figure 3.1, modern-day exact algorithms for solving SAT problems can be traced back to the vintage 1960 Davis-Putnam (DP) [27] and 1962 Davis-Logemann-Loveland (DPLL) [28] algorithms. Over the years, a vast research community has streamlined and upgraded the DPLL algorithm to yield enormously powerful tools, *e. g.*, Chaff [74], capable of solving problems of tremendous size: more than one million variables and more than 10 million clauses. Moreover, stochastic algorithms, having the power to outperform Chaff by an order of magnitude on certain types of problems, have been developed in the 1990s [95, 96].

⁶A literal is an atom or the negation of an atom; atoms are the most elementary building blocks of formulae, with respect to the underlying logical calculus.

3.2.2 Satisfiability Modulo Theories Problem

Since many satisfiability problems arising from real-life applications cannot be easily expressed in propositional logic, a more universal, problem-oriented, though still decidable, underlying theory is required [81]. For example, the properties of timed automata are naturally expressed in difference logic, where formulae contain atoms of the form $a-b \le k$, which may be interpreted with respect to a background theory T of real or integer linear arithmetic. Other common background theories, for which specialized decision procedures exist, are the theories of lists and arrays, bit-vectors, and the logic of equality and uninterpreted functions. Since arithmetic, lists, and arrays are ubiquitous in computer science, it seems very natural to consider satisfiability problems *modulo* the theory T of these data structures. Background theories are predominantly expressed in classical first-order logic with equality. Only those theories, for which satisfiability is actually decidable, are considered, though [5].

Problems may be composed of the conjunction of thousands of clauses like

$$\neg p \quad \lor \quad y = g(x-z) \quad \lor \quad send(s, g(x-7)) \le a,$$

where $\neg p, y = g(x-z)$, and $send(s,g(x-7)) \le a$ are literals. The *satisfiability modulo theories* (*SMT*) problem, the dual of first-order theorem proving, determines the satisfiability of such a formula F' with respect to a certain background theory T: Given F', determine whether F' is T-satisfiable, or in other words, whether there exists a model of T that is also a model of F'. Similar to the SAT problem above, F' is satisfied by a truth assignment M', denoted by $M' \models F'$, *i. e.*, M' is a T-model of F', if all clauses of F' are true in M'. F' is T-unsatisfiable *iff* it has no models in T. The set P' over which formulae are built is a fixed set of variable-free first-order atoms [81].

Two fundamentally different approaches for solving SMT problems exist today: the eager and the lazy approach. The eager approach converts the input formula within a single step into an equi-satisfiable propositional CNF formula. Although sophisticated ad-hoc translations exist for many theories, translators or SAT solvers run out of time or memory on many practical problems. If successful, this procedure is still several orders of magnitude slower than the undermentioned lazy approach to SMT [81]. The widely successful lazy approach to SMT was introduced by Armando and Giunchiglia in 1993 [3]. The basic idea is that of managing the search for a model via an existing efficient SAT algorithm, e.g., the DPLL algorithm, and delegating first-order reasoning to an appropriate T-solver [4]. Accordingly, each atom of a formula F' to be checked for T-satisfiability is simply regarded as a propositional symbol, "forgetting" temporarily

about the theory T. In this sense, the boolean abstraction of F' is checked for propositional satisfiability by a SAT solver. If the SAT solver reports unsatisfiability, then F' is T-unsatisfiable. Otherwise, the SAT solver returns a propositional model M^* of F'. This model, a conjunction of literals, is checked by a T-solver. If it is found T-satisfiable, then M^* is a T-model of F'. Otherwise, the T-solver builds a clause C which precludes M^* . The clause C could simply be the negation of M^* , but a smaller clause will lead to a more efficient algorithm. Subsequently, the SAT solver is started again with $F' \wedge C$ as input. This process is repeated until the SAT solver finds a T-satisfiable model or returns unsatisfiable [81].

3.3 Selection of an SMT Solver for Semantic Robustness Analysis of Statecharts

As mentioned in Chapter 1, the semantic robustness analysis of statecharts presented in Section 5.3, is based on automated theorem proving, particularly the satisfiability modulo theories problem. Accordingly, an SMT solver needs to be selected for this purpose. Therefore, a thorough survey of today's general-purpose SMT solvers—all currently under active development—was conducted. A brief characterization followed by a qualitative assessment of the considered tools is given below. On this basis, the most suitability SMT solver is finally chosen for integration into the *KIEL* framework.

3.3.1 Overview of SMT Solvers

Of the tools presented below, UCLID is the only SMT solver that has not participated in the first *Satisfiability Modulo Theories Competition* [10, 94], held in 2005, where SMT solvers competed against each other in seven categories covering different quantifier-free background theories. The categories are (1) uninterpreted functions, (2) real difference logic, (3) integer difference logic, (4) uninterpreted functions and integer difference logic, (5) linear real arithmetic, (6) linear integer arithmetic, and (7) arrays, uninterpreted functions and linear integer arithmetic. Not every tool necessarily competed in every category, though. According to the competition's organizers, each category comprised of approximately 50 SMT problems, ranging from "easy" to "hard." The results of the linear integer arithmetic category are shown in Figure 3.2 [11]. This category is of particular interest w. r. t. the semantic robustness analysis of statecharts.

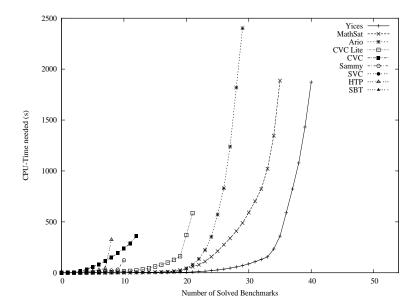


Figure 3.2: Results of the linear integer arithmetic category at the 2005 *Satisfiability Modulo Theories Competition* [11].

UCLID: Developed at Carnegie Mellon University, UCLID [18, 97] is the only (moderately) successful implementation of an SMT solver that follows the *eager* approach to SMT. The tool is capable of verifying formulae over equality and uninterpreted functions and integer linear arithmetic. UCLID is implemented in Moscow ML as a standalone decision procedure.

CVC Lite: In contrast to all other tools presented here, CVC Lite (CVCL) [8, 25] determines the validity of a formula, not its satisfiability. The open-source C++ implementation of decision procedures for a subset quantifier-free first-order logic is being developed by the Formal Verification Group at Stanford University and the Analysis of Computer Systems group at New York University. As a second reimplementation, CVC Lite supersedes the Cooperating Validity Checker (CVC) [99], which is in turn the successor the Stanford Validity Checker (SVC) [9]. The tool combines decision procedures for a multitude of theories including arrays, aggregate datatypes such as records and tuples, real and integer linear arithmetic, and bit-vectors. Uniquely, CVCL can be used in two modes: as a C/C++ library, and as a command-line executable (implemented as a command-line interface to the library). CVC Lite participated in all seven categories at the 2005 SMT competition [94]; scores were generally in the mid-field.

DPLL(T): As part of the *BarcelogicTools*, DPLL(T) [7, 81] is developed at the Technical University of Catalonia in Barcelona. The tool's modular implementation utilizes a general DPLL(X) engine—a slightly modified implementation of the DPLL algorithm [27, 28]—that is instantiated with a specialized theory solver T. DPLL(T) makes extensive use of the T-solver's capabilities, using it *a priori* to guide the SAT solver to a correct model. The highly efficient C-implementation currently supports difference logic over the integers and reals, equality and uninterpreted functions, as well as combinations of these theories. The tool won all four categories it participated in at the 2005 SMT competition [94].

MathSAT: MathSAT [17, 66], built on top of the MiniSAT [33] DPLL implementation, is a product of the Trentino Cultural Institute in Trento, Italy. The tool, programmed in C++, can decide the SMT problem for various background theories, including equality and uninterpreted functions, linear arithmetic over the integers and reals, as well as combinations of these. Contrary to most other SMT solvers, MathSAT accepts input formulae in non-clausal form, that may even include *if-then-else* constructs over non-boolean terms. A pre-processor translates the formula into conjunctive normal form in linear-time. At the 2005 SMT competition [94], MathSAT participated in six of the seven categories, receiving average scores.

Yices: One of several SMT solvers developed at the Computer Science Laboratory of SRI International (formerly the Stanford Research Institute), the prototype Yices [109] performed surprisingly well at the 2005 SMT competition [94], coming in first in two categories and second in the remaining five categories. Implemented in C++, the tool decides satisfiability for real and integer linear arithmetic, equality and uninterpreted functions, recursive datatypes, tuples and records, arrays, and lambda expressions.

3.3.2 Selection of SMT Solver

Table 3.1 provides an overview of the characteristics and availability of the aforementioned SMT solvers. In order to decide on the most suitable tool for solving the SMT problems arising in the context of semantic robustness analysis of statecharts, the following considerations were made: The selected tool must integrate smoothly into the KIEL framework, which implies executability on Linux as well as on Windows (cf. Section 6.1). This immediately eliminates all solvers except DPLL(T) and CVC Lite.

SMT Solver	Approach	Integer Arithmetic	Real Arithmetic	Linux		Windows		Open- Source
				Bin	Lib	Bin	Lib	
UCLID	Eager	+	_	+	_	_	_	_
CVC Lite	Lazy	+	+	+	+	+	+	+
DPLL(T)	Lazy	+	+	+*	_	+*	_	_
MathSAT	Lazy	+	+	+	_	_	_	_
Yices	Lazy	+	+	+	_	_	_	_

Table 3.1: Classification of SMT solvers

Moreover, both of these tools are able to handle the required SMT discipline of difference logic over the integers and reals. Judging by the results of the 2005 SMT competition [11, 94], it seems that DPLL(T), the tool that won all four categories it participated in, is the clear choice. On the other hand, the benchmark assessment of the SMT competition must not be mistaken for a universally valid metric for these tools, though. In general, the interpretation of benchmarking data is extraordinarily difficult. For example, in the case of the 2005 SMT competition, tools were ranked according to their performance in solving *difficult* problems. In their report, however, the organizers mention that in some categories the problems must have been easier than in others, considering the number of correct answers [10]. In judging the results, one should be aware of the general difficulty of defining and identifying "hard" problems [22, 72].

Irrespective of such intricacies, great numbers of very small and simple SMT problems must be solved in the present work. Accordingly, the call to the decision procedure must be fast. Due to the minimal size of the arising problems, the actual time to decide the satisfiability is almost negligible. Here, CVC Lite has the upper hand due to its availability as a C/C++ library, allowing for efficient access. As *KIEL* is implemented in Java, the library cannot be called directly, though, but only via the Java Native Interface (JNI) [101], as presented in Section 6.2.

The finally deciding aspect, however, was that DPLL(T) is available only as an expiring executable. Since new versions of the tool are subject to significant changes, maintenance far beyond the scope of this thesis would be necessary. Accordingly, CVC Lite emerges as the tool of choice, with the additional bonus of open-source availability.

^{*}The executable expires after approximately two months.

Chapter 4

Automated Software Error Prevention

The software engineering dream of error-free software delivered on time and within budget is almost as old as software itself. In 2003, Hoare re-proposed the goal of automatically verified software as a grand scientific challenge¹ for computing, originally suggested in 1969, but abandoned in the 1970s [48]. As automated software error prevention is the main theme of the present thesis, this chapter is concerned with exactly that topic: First, an introduction and disambiguation of style checking terminology within the context of automated software error prevention are given. Following, the state-of-the-art of style checking in textual computer programming is described, before turning to style checking in statecharts.

4.1 Introduction and Disambiguation of Terminology

Software error prevention encompasses a number of different techniques designed to identify programming flaws. It has thus become an important part of the certification process required for (real-time) safety-critical systems, since the failure of such systems—attributable to programming flaws—can often cause loss of human life or property. Numerous times during such certification processes, it has been observed

¹Grand challenges in science or engineering are proclaimed in order to distinguish certain projects from the many other kinds of short-term or long-term research problems. A grand challenge "represents a commitment by a significant section of the research community to work together towards a common goal, agreed to be valuable and achievable by a team effort within a predicted timescale. . . . A grand challenge may involve as much as a thousand man-years of research effort, drawn from many countries and spread over ten years or more" [48, page 63].

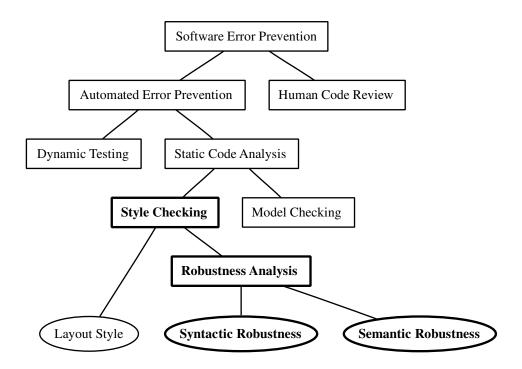


Figure 4.1: Software Error Prevention and its branches.

that "reviewers spent much too much of their time and energy checking for simple, application-independent properties, [distracting them] from the more difficult, safety relevant issues," in this case stated by Parnas [87, page 155] about the certification of a nuclear power plant. The statement refers to human code reviews, which, though time-consuming and highly dependent upon expertise and concentration, may sometimes find conceptual problems that are impossible to detect automatically. Taking part of the burden off the reviewers, as well as off the designers, and letting a computer perform preliminary checks, is the rationale for *automated error prevention*. Expert knowledge codified in tools is an additional benefit resulting from this automation.

Automated error prevention is commonly separated into dynamic and static methods [65], as outlined in Figure 4.1. *Dynamic testing* performs code evaluation while executing the program and attempts to detect deviations from expected behavior; *static code analysis*, on the other hand, performs an analysis of computer software without actual execution of programs, but by assessing source or binary files to identify potential defects. It thus allows for statements about all possible program executions rather than just one test-case execution. Moreover, while dynamic testing requires executable code, static methods can be applied much earlier in the development process. Static code analysis covers examinations ranging from the behavior of individual statements and declarations to the complete source code of a program. Use of the information obtained

from the analysis varies from highlighting possible coding errors to formal methods that mathematically prove properties about a given program, *e. g.*, that its behavior matches that of its specification, commonly known as *model checking*. The primary application area of static code analysis is the verification of safety-critical computer systems. It is considered vital for defect detection during analysis and design. However, it should always be used in conjunction with (and not as a replacement for) software testing, *i. e.*, static code analysis is "necessary but not sufficient" [65, page 1]. It does certainly not replace runtime access controls, systematic testing, careful security assessments, and a solid high-level design [36].

Style checking, another aspect of static code analysis, is concerned with layout style, *i. e.*, common appearance, as well as syntactic and semantic style. The later two are often collectively referred to as robustness analysis (see below). Layout style and robustness analysis are clearly distinguished within the realm of this thesis, as will be pointed out in the sections to follow. Style checking always requires the syntactic and semantic soundness of the code, as it typically contains guidelines on issues that do not directly affect correctness, but rather try to reveal common sources of errors: If there are less sources for errors, there should be less errors. Roughly 80% of the lifetime cost of a piece of software goes to maintenance [102], and hardly any software is maintained for its whole life by the original author. Therefore, style checking is especially important in large software projects.

Robustness² analysis, as an important field of style checking, refers to "the process of checking a design against a [defined] set of design rules, with the objective of eliminating certain types of errors and enforcing sound engineering practices" [40, page 17]. Robustness rules limit the general range of a given modeling/programming language, as they are entirely independent of what is being designed. By these means, a *subset* of the programming language is specified which—though less comprehensive and flexible—is considered to be also less error-prone [42, 75]. Hence, robustness analysis is a preventive instrument and substantially draws from the knowledge and understanding of software implementation flaws [36].

²Robustness, from the Latin *robustus*, meaning oaken or strong, indicates a property of strength, vigor, or firmness, or being of strong form or construction [34].

³This use of the word robustness must be clearly distinguished from other connotations, *e. g.*, robust control or robust design. Robust control aims at designing controllers so that they function correctly not only for a well-known design model, but also for (real) systems, whose dynamics deviate within certain boundaries from the dynamics of the model. Robust design, where robust may either describe robust data structures or robustness checks of implementations, with the aim of retaining the proper functioning of programs in the presence of hardware malfunctions and failures.

Coding standards, also called programming style guides, contain a list of rules used for style checking which have been gathered from common sense and collective engineering experience to describe conventions for writing source code in a certain programming language. A coding standard commonly consists of a set of programming rules (e. g., "Do not compare two floating point numbers."), naming conventions (e. g., "Classes should start with capital C.") and layout specifications (e. g., "Indent 4 spaces."). The development of coding standards is typically approached by first conducting a survey of available source material (e. g., common programming experience), then filtering and adapting the compiled information into rules, and finally subjecting the resulting material to expert review and revision [cf. 76]. As rules are likely to originate from subjective preferences, some of the contents of a style guide may only be advisory, while some must be considered mandatory. Still, there are typically means by which the programmer can indicate the he/she is aware of the rule, but is infringing it intentionally.

To automate style checking, specialized *code checking tools* have been developed. Such tools analyze whether a piece of software adheres to a certain coding standard. Code checkers are commonly employed as the number of rules in a coding standard is usually too large for anybody to remember. Moreover, some context-sensitive rules demand inspection of several files at once and are thus very hard to check for humans. Although code checkers can reduce formal code review time considerably, it certainly does not mean that human code reviews are obsolete.

Several characteristics can be applied to distinguish available code checkers [104]:

- **Possibility to define new rules:** Code checkers do not necessarily fully cover proprietary coding standards. As a consequence, it should be possible to define new rules, either via an API (complex to use, but powerful) or a graphical user interface (easy to use, but limited).
- **Integration in programming IDE:** As most end-users of code checkers are software engineers, the code checker should fit smoothly into the used programming environment, preferably running in the background at all times.
- **Presence of command-line version:** In order to be able to integrate the code checker into the software development process and/or into the programming IDE (if no immediate plug-in is available), the checker should be command-line based.
- **High performance:** Code checkers inherently perform a thorough, hence time-consuming, syntactical and semantical analysis of source code. However, high performance is a key issue in end-user acceptance.

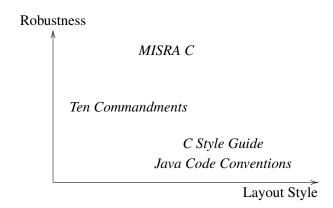


Figure 4.2: Classification of coding standards according to their emphasis of layout style vs. robustness.

4.2 Style Checking in Textual Computer Programming

In classical, *i. e.*, textual, computer programming, style checking has long found its way into the software development lifecycle. A multitude of coding standards and related code checking tools exits. Drawing from this large body of work, an exemplary selection of coding standards and checking tools is discussed in the following.

4.2.1 Coding Standards

Since programming style is often dependent on the actual choice of programming language, different coding standards exist for different programming languages. The most commonly applied coding standards for C include NASA's C Style Guide [29], MISRA's Guidelines for the Use of the C Language in Critical Systems (MISRA-C:2004) [75], and The Ten Commandments for C Programmers [98]; Java's dominant coding standard are Sun's Code Conventions for the Java Programming Language [102]. Figure 4.2 roughly classifies these standards according to their emphasis of layout style vs. robustness—a major distinction within style checking, as introduced in Section 4.1.

C Style Guide: The C Style Guide [29] contains recommended practices and advice on style for programmers using the C language. These guidelines are based on generally recommended software engineering techniques, industry resources, and local conventions. They offer preferred solutions to common C programming issues, illustrated through examples of C code. The document recommends a style for writing C programs, where code with "good style" is defined as that which is "organized, easy to read, easy

to understand, maintainable, [and] efficient" [29, page 1]. Guidelines for organizing the content of C programs, files, and functions are provided and the structure and placement of variables, statements, and comments is discussed.

Guidelines for the Use of the C Language in Critical Systems: MISRA C [75], first published in 1998 with a strong focus on the automobile industry and later extended to cover a more general scope of safety-critical system development [75, 76], is the British Motor Industry Software Reliability Association's style guide for the C programming language, currently containing 121 required and 20 advisory rules on programming style, i. e., forbidden layouts and allowed code structures, restrictions on which syntactic items of C should be used, stringent type checking rules, as strong typing is not part of C, but may help maintain a clearer design, and restrictions on ambiguous structures that can be subject to compiler interpretations and mistakes. Overall, these rules are aimed at three important aspects of the code, namely portability, reusability, and testability. Due to their comprehensiveness and maturity acquired over the past decade, the MISRA rules have become the established standard for the development of safety-critical systems all over the world.

Ten Commandments for C Programmers: Even the hacker community has established its own set of coding conventions, the slightly quirky Ten Commandments for C Programmers [98]. In a list of ten rules, good programming standards in C are compiled, involving suggestions such as the usage of Lint (see below), avoiding null pointers, correct type casting, and so on. Albeit its queer appearance, the establishment of the standard illustrates the importance of sound programming practices even in the realm of freelance and open-source programming.

Code Conventions for the Java Programming Language: Sun's Code Conventions for the Java Programming Language [102] are the conventions that the inventors of Java recommend for all programmers. The brief document contains rules on filenames, file organization, indentation, comments, declarations, statements, white space, naming conventions, programming practices, and also includes an example of "good" code. Although others exist, these conventions have established themselves over the years.

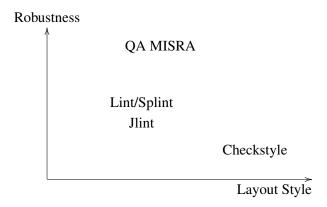


Figure 4.3: Classification of code checking tools according to their emphasis of layout style vs. robustness.

4.2.2 Code Checking Tools

Akin to coding standards, most code checking tools are programming language-specific. Available code checkers for C include Lint [52] (Sun Microsystems), its extension LCLint, now known as Splint [36] (University of Virginia), and QA MISRA [91] (Programming Research). Code checkers for Java are the open-source projects Jlint [6] and Checkstyle [20]. Figure 4.3 roughly classifies these code checkers according to their emphasis of layout style vs. robustness.

Lint and Splint: Originally developed and released in 1979 as part of Bell Labs' UNIX operating system, Lint [52] is nowadays distributed and maintained by Sun Microsystems. Lint extensively examines the source code of C programs for consistency and plausibility. According to the authors, Lint is intended to "encourage better code quality, clearer style, and may even point out bugs" [52, page 4]. Today, Lint has been superseded by is extension Splint [36], which comes with its own, extendable set of coding rules. Originally designed as a command-line tool, Splint can be efficiently integrated in state-of-the-art programming IDEs. In particular, the tool checks for unused variables, functions, function arguments, and return values, as well as uninitialized variables and unreachable fragments of code. It also enforces the type checking rules of C much more strictly and across file boundaries than most compilers.

Lint was introduced at a time when computing power was a rather limited resource. Compilers were designed with the supreme goal in mind to quickly produce fast code. The compilers were fast because they did not perform much checking, and the code was fast because the compilers did not generate many run time checks. Using Lint, program-

mers, for the first time, were able to protect themselves against producing error-prone code. Nowadays, many of the mentioned checks can be done by a modern compiler, if the user so desires, e.g., gcc -Wall [37]. However, even today, a compiler is supposed to rapidly generate efficient code. Therefore, the compiler definitely should not do too much checking at compile time and should also not generate too many run-time checks. Furthermore, the compiler checks are neither customizable nor extendable. For example, gcc -Wall issues no warning for a statement such as a[i] = b[i++], where the execution order is undefined. Rather, it is Lint's job to do so.

QA MISRA: As part of Programming Research's static analysis toolkit, QA MISRA [91] is a powerful, commercially developed, and industrially adopted solution for MISRA C compliance checking. The tool analyzes source code and detects constructs, which do not comply with the MISRA C rules. Rule violations are clearly identified in annotated source code. Warning messages usually include a suggestion of alternative MISRA compliant code as well as a cross-reference to the definition of the infringed rule. QA MISRA further allows users to tailor or add checks appropriate to individual company standards or other conventions. The tool, however, cannot be used outside of Programming Research's proprietary IDE.

Jlint: Jlint [6] performs syntactic checks and dataflow analysis on Java bytecode. The tool also builds a lock graph in order to find possible deadlocks in multithreaded applications. It is easy to run from the command-line or from within many programming IDEs, and it is very fast to execute. Jlint's downside is that its rule-set cannot easily be expanded.

Checkstyle: The extremely adaptable tool Checkstyle [20] efficiently verifies Java source code against any given or personal coding standard, naturally including Sun's Java code conventions. New rules can easily be added and flexibly managed. A command-line version as well as plug-ins for all common programming IDEs are available.

4.3 Style Checking in Statecharts

Statechart style checking is much less developed and less sophisticated as compared to style checking in textual computer programming. In modeling and analysis of the

dynamics of (safety-critical) reactive systems, it is, however, all the more important that models are designed according to approved rules. This achieves not only a homogeneous modeling and layout of statecharts within projects, but also ensures that best practices, tool specific optimizations, and domain or company specific conventions are observed. Checking these rules automatically, the developer can be released from identifying oversights and simple syntactic or semantic errors and, additionally, the model transfer between various CASE tools can be simplified [43, 58, 59, 78, 80].

Although the commercial statechart modeling tools, Esterel Studio, MATLAB Simulink/Stateflow, and Statemate, have been supplemented with a number of consistency checks, Mutz and Huhn [80], von Hanxleden [43], and Kossowan [58] point to the following main deficiencies in style checking capabilities of statechart modeling tools: (1) Analyses are tool-specific. (2) Analyses are inalterable, i. e., rules are neither extendable, individually selectable, nor parametrizable. Thus, the user has to adhere to the set of rules as implemented in the tool. (3) The scope of the rules checked by tools varies from rudimentary analysis to advanced model checking. (4) In Esterel Studio, for example, checking cannot be invoked explicitly, but is part of the simulation or code generation. Moreover, certain checks cover merely those parts of the statechart that are actually reached by the control flow of the current simulation (non-static analysis). These shortcomings motivated many large industrial companies, where statecharts have long become an integral part of software development, to devise team- and domain-specific pattern collections in an effort to harmonize solutions for prevalent design problems [80]. Three such collections and four appendant checking tools are briefly characterized below. These checking tools as well as the style checker developed within the context of this thesis, the KIEL Checking plug-in, are roughly classified according to their emphasis of layout style vs. robustness in Figure 4.4.

Mint: The commercial MATLAB Simulink/Stateflow add-on Mint [93], distributed by the Ricardo Company, checks the style guide of the MathWorks Automotive Advisory Board (MAAB) [67]. The more than 100 MAAB rules, developed by Ford, Daimler Benz (now DaimlerChrysler), and Toyota in the late 1990s, primarily aim at achieving a consistent look-and-feel, enhancing readability, and avoiding common modeling errors. The rules go as far as specifying a certain background color for the Simulink environment and even give advice on project and model filenames. A few simple robustness rules regarding, *e. g.*, the scope of events, are also part of the checks. Mint features an interactive GUI frontend as well as an open API which allows for additional custom checks. The MAAB rules as well as Mint are specific to the MathWorks tool suite.

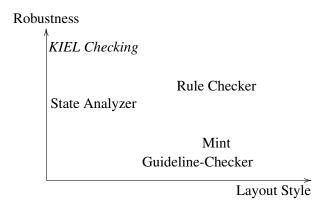


Figure 4.4: Classification of statechart style checking tools according to their emphasis of layout style vs. robustness.

Guideline-Checker: Intended as a no-cost/academic alternative to Mint, the Guideline-Checker results from a cooperation between DaimlerChrysler and the University of Applied Sciences in Esslingen [77]. The checking tool, which is based on the MAAB rules and coded in MATLAB, emphasizes modifiability and extensibility of the rule set. However, existing checks can only be modified and new ones added by directly manipulating the MATLAB code. Although the checked rules are individually selectable, they cannot be parametrized at runtime. The range of the Guideline-Checker is currently constricted to the most trivial checks, *e. g.*, "A [state] name does not include a blank," or "A [state] name consists of [at least] 3 characters" [77, page 26]. Sightly more complicated rules, *e. g.*, the uniqueness of state names, cannot be checked automatically. It has been further criticized that the tool only applies to the MathWorks family, with function queries and access to the internal representation mixed up [80].

State Analyzer: The State Analyzer, also developed within DaimlerChrysler's R&D, is a prototypical software tool to check the "determinism" of statecharts [41, 58]. Performing an automated robustness analysis of requirements specifications, the tool verifies that for every state, the predicates (trigger and condition) of multiple outgoing transitions are pairwise disjoint. The approach for detecting non-determinism employs automated theorem proving (see Chapter 3), *i. e.*, proving the satisfiability of a formula consisting of the conjunction of each pair of transition predicates. More specifically, the tool tests whether there is a pair of transitions which may be enabled simultaneously. For this automated consistency analysis, the Stanford Validity Checker (SVC), an off-the-shelf theorem prover (as discussed in Section 3.3), is employed. The consistency check, thus, necessitates that the Statemate transition labels are transformed to SVC

syntax. The tool is described to require only minimal effort to get familiar with, to scale well to large models, and its analysis results to be compositional, as results from the analysis of one subsystem are not sensitive to modifications of other subsystems.

Rule Checker: At the Technical University Braunschweig, Mutz and Huhn have developed a tool for the automated analysis of user-defined design rules for UML state machines, which can handle statechart models created by various UML modeling tools [79, 80]. They pursue an analysis based on the Object Constraint Language (OCL) [82], which they use to formulate rules and queries independent of the underlying data structure. This advantage is, however, bought at the cost of not being able to address graphical information. Hence, using OCL, it cannot be analyzed, e.g., whether the initial state is located in the upper left corner of a statechart. Rules pertaining to graphical information must, therefore, be implemented directly in Java. Specifically, the tool is capable of checking rules from the following four areas: (1) consistency rules, i. e., rules that verify the syntactic and semantic correctness of statecharts; (2) modeling rules, i. e., rules that address the positioning of states and labels, the layout and direction of transitions, and other aspects to improve homogeneity and readability; (3) compatibility rules, i. e., constraints that secure the exchange of models between different development environments; and (4) dialect-specific rules, as some dialects support intrinsic modeling constructs.

Due to the UML standard, the tool allows to import and export statecharts in the XML Metadata Interchange (XMI) format [83]. The user can configure the rule checker according to his/her needs by activating, deactivating, and parametrizing nearly 100 design rules. The tool then informs about problems and rule violations. New rules can be added either in Java or OCL, allowing for checks of widely accepted "best practices" as well as individual preferences on different statechart notations. Models can be analyzed with respect to their conformance to a standard and their compatibility to other CASE tools. Additional functions of Mutz and Huhn's tool include a tree-like representation of statecharts, advanced error and exception handling, automated and configurable report generation, a dynamic manual, and mechanisms for rule declaration and parametrization.

In summary, none of the presented tools entirely lives up to expectations. The two tools developed at DaimlerChrysler as well as Ricardo's Mint all address only a single state-chart dialect. Mint, the Guideline-Checker, and the Rule Checker merely perform graphical and—partly trivial—syntactic checks, but not profound semantic checks which re-

quire automated theorem proving as realized in the State Analyzer. However, semantic checks are particularly important since they eliminate possible non-trivial sources of error, which are very hard to discern for humans. Thus, the semantic checks, put forth in the next chapter of this thesis, aspire to fill the gap. The positioning of the *KIEL Checking* plug-in within Figure 4.4 further emphasizes this intention.

Chapter 5

A Proposal for Style Checking in Statecharts

Building on the aforementioned theoretical foundation, practical know-how, and available prototypes, this thesis set out to define a comprehensive statechart style guide, striving at applicability to all statechart dialects, present and future, within the limits of the UML state machines specification. Further, a corresponding automatic checking framework was implemented as part of the *KIEL* [55] statechart modeling tool, assuring flexibility and independence from any particular modeling tool.

As Buck and Rau correctly notice, it is essential that software developers recognize a style guide "as a means of support rather than a burden or evil management scheme to limit their freedom and suffocate their creativity" [19, page 22]. In order to promote acceptance, Buck and Rau give the following recommendations on formulating style guide rules:

Clarity: The meaning and motivation of all guidelines must be understandable for all developers.

Minimality: Each guideline should only cover one aspect to facilitate conformance testing and limit the rippling effect of guideline-changes.

Consistency: The whole set of guidelines must be consistent, *i. e.*, adhering to guideline *A* must not lead to breaking guideline *B*. Where mutually exclusive guidelines exist they should be clearly marked as such.

39

- **Consensus:** Guidelines must not be imposed as laws from upper management. Instead, the developers should be involved in their definition and/or the tailoring process (see "Adaptability").
- **Flexibility:** Guidelines can only try to capture "best practices" that apply to the majority of cases. Thus, it must be possible to deviate from them in well-justified cases.
- **Adaptability:** Every project has slightly different needs. Therefore, it must be possible to tailor project specific guidelines from a generic set. To facilitate this, the scope, priority and dependencies between guidelines must be documented.
- **Stability:** Guidelines must not be changed frequently. Otherwise, developers will need to spend excessive time to keep up with the changes and update their work and eventually become frustrated.
- **Testability:** Like requirements, guidelines are useless if conformance with them cannot be tested, either manually in a review or automatically using tools.

- Buck and Rau [19, page 22f.]

This advice was followed in formulating the robustness rules for statecharts described below. First, however, a well-structured taxonomy for style checking in statecharts is presented.

5.1 Taxonomy for Style Checking in Statecharts

In the general context of static code analysis, a clear and clean separation must be made between syntactic and semantic correctness on the one hand and style checking on the other hand. Figure 5.1 illustrates this contrast, which holds true not only for statecharts, but for all areas of computer programming. On this foundation, as a first step toward systematically devising an extensive style guide for statecharts, the following taxonomy, also depicted in Figure 5.2, was laid down:

1 Syntactic Analysis: The enforcement of syntax-related rules does, in general, not necessitate knowledge of model semantics. However, deriving the rule set may require limited knowledge of model semantics, as is the case for items 1.2 and 1.3.

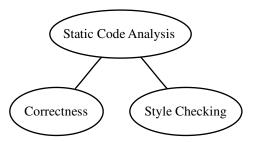


Figure 5.1: Distinction between correctness and style checking in the context of static code analysis.

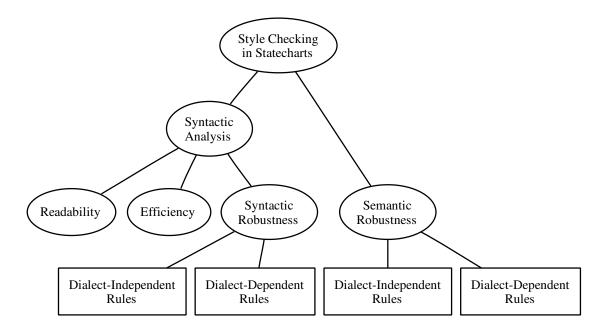


Figure 5.2: Taxonomy for style checking in statecharts.

- **1.1 Readability**¹: Readability (or layout style) is the domain of classic style guides. It aims at a graphical normal form, *e. g.*, transitions connect states in a clockwise direction, charts contain a limited number of states, transitions do not cross each other, or transition labels must be placed so that the relation between label and transition is clear and unambiguous [59].
- **1.2 Efficiency:** Efficiency (or compactness, simplicity) eliminates superfluous and redundant elements from the statechart model. This can be achieved by applying optimizers to the model. A meta-language for formulating the rules may be beneficial.
- **1.3 Syntactic Robustness:** Syntactic Robustness aims at reducing errors due to inadvertence and enhancing maintainability. Statechart dialect-dependent and dialect-independent rules are differentiated; rules may be formulated in OCL, as elaborated below.
- **2 Semantic Robustness:** Deriving and enforcing semantic robustness rules requires knowledge of specific aspects of the model semantics. In this case, a descriptive language for formulating the rules, *e. g.*, OCL, is less practicable. Exact analysis typically requires the use of verification tools, *e. g.*, reachability, disjunction of transition predicates, shadowing of (less-prioritized) transitions. Structure-based heuristics may be beneficial as well, *e. g.*, in checking for race conditions. Statechart dialect-dependent and dialect-independent rules are differentiated.

As a whole, this taxonomy is suggested as a productive groundwork for systematically devising an extensive style guide for statecharts. From hereon, the discussion focuses exclusively on statechart robustness analysis, syntactic as well as semantic.

5.2 Robustness Rules for Statecharts

As mentioned before, robustness rules typically stem from collective engineering experience and common sense. Therefore, in the style of the MISRA C rules development process [75], all available "raw" information, stemming from documented best-practices and collective engineering experience, was filtered and adapted into rules; next, the resulting rules were subject to peer and expert review and revision. In this sense, the

¹Within the *KIEL* [55] statechart modeling framework, briefly introduced in Chapter 1, a readability style guide and style check exist implicitly as part of the automatic layout functionality [57].

bibliographic references mentioned in the finally evolved set of rules presented below should be understood as mere sources of inspiration. Robustness rules are always built on the assumption of syntactic and semantic soundness. Hence, rules regarding the correctness of statecharts, *e. g.*, the presence of exactly one initial pseudo-state in each OR-state, are certainly not part of this set. Such rules are, however, often part of the tools discussed in the previous chapter, which partly explains their self-praised sizable number of rules. Moreover, robustness rules are divided into tool-independent and tool-dependent rules. Tool-dependent semantic robustness rules do not exist at the moment since the three statechart dialects considered in this thesis have rather closely related semantics.

I. Syntactic Robustness Rules

Tool-Independent Rules

- **1 Departability:** All non-final states should have at least one departing transition [78].
- **2 Non-Emptiness:** There should not be "empty" transitions, *i. e.*, transitions without trigger and condition, leading directly from one state to another state [78]. If a statechart dialect contains a default signal that is present at every instant, default transitions should be labeled with that signal. If no such default signal exists, one should be defined.
- **3 Parsimony:** All regions of an AND-state should contain at least one sub-state in addition to the initial pseudo-state, and all OR-states should contain at least two sub-states in addition to the initial pseudo-state [78]. Otherwise, such constructs merely introduce unnecessary levels of hierarchy, spawning additional sources of error.
- **4 Reachability:** There should not exist any isolated states, *i. e.*, states that have no incoming transitions [78]. Such states are unreachable and should therefore be removed.
- **5 Uniqueness:** The labels of all states should be unique [78]. Comprehension may be impaired, if sub-states of two different composite states carry the same label.
- **6 Variable Initialization:** System variables should be properly initialized [43, 58, 59, 78]. As the environment of a system will continue to change when the system is off-line, it is crucial that all variables are initialized at system start-up. To illustrate the relevance of this rule,

Leveson [61] describes a system controlling a chemical reactor that is taken off-line for an update during the charging of the reactor. When restarted, the system was not properly re-initialized and "assumed" the reactor to still be in its last known state. This eventually led to an overcharging of the reactor.

Tool-Dependent Rules

- 1 Connective Junctions I: In Stateflow, transition segments that lead to a connective junction, should not have any condition actions, or the connective junction must have a departing default transition [40]. Such condition actions are evaluated even if none of the following transition segments become active [68, pages 3-49f.].
- **2** Connective Junctions II: In Stateflow, Connective Junctions should not be used as they constitute an error-prone concept [40]. This rule, of course, cancels out the previous rule.

II. Semantic Robustness Rules

Tool-Independent Rules

- **1 Dwelling:** The predicates of incoming and outgoing transitions of a state should be pairwise disjoint, or at least not completely overlapping [43, 58]. This rule ensures that the system pauses at every state it reaches. A state that is passed without stopping might be superfluous.
- **2 Transition Overlap:** All transitions (directly or indirectly) outgoing from a state should have disjoint predicates [43, 58]. If the predicates overlap, a transition might be shadowed, and its target state might therefore be unreachable.
- **3** Write/Read Race Conditions, "Dirty Read": In parallel states, there should not be concurrent reading and writing of a variable [43, 58]. Unfortunately, Write/Read-Races are not detectable, in general. A very conservative approximation is implemented in Esterel Studio: "If a variable is written in a thread, then it can be neither read nor written in any concurrent thread" [15, page 52].
- **4 Write/Write Race Conditions, "Lost Update":** In parallel states, there should not be concurrent writing of a variable [43, 58]. Here, the same as stated above for Write/Read Race Conditions holds.

As a next step toward an automatic checking framework, the rules were divided into two sets: those rules that can be formally defined as constraints in OMG's Object Constraint Language (OCL)—to be subsequently translated to Java code, utilizing the Dresden OCL Toolkit [31]—and those rules that cannot. The former set includes all syntactic rules as these can easily be expressed as OCL constraints. On the other hand, semantic robustness rules, in general, cannot be expressed entirely as OCL constraints because checking a statechart w.r.t. these rules typically requires extensive knowledge of the model semantics and even automated theorem proving, as explained below. In particular, the Dwelling check and the Transition Overlap check cannot be specified using OCL constraints alone; additional Java code is needed for formulating the required theoremproving queries and sending them to an outside tool for analysis. The premise of using OCL in conjunction with Java, however, entails many complications, outweighing the gains of using OCL in the first place. Moreover, the intricate, global scoping of the Race Conditions check, makes it impossible to formulate this check in OCL, where a clearly defined scope is indispensable. Accordingly, these three checks are implemented directly in Java code.

The author is well aware that a twofold rule-handling—Java code on the one hand and OCL constraints on the other hand—leads to drawbacks in maintainability and uniform extendability of the checking framework. However, accepting these deficits, facilitates a vast range of automatic checks, while at the same time achieving a highest-possible level of abstraction in implementing the checks. Whereas the implementation of the syntactic checks is subject of a separate, but closely related diploma thesis [13], the specifics of automated semantic robustness analysis of statecharts are hereafter illuminated in detail.

5.3 Semantic Robustness Rules for Statecharts

As introduced in Section 4.1, robustness rules for statecharts seek the definition of a less error-prone subset of this powerful modeling paradigm. This section provides a semi-formal specification and in-depth description of the semantic robustness rules put forward in the previous section. All examples depicting partial statecharts have been modeled and laid out using *KIEL*. For these particular rules, transitions are always considered pairwise. Thus, let $trans_1$ and $trans_2$ be the two transitions under investigation. The label of $trans_i$ is l_i , which consists of an event expressions e_i , a condition expressions c_i , and action expression a_i , where $i \in \{1,2\}$.

5.3.1 Dwelling

The *Dwelling* rule ensures a system's capability to pause at every state it reaches. A state in which the system cannot pause is not in accordance with the definition of a state as given in Section 2.1. Reaching a state due to the occurrence of an event and later leaving the state due to another occurrence of the same event certainly represents impeccable behavior (Figure 5.3a). However, reaching a state and instantly leaving it due to a single occurrence of an event constitutes a potential modeling error (Figures 5.3b and 5.3c).

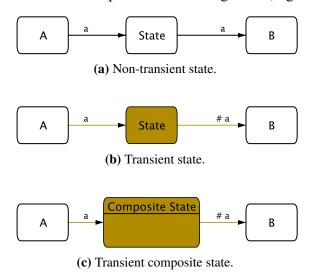


Figure 5.3: Semantic robustness rule *Dwelling*.

In order to determine if a *Dwelling* violation exists at a state, all incoming transitions and all "immediate" outgoing transitions (in Figure 5.3 denoted by Esterel Studio's #) are evaluated pairwise. A *Dwelling* violation exists if the event expression and condition expression of incoming transition $trans_1$ are disjoint from the respective expressions of outgoing transition $trans_2$. Technically, the satisfiability w. r. t. the theory of booleans in combination with linear integer and real arithmetic of the formula

$$\left((e_1 \wedge c_1) \wedge (e_2 \wedge c_2) \right) \tag{1}$$

must be determined. Satisfiability of the formula implies that the predicates of $trans_1$ and $trans_2$ are not disjoint, *i. e.*, a *Dwelling* violation is on hand. Such a violation may be eliminated by simply adding the negation of the predicates of one transition to the predicates of the other transition, *e. g.*, $trans_2$ remains unchanged, but the predicates of $trans_1$ are augmented by $\neg e_2$ and $\neg c_2$ to yield $(e_1 \land \neg e_2)$ for the event expression and $(c_1 \land \neg c_2)$ for the condition expression. Other solutions are certainly conceivable. Ultimately, the modeler must decide if and how to resolve the situation.

5.3.2 Transition Overlap

Ensuring that the predicates of two transitions departing from a state have disjoint predicates warrants that at most one transition is enabled at any time. This leads to guaranteed deterministic behavior independent of transition priorities, thus reducing the risk of errors otherwise easily introduced as part of an incremental modeling or remodeling process. The rule applies to simple and composite states as well as all pseudo-states with more than one departing transition, as shown in Figure 5.4. Although requiring considerable computational complexity, outgoing transitions must be considered pairwise, in order to identify two overlapping ones. Technically, checking this rule is similar to checking the previous rule. In this case, the satisfiability of Formula (1) indicates the overlapping of the predicates of transitions *trans*₁ and *trans*₂. As above, a possible solution may be obtained by adding the negation of the predicates of one transition to the predicates of the other transition. Again, the modeler must decide on the correct resolution on a case-by-case basis.

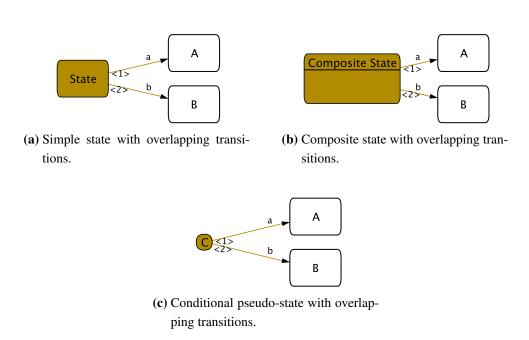


Figure 5.4: Semantic robustness rule *Transition Overlap*.

The strict enforcement of this rule, however, has the side-effect of eliminating the concept of a default transition that is always enabled, but only taken when no other transition is enabled. This occurs because a transition with empty predicates always overlaps with any other transition. Therefore, as shown in Figure 5.5, a single default transition

without trigger and condition is allowed for every state and pseudo-state, but only if this transition has the lowest priority of all transitions.



- (a) Unlabeled transitions with lower priority are allowed.
- **(b)** Unlabeled transitions with higher priority should be avoided.

Figure 5.5: Semantic robustness rule *Transition Overlap*: applicability to default transitions.

In addition to transitions departing directly from a state, transitions departing from an enclosing state may also be enabled. Depending on the statechart dialect, such indirectly departing transitions have higher or lower priority than directly departing transitions. In any case, the situation depicted in Figure 5.6 must be regarded as an infringement of the *Transition Overlap* rule. However, this strict interpretation of the rule might disturb the "abort" mechanism represented by indirectly departing transitions with higher priority. Hence, whether such transitions are considered in the automatic checking of this rule is configurable.

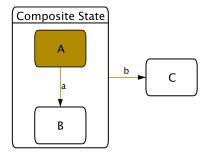


Figure 5.6: Semantic robustness rule *Transition Overlap*: applicability to "indirectly" outgoing transitions.

Transitions ending in a conditional connector, as shown in Figure 5.7, present another special case. Such transitions must be pursued in all possible directions until a regular state is reached. Accordingly, the satisfiability of the formula

$$\left(\left(\left(e_1 \wedge c_1\right) \wedge \left(e_c \wedge c_c\right)\right) \wedge \left(e_2 \wedge c_2\right)\right) \tag{2}$$

must be determined, where e_c and c_c represent the event and condition expressions, respectively, of the transition segment departing from the conditional connector.

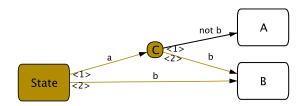
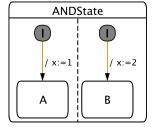


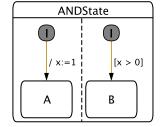
Figure 5.7: Semantic robustness rule *Transition Overlap*: applicability to transitions ending in a conditional.

5.3.3 Race Conditions

As in any other programming language, race conditions also pose a potential source of errors in statecharts. Two different forms of race conditions exist: write/read races, so called "dirty reads", and write/write races, so called "lost updates." Since, in general, neither of these are detectable, the following conservative approximation, as implemented in Esterel Studio, is adopted here: "If a variable is written in a thread, then it can be neither read nor written in any concurrent thread" [15, page 52]. Such behavior is shown in Figure 5.8.



(a) Write/Write race condition.

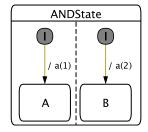


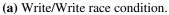
(b) Write/Read race condition.

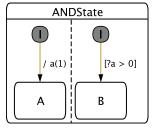
Figure 5.8: Semantic robustness rule *Race Conditions*: applicability to variables.

For the valued signals of Safe State Machines, circumstances are similar, as depicted in Figure 5.9. However, if a valued signal is declared as a combine signal, the situation in Figure 5.9a does not constitute a "lost update." The value of a combine signal is much rather updated according to a declared associative combine operation (addition, multiplication, or any associative user-defined operation). For the example in Figure 5.9a and

addition as the combine operation, this means that signal a is emitted with the value 3, not 1 or 2.



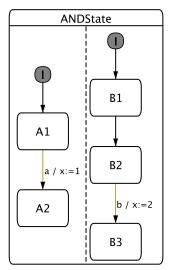




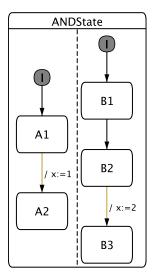
(b) Write/Read race condition.

Figure 5.9: Semantic robustness rule *Race Conditions*: applicability to valued signals of Safe State Machines.

In the examples shown in Figures 5.8 and 5.9, the existence of a race condition is always clear and unambiguous. Due to the aforementioned approach, however, also cases where it is unclear if a race condition is on hand, as in Figure 5.10a, and even certain race-free cases, as in Figure 5.10b, are flagged. This is a result of the conservative structure-based heuristic of this robustness rule.



(a) Ambiguous case of a write/write race condition.



(b) Race-free case that is marked to have a write/write race-condition.

Figure 5.10: Semantic robustness rule *Race Conditions*: applicability to ambiguous cases of parallelism.

Finally, the check is not only applicable to transitions that are directly parallel, i. e.,

within neighboring regions of the same AND-state. Ascending and descending to all levels of hierarchy, the check also applies to cases such as the one depicted in Figure 5.11.

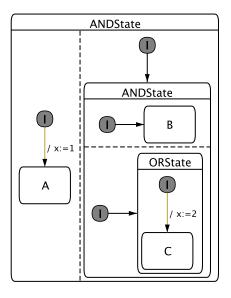


Figure 5.11: Semantic robustness rule *Race Conditions*: applicability to parallel transitions at all levels of hierarchy.

Chapter 6

The Implementation

The objective of this thesis was the development and implementation of an automated semantic robustness analysis of statecharts. After establishing the necessary theoretical ground, Chapter 5 provided a thorough definition of statechart robustness rules. Subsequently, this chapter presents the implementation of a tool for performing an automated semantic robustness check on statecharts. The tool is designed to adhere to the following constraints: modularity, extendability, and customizability of the rule set; and clear distinction of semantic robustness rules from correctness rules and syntactic robustness rules. Before turning to this, however, a brief overview of the *KIEL* framework is given.

6.1 The *KIEL* Framework

As already outlined in Chapter 1, *KIEL* is a software for the modeling and simulation of statecharts. The tool's main goal is to enhance the intuitive comprehension of the behavior of the system under development by providing an innovative dynamic visualization of the statechart simulation [89].

KIEL is implemented in Java (Standard Edition, Version 1.4.2 [100]); it can be compiled and executed both on Linux and on Windows XP. As shown in Figure 6.1 and briefly characterized below, *KIEL* consists of several independent components with well defined interfaces [56], which have largely been developed within the scope of student projects and diploma theses.

DataStructure: Represents a statechart's topology.

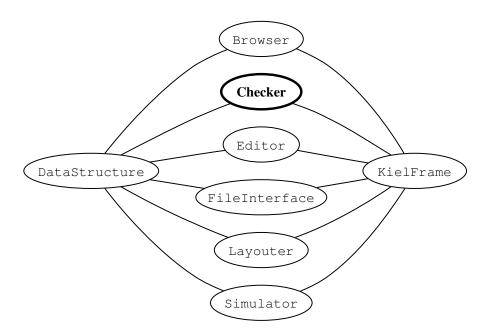


Figure 6.1: The components of *KIEL* and their conceptual interaction.

Browser: Controls the simulator and displays the statechart simulation [108].

Checker: Checks statecharts w. r. t. a modeling style guide—the focus of this thesis.

Editor: Enables the user to create new charts and modify existing ones [64].

FileInterface: Enables import and export of statecharts and simulation input data of several modeling tools [107].

Layouter: Provides different layout algorithms for the automatic layout of state-charts [57].

Simulator: Performs the simulation of models of various statechart dialects [84], currently Esterel Studio and Stateflow.

KielFrame: Provides *KIEL*'s main window and separates all components of the program from each other to warrant modularity. KielFrame encapsulates the Checker, the FileInterface, the Layouter, and the Simulator. No module calls methods of another module directly; KielFrame methods are called instead.

The tree data structure that represents a statechart's topology and the automatic layout mechanism that generates graphical views of the statechart form the foundation of *KIEL*.

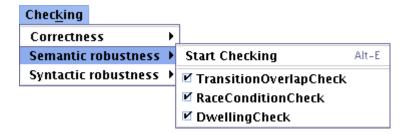


Figure 6.2: Screenshot of *KIEL*'s *Checking* menu.

The strict separation of topological and graphical information is the key to *KIEL*'s automatic layout capability and its support of multiple different layout algorithms. This powerful feature, in turn, facilitates a dynamic focus and context during statechart simulation as well as the possibility to edit statecharts based on their topology. The automatic layout further eliminates the need for an explicit layout style guide for statecharts. The *Checking* plug-in developed within this thesis operates directly on the data structure and sends its results to KielFrame for display. In addition to a graphical user interface (GUI), a command line version of *KIEL* exists, capable of rendering and exporting, optimizing, and checking statecharts.

6.2 The KIEL Checking Plug-In

The semantic robustness checks are realized as part of the *Checking* plug-in for the *KIEL* framework. The *Checking* plug-in provides the underlying infrastructure and utility methods needed for checking a statechart. Special care was taken to lay the ground for an arbitrary number of further checking packages, such as syntactic robustness checks or correctness checks. The individual checks are implemented as separate Java classes (Appendix A.3), extending a common base class (Appendix A.2.1). Checks are compiled into Java Archives (JARs), one JAR for each package of checks. In turn, the checks are dynamically loaded from the JARs when *KIEL* is started (Appendix A.2.2). Following the *Visitor* design pattern, all checks of a package are carried out on demand in a single depth-first traversal (Appendix A.2.3) of the abovementioned *KIEL* tree data structure. As show in Figure 6.2, checks may be individually enabled and disabled. Moreover, for each statechart dialect, a user-configurable default checking profile exists, specifying which checks are initially enabled and which are disabled.

As outlined in Section 5.3, an automated theorem prover is required for performing the semantic robustness checks. The open-source tool CVC Lite has been selected for this

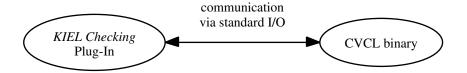


Figure 6.3: Outline of *KIEL Checking* plug-in communicating directly via standard I/O with CVC Lite executable.

purpose (cf. Section 3.3). After compilation, CVC Lite is available as a stand-alone executable and also as a shared-object C++ library. Using the executable is straightforward, as shown in Figure 6.3, but requires error-prone and time-consuming argument passing via standard I/O. In addition, CVC Lite's output must be parsed for interpretation. Alternatively, the CVC Lite library can be integrated into *KIEL*'s Java framework using the standardized Java Native Interface (JNI) [101]. As it could not be known ahead of time whether calling the CVC Lite library via JNI or communicating directly with the executable via standard I/O is more efficient, both possibilities have been implemented. Concluding performance issues are discussed below in Section 6.3.

The Java Native Interface enables Java programs to call native methods written in C or C++. Reasons for incorporating native methods generally include timing constraints, reuse of existing native code, and platform-specific tasks. Three conceptually different approaches to utilizing native code via JNI exist:

Native code modification: Modifying the native code to be in accord with the JNI naming scheme and augmenting two JNI pointer arguments to each method declaration; declaring native methods on the Java side.

Wrapper implementation: Manually implementing native wrapper methods to avoid modifying the existing native code; implementing Java wrapper methods to avoid declaring native methods on the Java side. By doing so, native methods may be used from within Java just as if they were Java methods.

Wrapper generation: Auto-generating native wrapper methods as well as Java wrapper methods.

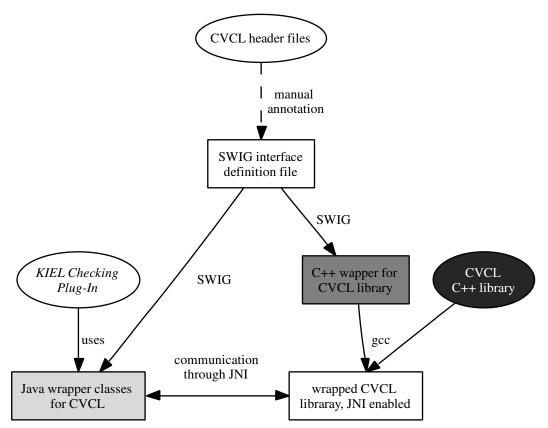
In case of CVC Lite, modifying the native source code is not feasible, simply due to the great size and complexity of the tool. Moreover, implementing native and Java wrappers manually is quite a tedious and error-prone task, especially on a large scale, as required for CVC Lite. Therefore, the open-source *Simplified Wrapper and Interface Generator*

(SWIG) [103] was employed. SWIG generates wrappers and interface files enabling the use of native methods from within many programming languages, including Java. The Java and C++ JNI wrappers, in this case, are produced from CVC Lite's annotated C++ header files, as shown in Appendix A.1. The complete SWIG workflow as well as the conceptual hierarchy of wrapper layers around the CVC Lite library are shown in Figure 6.4.

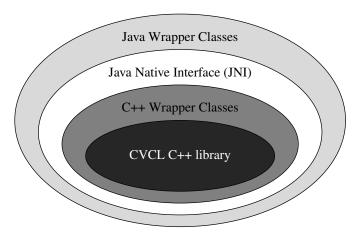
To perform the required satisfiability checking addressed in Section 5.3, the statechart transition predicates must be decomposed into their components and those components transformed from *KIEL* syntax to equivalent CVC Lite syntax. This is done by recursively parsing the transition predicates in order to form appropriate satisfiability queries. Depending on whether the CVC Lite library or binary is in use, a nested tool-specific expression is built for the library, while a lengthy string is concatenated for the binary (Appendix A.4). However, as mentioned in Section 3.3, CVC Lite does not determine the satisfiability of a formula, but rather its validity. Thus, the negation of Formula (1), derived in Section 5.3, is passed to CVC Lite. *Iff* this formula is found to be not valid, then the original Formula (1) is satisfiable.

The results of the semantic robustness checks are either displayed as a table on the *Semantic Checker* tab of *KIEL*'s GUI or as a textual description on the command line. When working with the GUI, individual or multiple messages may be selected with the mouse or keyboard (multiple interval selection [100]). For each selected message, the pertaining states and transitions are highlighted in the statechart above, as shown in Figure 6.5.

During the entire implementation process, only minor problems were encountered. One unsolvable technical predicament, however, regrettably entails the impossibility of utilizing the CVC Lite library when working on Windows XP. Here, CVC Lite cannot be compiled directly as it depends on several unavailable POSIX functions. With the aid of Cygwin's POSIX subsystem [26], however, compilation is straightforward. Unfortunately, native libraries depending on Cygwin cause the Java Virtual Machine (JVM) to crash when it tries to load such a library. This behavior is documented [49] and arises because the bottom-four kilobytes of the JVM's stack are overwritten by Cygwin. The incompatibility exists since version 1.5.5 of Cygwin's POSIX subsystem and occurs with all JVM versions. As a result, the CVC Lite library cannot be employed on the Windows platform, and thus, only the CVC Lite binary is available.



(a) Outline of the SWIG workflow, including the link-up of the CVC Lite library to the *KIEL Checking* plug-in.



(b) Conceptual diagram of the hierarchical composition of wrapper layers around the CVC Lite library.

Figure 6.4: Interfacing of *KIEL* and the CVC Lite library via JNI and SWIG.

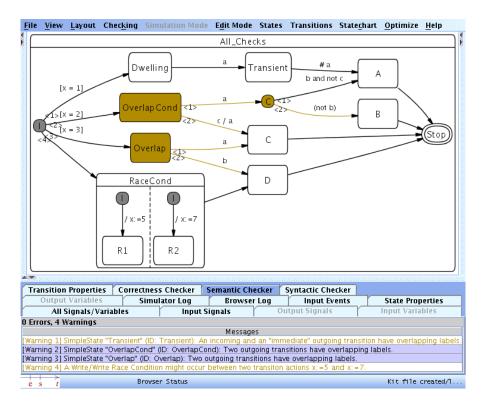


Figure 6.5: Results of the semantic robustness analysis displayed in *KIEL*'s graphical user interface.

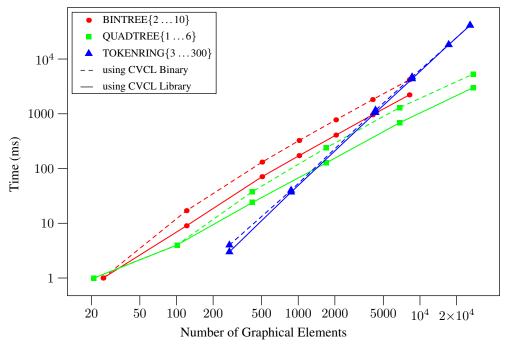
6.3 Performance Analysis

To quantitatively assess the efficiency of the automatic conformance checking of the semantic robustness rules, the checks were applied to a number of pertinent examples. The examples were largely taken from the Estbench Esterel benchmark suite [21] and the Columbia Esterel Compiler distribution [32]. In order to apply the checks, the Esterel programs were transformed to equivalent Safe State Machines using *KIEL*'s Esterel transformation [90]. Without any further optimization, this transformation generally yields statecharts with a large number of graphical elements (states, pseudo-states, transitions, etc.), well-fit for a performance analysis of the checking framework. In addition to these "artificial" examples, which were mainly chosen to assess the scaling of the checking run-time, manually created models (ELEVATOR DOOR¹, ABRO, and STOP-WATCH) were evaluated, as well. Table 6.1 and Figure 6.6 present the experimental results; specifically, the number of graphical elements in the model, the run-time of the semantic robustness analysis, and the number of generated warnings are shown.

¹The model of an elevator door is taken from a larger example which is part of the Esterel Studio distribution.

Table 6.1: Experimental results of the semantic robustness analysis of state-charts, listing the number of graphical elements in the models, run-times of the analysis, and numbers of generated warnings.

Model	Graphical Elements	Time (ms)		Generated Warnings
		CVCL Bin	CVCL Lib	
ELEVATOR DOOR	27	1	1	2
ABRO	37	1	<1	2
STOPWATCH	57	4	3	8
SCHIZOPHRENIA	42	1	1	0
REINCARNATION	86	4	3	8
JACKY1	98	6	3	11
RUNNER	131	21	9	55
ABCD	750	93	66	136
GREYCOUNTER	768	48	48	28
WW	1,167	92	72	137
MEJIA	1,317	183	152	142
TCINT	1,614	217	173	235
ATDS-100	3,308	387	249	1,262
MCA200	19,156	60,371	57,662	51,196
BINTREE-2	25	1	1	4
BINTREE-4	121	17	9	68
BINTREE-6	505	131	71	516
BINTREE-8	2,041	775	408	3,076
BINTREE-10	8,185	4,181	2,214	16,388
QUADTREE-1	21	<1	<1	0
QUADTREE-2	101	4	4	16
QUADTREE-3	421	38	24	144
QUADTREE-4	1,701	240	127	912
QUADTREE-5	6,821	1,299	687	5,008
QUADTREE-6	27,285	5,303	2,998	20,032
TOKENRING-3	272	4	3	0
TOKENRING-10	874	40	37	0
TOKENRING-50	4,314	1,165	1,051	0
TOKENRING-100	8,614	4,708	4,345	0
TOKENRING-300	25,814	41,376	41,265	0



(a) Checking run-times of the BINTREE, QUADTREE, and TOKENRING series.

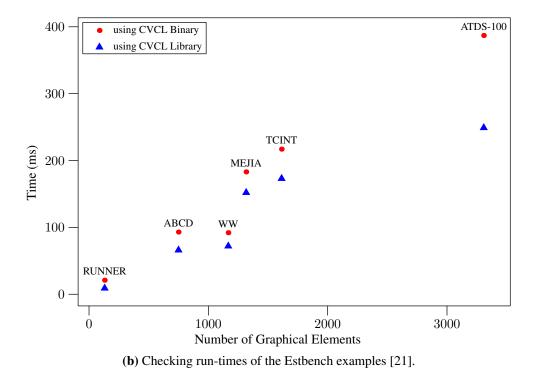


Figure 6.6: Plots of checking run-time vs. model size, illustrating the experimental results of the automated semantic robustness analysis of statecharts.

Irrespective of whether using the CVC Lite binary or library, the time required to perform the checking varies from a few milliseconds needed for small statechart models up to 60 seconds needed for very large models containing elaborate parallelism and generating a great number of warnings. For the majority of the examples, checking is much faster, though. Run-times scale approximately linearly w.r.t. the number of graphical elements of the checked models, as illustrated in Figure 6.6a. However, the TO-KENRING series of statecharts exhibits a quadratically scaling run-time characteristic. The massive parallelism (all within a single AND-state) causes a quadratically growing number of *Race Condition* checks. Also, for the MCA200 model, the enormous number of more than 51,000 generated warnings (cf. Table 6.1) contributes heavily to the 60-second run-time. Overall, the collected data suggests the complexity class $O(n^2)$, where n is the number of graphical elements, as an upper bound to the checking run-time.

When utilizing the CVC Lite library, run-times are consistently shorter as compared to the CVC Lite binary. This performance enhancement, also portrayed in Figure 6.6, certainly justifies the additional labor required to incorporate the CVC Lite library into the *KIEL* framework, as described in Section 6.2. Moreover, the run-time interval between the library and binary expands as the number of queries sent to CVC Lite grows for larger models. The increasing amount of communication via standard I/O affects the run-time of the binary more severely than the equally growing number of JNI calls affects the library run-time.

In Figure 6.6b, it can be further observed that the checking run-times for the models ABCD and WW are very similar, although the model WW is approximately 50% larger. This is caused by WW's low number of states with more than one departing transition, resulting in a low number of *Transition Overlap* checks. Moreover, WW contains an unusually high number of transition labels which are not interpreted by *KIEL*, *e. g.*, containing calls to C-functions.

Despite the synthetic nature of the majority of the examples, the mere quantity of generated warnings suggests, but certainly does not prove, the necessity and success of a robustness analysis for statecharts. Beyond that, even small and concise handmade models of a stopwatch or an elevator door yield several robustness warnings (cf. Table 6.1). The conclusion of this thesis (Chapter 7) contains a more thorough qualitative appraisal of the efficacy of the suggested robustness rules.

Chapter 7

Discussion and Conclusion

Statecharts have made reactive system development easier, certainly more intuitive, and hence, less error-prone. Although, they are no magic bullet. To take error prevention even further, a statechart style guide has been developed as the foundation of this thesis. Based on the well-structured set of robustness rules, both syntactic and semantic, an automated checking framework has been implemented as a plug-in for the *KIEL* statechart modeling tool [55]. Great care was taken in devising the rule set and in designing the checking framework as not to constrict the modelers' creativity, but to cater for more explicit, easy to comprehend, and less error-prone models. This was achieved by adhering to the following fundamental design principles:

Modularity and Configurability: In the spirit of Buck and Rau's notion of *flexibility* and *adaptability* [19] (cf. Chapter 5), all robustness checks are independently implemented, individually selectable, and parametrizable via a preferences management. A configurable default checking profile for models of each statechart dialect further enhances useability.

Extendability of the rule set: The set of checks is easily extendable by either implementing a new Java class or, if feasible, by adding an appropriate OCL constraint.

Automatic conformance checking: As shown in Section 6.3, compliance with the semantic robustness rules can be checked very rapidly—a key quality, imperative for end-user acceptance. Due to the uncoupling of the checking process from the modeling process, the checks may be applied at all stages of system development, even to partial system models.

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In working with the presented semantic robustness rules, a duality between robustness and minimality of statecharts has become evident. For example, eliminating a *Transition Overlap* or *Dwelling* violation by adding the negation of the predicates of one transition to the predicates of the other transition, as suggested in Section 5.3, constitutes an infringement of the *write things once* principle of modeling [14]. Thus, fully explicit behavior specification postulated by robustness rules stands in contrast to the clever exploitation of implicity. Correspondingly, statechart models optimized w.r.t. compactness and minimality frequently yield more robustness warnings than their non-optimized counterparts. In the development of new robustness rules and the enforcement of existing rules this duality must be kept in mind to ensure that modeling does not loose its inherent intuitiveness. Ultimately, it must always be left up to those who utilize the proposed rules to decide what actually represents an undesirable modeling construct and what not.

Backed by the experimental results presented in Section 6.3, the robustness rules, in combination with an automatic conformance checking, appear to fulfill their expected purpose. Large numbers of all three kinds of robustness violations, denoting potential modeling errors, are detected in models ranging from small to large and from trivial to highly complex. Even long before exposing true modeling errors, the robustness checks can expedite and ease the understanding of an unfamiliar model. For example, the *Dwelling* violations found in the model of a wristwatch (cf. model WW in Table 6.1) reveal a multitude of transient states resulting from the transformation of Esterel code to Safe State Machines. Eliminating these transient states leads to a more stringent and, hence, more intuitive model. The Transition Overlap violations found in the same model expose far-reaching relations spread-out over many levels of hierarchy, which might otherwise remain undiscovered. Similarly, the potential race conditions found in the model MCA200 help to identify concurrent access of variables even in far apart regions of the model. Altogether—although no immediate errors have been found in any model—the robustness rules and their automatic conformance checking satisfy the expectations. Intricate interrelations between various components of a model, which are nearly impossible to discover for the human beholder, are elegantly brought to attention.

The true practicality and efficacy in terms of error prevention of the proposed set of robustness rules can, however, only be proven in an extensive study. For this, two groups of test subjects would need to be asked to model a realistic system. Of these two groups, only one would have knowledge of the robustness rules and access to the automatic conformance checking. Significantly fewer modeling errors would then be expected from the "robustness" group. Assuming that everything else was equivalent

between the two groups, this would conclusively indicate the success of the suggested rules. A likewise elaborate alternative would be to apply the robustness checks to a (large) number of industry-sized models of real systems and consequently detecting errors in these models. This would obviously require in-depth knowledge of the modeled systems. Both propositions are unfortunately far beyond the scope of this thesis. Nevertheless, *KIEL*'s transformation of Esterel programs to Safe State Machines could be modified so that it generates statechart models containing only a minimal number of robustness violations—or better even, none at all. Moreover, in light of the small number of robustness rules established so far, the development of a much more extensive catalog of statechart dialect-independent and dialect-dependent robustness rules remains as future work.

In closing, statechart robustness rules step up, where the human modeler lets off—either due to inadvertence and carelessness or because size and complexity become nearly unmanageable for models of many real-life systems. Robustness rules and their automatic checking, in conjunction with the right modeling attitude, have the potential to make software and system development safer and less error-prone. Hence, we come a small step closer to the age-old dream of error-free software.

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Appendix A

Source Code

As discussed in Section 6.2, this appendix presents the source code of the *KIEL Checking* plug-in, including the implementation of the semantic robustness checks for statecharts. In particular, Appendix A.1 displays the SWIG interface definition file used to generate C++ and Java wrappers for CVC Lite. Next, Appendix A.2 presents the Java source code of the underlying checking infrastructure, which provides for an arbitrary number of checking packages. As illustrated in Figure A.1, all checks extend a common base class (see Appendix A.2.1). Appendix A.3 displays the Java-implementation of the sematic robustness checks: the

Dwelling check, the Transition Overlap check, and the Race Conditions check. Finally, Appendix A.4 exhibits the linkup of the CVC Lite binary and library, which includes the recursive parsing of the transition predicates and the forming of appropriate CVC Lite satisfiability queries.

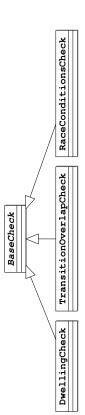


Figure A.1: Partial class diagram showing the semantic robustness checks and their common base class.

A.1 SWIG Interface Definition

The SWIG interface definition file is composed of CVC Lite's annotated C++ header files. It is used to generate C++ and Java wrappers for CVC Lite. Thereby, the CVC Lite library may be used from within Java just as if it was a Java library.

```
=== (TYPEDEF I type)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           // BOOL_VAR, //!< Boolean variables are treated as 0-ary predicates
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         \ensuremath{//} representation of the conditional. Parser produces (IF \ldots) .
                                                                                                                                                                                                                                                                      // Declaration of new (uninterpreted) types: Il, I2, ... : IYPE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 // (ITE c el e2) == IF c THEN el ELSE e2 ENDIF, the internal
                                                                                                                                                                                                                     \ensuremath{//} The "type" of any expression type (as in BOOLEAN : TYPE).
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            // Propositional relations (for circuit propagation)
                                                                                                                                                                                                                                                                                                                                            // Declaration of a defined type T : TYPE = type
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     // Propositional connectives
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                // Application of a function
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               // Uninterpreted function
                                                                                                                                                                                                                                                                                           // (TYPEDECL T1 T2 ...)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      // Top-level Commands
                                                                                                                                          BOOLEAN,
/ TUPLE_TYPE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 // Quantifiers
                                                   RATIONAL_EXPR,
// Leaf exprs
                       STRING_EXPR,
                                                                                                                                                                                                                                                                                                                                                                                                                     // Equality
                                                                                                                                                                                                                                                                                                                     TYPEDECL,
                                                                                                                     // Types
                                                                                                                                                                                                                                                                                                                                                                 TYPEDEF,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      IMPLIES,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         FORALL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                EXISIS,
                                                                                               FALSE,
                                                                                                                                                                                               ARROW,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ITE_R,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 AND_R,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           IFF_R,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        APPLY,
                                                                          TRUE,
                                                                                                                                                                                                                                                TYPE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ITE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    NEQ,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            NOT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     XOR,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    AND,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            IFF,
                                                                                                                                                                                                                                                                                                                                                                                                                                            EQ,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           OR,
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         // The commonly used kinds and the kinds needed by the parser. All
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                // these kinds are registered by the ExprManager and are readily
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                // Generic LISP kinds for representing raw parsed expressions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        RAW_LIST, //!< May have any number of children >= 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     %template(CVectorExpr) vector<CVCL::Expr>;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            %template(CVectorType) vector<CVCL::Type>;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             //! Identifier is (ID (STRING_EXPR "name"))
ID,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   %rename (equals) CVCL::Expr::operator==;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     %rename(assign) CVCL::Expr::operator=;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            %rename(get) CVCL::Expr::operator[];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     // available for everyone else.
                                                                                                                       #include "command_line_flags.h"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    %array_class(int, CIntArray);
                                                                                                                                                                                                                                                                                                                     #include "theory_arith.h"
                                                                                                                                                                                                                       #include "statistics.h"
                                                                                               #include "exception.h"
                                                                                                                                                                                                                                                                                               #include "rational.h"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            %include std_string.i
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    %include std_vector.i
                                              #include "expr_op.h"
                                                                                                                                                                                                                                              #include "theorem.h"
                                                                                                                                                                                                                                                                                                                                                                                                                                            %include "carrays.i"
                                                                                                                                                                                                                                                                                                                                                                                           %include typemaps.i
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     %include std_pair.i
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        class Statistics;
                                                                                                                                              #include "debug.h"
                                                                                                                                                                                                                                                                        #include "proof.h"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             %include std_map.i
                                                                                                                                                                                               #include "type.h"
                                                                                                                                                                        #include "expr.h"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         NULL_KIND = 0,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           class Context;
                                                                        #include "vc.h"
Smodule JavaCVC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             namespace std{
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  namespace CVCL
                                                                                                                                                                                                                       10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 9
```

```
// User function definition f(args) : type = e === (DEFUN args type e) // Here 'args' are bound var declarations DEFUN,
                                                                                                                                                                                                                                 === (LAMBDA <vars> e)
                                                                                                                                                                                                                                                                                                        === (CONSIDEF x type e)
                                                                                                                                                                                                                                 // Lambda-abstraction LAMBDA (<vars>) : e
                                                                                                                                                                                                                                                                                                     // Constant declaration x : type = e
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    SKOLEM_VAR,
//! Must always be the last kind
LAST_KIND
                                                                                                                                                                                                                                                             // Symbolic simulation operator
                                                                                                                                                                                                                                                                                                                                                                                                                                                               // Kinds for proof terms
PF_APPLY,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         //Skolem variable
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           typedef enum {
REAL = 3000,
                           BOUND_ID,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       SUBRANGE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 UMINUS,
PLUS,
                                                                                                                                                                                                                                                                                                                     CONSTDEF,
VARDECLS,
                                                                                                                                                                                                    LETDECLS,
                                                                                                                                                                                                                                                                         SIMULATE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            PF_HOLE,
                                                                                                                                                                                                                                                                                                                                                              VARLIST,
                                                                       SUBIYPE,
                                                                                                   IF,
IFTHEN,
                                                                                                                                                                                                                  LETDECL,
                                                                                                                                                                                                                                               LAMBDA,
                                                                                                                                                                                                                                                                                                                                                                              UCONSI,
                                                                                                                                                                                                                                                                                                                                                 CONST,
                                                                                                                              ELSE,
                                                                                                                                                           COND,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             190
                            150
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                                                                                                                                                                                                                                                                                                                     170
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             // A list of variable declarations (VARDECLS (VARDECL ...) (VARDECL ...) ...)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   // Variable declaration (VARDECL v1 v2 ... v_n type). A variable // can be an ID or a BOUNDVAR. VARDECL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             // Kinds used mostly in the parser
                                                                                                                                                                                                                                                                        DUMP_TCC_ASSUMPTIONS,
                                                                                                                                                                                                                                                                                     DUMP_TCC_PROOF,
DUMP_CLOSURE,
DUMP_CLOSURE_PROOF,
                                                                                                                                                                                                                                DUMP_ASSUMPTIONS,
                                                                                                                                                                                                                                                                                                                                                              ASSUMPTIONS,
COUNTEREXAMPLE,
                                                                                                                                                                                                                                                                                                                                                                                          COUNTERMODEL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CHECK_TYPE,
GET_CHILD,
SUBSTITUTE,
                                                                                                                             HELP,
TRANSFORM,
PRINT,
                                                                                                                                                                                                                  DUMP_PROOF,
                                                                                                                                                                                                                                                                                                                                                 ASSERTIONS,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              POPTO_SCOPE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                   PUSH_SCOPE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 POP_SCOPE,
            QUERY,
CHECKSAT,
CONTINUE,
                                                                                                                                                                                                                                               DUMP_SIG,
                                                                                                                                                                                                                                                             DUMP_TCC,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CONTEXT,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         GET_TYPE,
                                                        RESTART,
                                                                                                UNTRACE,
                                                                                                                                                                                                    INCLUDE,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           FORGET,
 ASSERT,
                                                                                                                OPTION,
                                                                       DBG,
TRACE,
                                                                                                                                                                                                                                                                                                                                    WHERE,
                                                                                                                                                                                                                                                                                                                                                                                                                                     POP TO,
                                                                                                                                                                         CALL,
                                                                                                                                                                                                                                                                                                                                                                                                        PUSH,
                                                                                                                                                                                        ECHO,
               100
                                                                                                                                                          110
                                                                                                                                                                                                                                                                                                      120
                                                                                                                                                                                                                                                                                                                                                                                                                                                   130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              140
```

```
// These constructors grab the ExprManager from the Op or the first
                                                                               const std::vector<std::pair<std::string,bool> >% sv);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         //Expr rebuildExpr(const Expr& e) { return Expr(rebuild(e)); }
                                                                                                                                                                                                                                                                                                                                                                                                        //inline bool operator==(const Expr& e1, const Expr& e2) {
                                                                                                                                                                                                                                                                                                                                                                                                                                    // Comparing pointers (equal expressions are always shared)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (o == null || !(o instanceof Expr)) return false;
                            const std::pair<std::string,bool>% p);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      return (int)computeHashCode (this);
                                                      void setFlag(const std::string& name,
void setFlag(const std::string& name,
                                                                                                                                                                                                                                                                                                                                                                              typedef long long unsigned ExprIndex;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     return equal (this, (Expr)o);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     public boolean equals (Object o)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                // return el.d_expr == e2.d_expr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   const Rational & getRational();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ExprIndex getIndex() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           %typemap(javacode) Expr %{
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Expr(): d_expr(NULL) {}
Expr(const Expr& e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                public int hashCode ()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       int getKind() const;
                                                                                                                                                                                                                 delete self;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             int arity() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        class ExprManager{
                                                                                                                                                      ~CLFlags()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                class Expr (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  class Expr;
                                                                                                                                   %extend{
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                class Op;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 public:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          public:
                                                                                                                                                                                                                                                                                                                                                                                260
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 290
                                                                                                         250
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            // Equivalent to (getDenominator() == 1), but possibly more efficient
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   //void setFlag(const std::string& name, const std::string& s);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             void setFlag(const std::string& name, const char* s);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   std::vector<std::string>& names);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                // Convert to int; defined only on integer values
int getInt() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             void setFlag(const std::string& name, bool b);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       void setFlag(const std::string& name, int i);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         size_t countFlags(const std::string& name);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         size_t countFlags(const std::string& name,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Rational getDenominator() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              std::string toString() const (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Rational getNumerator() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Rational (const Rational &n);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Rational (int n, int d = 1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        std::ostringstream ss;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      bool isInteger() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  // Copy constructor
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           return ss.str();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ss<<(*this);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       class CLFlags {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         class Rational{
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Rational();
                                                                                                                                                                                                                                                                                                                                                    DARK_SHADOW,
                                                                                                                                                                                                                                                                                                                                                                              GRAY_SHADOW
                                                                                                                                                                                                                                                                       IS_INTEGER,
                                                                                                                                                                                                                                                                                                                                                                                                     ArithKinds;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        class Proof{
                                                                                                                                                                                                                                                                                                                                                                                                                                                              %nodefault;
                                                                                                                                                                                                                                                                                                   NEGINE,
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                                                                                                         INTDIV,
                                                      DIVIDE,
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                                                                                                                                        Expr iteExpr(const Expr& thenpart, const Expr& elsepart) const;
                                                                                                                                                                                                                                                                                                       inline bool operator == (const Expr& el, const Expr& e2) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              \ensuremath{//} is an error to call this when \ensuremath{\text{Op}} has no associated Expr.
                                //static Expr andExpr(std::vector <Expr>& children);
                                                                                                    //static Expr orExpr(std::vector <Expr>% children);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 bool equal(const Expr& el, const Expr& e) (
Expr andExpr(const Expr& right) const;
                                                                                                                                                                        Expr iffExpr(const Expr& right) const;
                                                                                                                                                                                                         Expr impExpr(const Expr& right) const;
                                                                    Expr orExpr(const Expr& right) const;
                                                                                                                                                                                                                                                                                                                                        return el.d_expr == e2.d_expr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  size_t computeHashCode (const Expr&
                                                                                                                                                                                                                                                                                                                                                                                                                                               const Expr& operator[](int i) const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  int getKind() const ( return d_kind;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    return CVCL::operator == (e1, e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                return e.getEM ()->hash (e);
                                                                                                                                                                                                                                                                       Expr& operator=(const Expr& e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Op (ExprManager *em, int kind);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           delete self;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            const Expr& getExpr() const {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   std::string toString() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      std::string toString() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          //bool hasExpr() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ~Expr ()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Op (const Op& op);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               return d_expr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Op(int kind);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   %extend{
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  class Op{
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   public:
                                                                                                                                                                                                                                                                                                          1
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The operator and all children must belong to the same
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          >>> isRational() const { return getKind() == RATIONAL_EXPR; }
                                                                                                 Expr(const Op& op, const Expr& child0, const Expr& child1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 sool isBoolConst() const { return isFalse() || isTrue(); }
                                                                                                                                     Expr(const Op& op, const Expr& child0, const Expr& child1,
                                                                                                                                                                                                         Expr(const Op& op, const Expr& child0, const Expr& child1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       //! Expr is an application of a LAMBDA-term to arguments
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      bool isForall() const { return getKind() == FORALL; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         bool isExists() const ( return getKind() == EXISTS; }
                                                                                                                                                                                                                                                                       Expr(const Op& op, const std::vector<Expr>& children,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     isImpl() const { return getKind() == IMPLIES; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             cool isFalse() const { return getKind() == FALSE; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 cool isTrue() const { return getKind() == TRUE; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    bool isITE() const { return getKind() == ITE; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  bool isNot() const { return getKind() == NOT; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    cool isIff() const { return getKind() == IFF; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   bool isAnd() const { return getKind() == AND; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                negate() const; // avoid double-negatives
                                                                                                                                                                                                                                         const Expr& child2, const Expr& child3);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  == EQ; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      oool isOr() const { return getKind() == OR; }
                                                                 Expr(const Op& op, const Expr& child);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              bool isGeneric(size_t idx) const;*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            eqExpr(const Expr& right) const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  isEq() const { return getKind()
                                                                                                                                                                                                                                                                                                       ExprManager* em = NULL);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            oool isTupleAccess() const; */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   //const Expr& getOp() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            oool isRecordAccess() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /*size_t isGeneric() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   isQuantifier() const;
                                                                                                                                                                        const Expr& child2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* bool isRecord() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  isString() const;
isClosure() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       oool isLambda() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           oool isApply() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                               //bool hasOp() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                notExpr() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           oool isNull() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  oool isVar() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             // Arith testers
// child.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  bool
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// Test if we are running in a proof production mode and with assumptions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            //! Creates a subtype defined by the given predicate (a LAMBDA-term)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * \param pred is a term (LAMBDA (x: T): p(x)), and the resulting * type is a subtype of T whose elements x are those satisfying the
                                                                                                                                                                  bool withAssumptions() const { return d_thm.withAssumptions(); }
// Return the lowest scope level at which this theorem is valid.
                                                                                                                                                                                                                                                                                                                                                                                                                                                             bool isAbsLiteral() const { return d_thm.isLiteral(); }
                                                                                                                                    bool withProof() const { return d_thm.withProof(); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Type subrangeType(const Expr& 1, const Expr& r);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       static ValidityChecker* create (CLFlags flags);
                              // Value -1 means no information is available.
                                                                                                                                                                                                                                                                                                                                                 void printx() const { d_thm.printx(); }
                                                                                                                                                                                                                                                                                                                                                                                                                               //! Check if the theorem is a literal
                                                                                                                                                                                                                                                                                                                                                                          void print() const { d_thm.print(); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        static ValidityChecker* create ();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               static CLFlags createFlags ();
                                                                                                                                                                                                                                                            std::string toString() const;
                                                            // int getScope() const;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            class ValidityChecker {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * predicate p(x).
                                                                                                                                                                                                                                                                                                                   // For debugging
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  delete self;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Type boolType();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Type realType();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 delete self;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Type intType();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ~Theorem3(){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           class Context {
public:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ~Context(){
                                                                                                                                                                                                                                 // Printing
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      %extend{
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       %extend{
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      460
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            490
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     // Return the proof of the theorem. If running without proofs,
                                                                                                                                                                                                                                                                                                                                                                                                                                 std::string toString() const { return getExpr().toString(); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            const Proof& getProof() const { return d_thm.getProof(); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  const Expr& getExpr() const { return d_thm.getExpr(); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        // True if theorem is of the form t=t' or phi iff phi'
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   const Expr& getLHS() const { return d_thm.getLHS(); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              const Expr& getRHS() const { return d_thm.getRHS(); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       bool isRewrite() const { return d_thm.isRewrite(); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  //bool isAxiom() const { return d_thm.isAxiom(); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                               const Expr& getExpr() const { return d_expr; }
int arity() const { return d_expr.arity(); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               bool isNull() const { return d_thm.isNull(); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         // Return the theorem value as an Expr
                                                                                                                                                                          delete self;
                              Op getOp(const Expr& e){
                                                            return CVCL::getOp(e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   // return the Null proof.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           delete self;
                                                                                                                ~0b()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  \sim Type ()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ~Statistics() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            delete self;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           %extend{
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            class Statistics{
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          class Theorem3{
                                                                                                                                                                                                                                                                                                                                                 class Type (
  /*%extend{
                                                                                                                                                                                                                                                                                                                                                                                                        Type ();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   %extend{
                                                                                                              ======
                                                                                                                                                                                                                                                                                                                                                                             public:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       public:
                                                                                                                                                                                                   400
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           410
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        430
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 440
```

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Expr listExpr(const std::string& op, const Expr& el, const Expr& e2, const Expr& e3);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      //! Overloaded version of listExpr with string operator and three arguments
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             //! Overloaded version of listExpr with string operator and many arguments
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 //! Overloaded version of listExpr with string operator and two arguments
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                //! Overloaded version of listExpr with string operator and one argument
                                                                                                                                                                                                                                                                                     \return a variable by the name. If there is no such Expr, a NULL \mbox{\ \ }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Expr listExpr(const std::string& op, const Expr& e1, const Expr& e2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Expr listExpr(const Expr& el, const Expr& e2, const Expr& e3);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       //! Import the Type from another instance of ValidityChecker
                                              //! Get the variable associated with a name, and its type
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          //! Parse an expression using a Theory-specific parser
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             //! Overloaded version of listExpr with three arguments
                                                                                                                                                                                                                                                                                                                                                                                                                                         Expr lookupVar(const std::string& name, Type* type);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Expr listExpr(const std::string& op, const Expr& el);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          const std::vector<Expr>& kids);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            //! Overloaded version of listExpr with two arguments
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           //! Overloaded version of listExpr with one argument
                                                                                                                                                                                         \param type is where the type value is returned
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Expr listExpr(const Expr& e1, const Expr& e2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Expr listExpr(const std::vector<Expr>% kids);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      //! Get the largest supertype of the Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             //! Prints e to the standard output
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Expr listExpr(const std::string& op,
                                                                                                                                               \param name is the variable name
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Type getBaseType(const Expr& e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Expr importExpr(const Expr& e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Type importType(const Type& t);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            void printExpr(const Expr& e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Expr parseExpr(const Expr& e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 //! Get the type of the Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Expr listExpr(const Expr& el);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Type getType(const Expr& e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         //! Return FALSE Expr
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          /*! \sa getType() */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     //! Return TRUE Expr
                                                                                                                                                                                                                                                                                                                                            Expr is returned.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Expr falseExpr();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Expr trueExpr();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   550
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          990
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  570
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       580
540
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Type funType(const std::vector<Type>% typeDom, const Type& typeRan);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         //! n-element record (fields and types must be of the same length)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              //! Create named user-defined interpreted type (type abbreviation)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       const std::string& field2, const Type& type2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               const std::string& field1, const Type& type1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Type createType (const std::string& typeName, const Type& def);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Type recordType (const std::string& field0, const Type& type0,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        const std::string& field1, const Type& type1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Type recordType (const std::string& field0, const Type& type0,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Type arrayType (const Type& typeIndex, const Type& typeData);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Type recordType (const std::string& field, const Type& type);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Expr varExpr(const std::string& name, const Type& type);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Type funType (const Type& typeDom, const Type& typeRan);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Type recordType(const std::vector<std::string>& fields,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 //! Create an array type (ARRAY typeIndex OF typeData)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           //! Lookup a user-defined (uninterpreted) type by name
                                                                                                                                                                                                 Type tupleType (const Type& type0, const Type& type1);
                                                                                                                                                                                                                                                                                          Type tupleType (const Type& type0, const Type& type1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                //! Create a function type ([typeDom -> typeRan])
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        const std::vector<Type>% types);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             //! Create named user-defined uninterpreted type
                                                                                                                                                                                                                                                                                                                                                                                                                                         Type tupleType(const std::vector<Type>% types);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Type createType (const std::string& typeName);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Type lookupType (const std::string& typeName);
                                                                                                                                                                                                                                                                                                                                                                                      //! n-element tuple (from a vector of types)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /*! Fields will be sorted automatically */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /*! Fields will be sorted automatically */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /*! Fields will be sorted automatically */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Expr boundVarExpr(const std::string& name,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 std::string& uid,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Type& type);
                                              Type subtypeType(const Expr& pred);
                                                                                                                                                                                                                                                                                                                                            const Type& type2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 const
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    const
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              //! 3-element record
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ExprManager* getEM();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        //! 1-element record
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         //! 2-element record
                                                                                                                                               //! 2-element tuple
                                                                                                                                                                                                                                                    //! 3-element tuple
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     // Record types
```

200

510

520

530

```
//! Create a 2-element record value (# field0 := expr0, field1 := expr1 #)
3xpr ratExpr(const std::string& n, const std::string& d, int base);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Expr divideExpr(const Expr& numerator, const Expr& denominator);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          const std::string& field1, const Expr& expr1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 const std::string& field2, const Expr& expr2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Expr recordExpr(const std::string& field0, const Expr& expr0,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       const std::string& field1, const Expr& expr1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Expr recordExpr(const std::string& field0, const Expr& expr0,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Expr recordExpr(const std::string& field, const Expr& expr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               //! Create an n-element record value (# field_i := expr_i #)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    //! Create a 3-element record value (# field_i := expr_i #)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            //! Create a power expression (x ^n); n must be integer
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             //! Create a 1-element record value (# field := expr #)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Expr recordExpr(const std::vector<std::string>& fields,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Expr minusExpr (const Expr& left, const Expr& right);
                                                                                                                                                                                                                                                                                                                                                                                     Expr plusExpr(const Expr& left, const Expr& right);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Expr multExpr(const Expr& left, const Expr& right);
                                                                                            Expr ratExpr(const std::string& n, int base = 10);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Expr geExpr(const Expr& left, const Expr& right);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Expr leExpr(const Expr& left, const Expr& right);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    const Expr& right);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * \param exprs must be the same length as fields
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Expr ltExpr(const Expr& left, const Expr& right);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         const std::vector<Expr>% exprs);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Expr powExpr(const Expr& x, const Expr& n);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          /*! Fields will be sorted automatically */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /*! Fields will be sorted automatically */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /*! Fields will be sorted automatically */
                                                                                                                                                                                                                                                                                                                                   //! Create 2-element sum (left + right)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * Fields will be sorted automatically
                                                                                                                                                                                                                                                                                                                                                                                                                                       //! Make a difference (left - right)
                                                                                                                                                                                                                                      Expr uminusExpr(const Expr& child);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        //! Create a product (left * right)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 //Expr floorExpr(const Expr& expr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Expr gtExpr (const Expr& left,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  //! Create (left >= right)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         //! Create (left <= right)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      //! Create (left > right)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         //! Create (left < right)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  //! Create FLOOR(expr)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * \param fields
                                                                                                                                                                                        //! Unary minus.
                                                                                                                                          640
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                650
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  099
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    920
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              089
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  \param thenpart and \param elsepart must have the same type, which will
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               The two children must have the same type, and cannot be of type
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Expr funExpr(const Op& op, const Expr& left, const Expr& right);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            //! Create a rational number with numerator n and denominator d.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         //! Ternary function application (op must be of function type)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Expr funExpr(const Op& op, const std::vector<Expr>& children);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    //! Binary function application (op must be of function type)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               //! n-ary function application (op must be of function type)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    //! Unary function application (op must be of function type)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        They are converted to
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           arbitrary-precision integers according to the given base.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            //! Create IF ifpart THEN thenpart ELSE elsepart ENDIF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Op createOp(const std::string& name, const Type& type);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Expr iteExpr(const Expr& ifpart, const Expr& thenpart,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 const Expr& child1, const Expr& child2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Expr impliesExpr(const Expr& hyp, const Expr& conc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Expr eqExpr(const Expr& child0, const Expr& child1);
                                                                                                                                              3xpr andExpr(const Expr& left, const Expr& right);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Expr iffExpr(const Expr& left, const Expr& right);
                                                                                                                                                                                                                                                                                                                                       Expr orExpr(const Expr& left, const Expr& right);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              //! Create left IFF right (boolean equivalence)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Expr funExpr (const Op& op, const Expr& child0,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Expr funExpr (const Op& op, const Expr& child);
                                                                                                                                                                                                                                      Expr andExpr(std::vector<Expr>% children);
                                                                                                                                                                                                                                                                                                                                                                                                                                   Expr orExpr(std::vector<Expr>& children);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            also be the type of the ite expression.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    \param ifpart must be of type Boolean.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /*@}*/ // End of Core expression methods
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Here n and d are given as strings.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               const Expr& elsepart);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          //! Create an equality expression.
                                                                                                //! Create 2-element conjunction
                                                                                                                                                                                        //! Create n-element conjunction
                                                                                                                                                                                                                                                                                         //! Create 2-element disjunction
                                                                                                                                                                                                                                                                                                                                                                                     //! Create n-element disjunction
                                              Expr notExpr (const Expr& child);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Expr ratExpr(int n, int d = 1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      //! Create Boolean implication
//! Create negation
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Boolean.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ---
                                                                                            590
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    610
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          620
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            630
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/*! If there has not been a successful query, it should return a NULL proof
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             >>> query(const Expr& e, bool tcc = false) throw(CVCL::Exception);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ICC
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         \
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          //! Get all assumptions made in this and all previous contexts.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           //! Return the set of assertions used in the proof of the last
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    //! After successful query, return its closure |- Gamma => phi
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /*! Returns Null if no assumptions or queries were performed.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           //! Returns the proof of TCC of the last assumption or query
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   void getAssumptionsUsed(std::vector<Expr>% assumptions);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          /*! Turn a valid query Gamma |- phi into an implication
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             void getAssumptionsTCC(std::vector<Expr>% assumptions);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            void getCounterExample(std::vector<Expr>% assumptions,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     //! Returns the proof term for the last proven query
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           void getAssumptions(std::vector<Expr>% assumptions);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      //! Returns the TCC of the last assumption or query
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          bool inconsistent(std::vector<Expr>% assumptions);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        //! Simplify e with respect to the current context
                                                                                           const std::vector<Expr>& inputs,
                                         Expr simulateExpr(const Expr& f, const Expr& s0,
                                                                                                                                                                                                                                                                                                                                    //! Assert a new formula in the current context.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /*! \param assumptions should be empty on entry.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              bool inOrder=true);
                                                                                                                                                                                                                                    /*@}*/ // End of Other expression methods
                                                                                                                                                                                                                                                                                                                                                                                  /*! The formula must have Boolean type.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Theorem3 simplifyThm(const Expr& e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             void assertFormula(const Expr& e);
                                                                                                                                             const Expr& n);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Expr simplify (const Expr& e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       const Proof& getProofTCC();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     void printV(const Expr& e);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              const Expr& getTCC();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * |- Gamma => phi.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Proof getProof();
<u>*</u>
                                                                                                                                                                                                                                    740
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  750
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   760
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     770
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  780
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            //! Tuple select; equivalent to "tuple.n", where n is an numeral (e.g. tup.5)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                \param n is a constant, the number of cycles to run the simulation.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /*! Create an expression for the value of array at the given index */
                                                                                       / \, \star ! Create an expression representing the selection of a field from
                                                                                                                                                                                                                                                                                                                                /*! Notice the `` before field in the presentation language (and
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    \param inputs is the vector of LAMBDA-expressions representing
                                                                                                                                                                                                                                                                                  //! Record update; equivalent to "record WITH .field := newValue"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         //! Datatype update; equivalent to "dt WITH accessor := newValue"
                                                                                                                                                                                      3xpr recSelectExpr(const Expr& record, const std::string& field);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Expr existsExpr(const std::vector<Expr>% vars, const Expr& body);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Expr recUpdateExpr(const Expr& record, const std::string& field,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Expr forallExpr(const std::vector<Expr>& vars, const Expr& body)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Op lambdaExpr(const std::vector<Expr>% vars, const Expr& body);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           //Expr datatypeUpdateExpr(const Expr& dt, const Expr& accessor,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          //! Array update; equivalent to "array WITH index := newValue"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                //! Tuple update; equivalent to "tuple WITH index := newValue"
                                                                                                                                                                                                                                                                                                                                                                             the comment above); this is to distinguish it from datatype
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * \param f is the next state function (LAMBDA-expression)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    //! Create an expression array[index] (array access)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               Expr readExpr(const Expr& array, const Expr& index);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Expr writeExpr(const Expr& array, const Expr& index,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Expr tupleSelectExpr(const Expr& tuple, int index);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Expr tupleUpdateExpr(const Expr& tuple, int index,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Expr tupleExpr(const std::vector<Expr>% exprs);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                const Expr& newValue);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /*@}*/ // End of Record expression methods
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             const Expr& newValue);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      /*@}*/ // End of Array expression methods
                                         //! Create record.field (field selection)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              const Expr& newValue);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             //! Symbolic simulation expression
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       \param s0 is the initial state
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  the sequences of inputs to f
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  //! Existential quantifier
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   //! Universal quantifier
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         //const Expr& newValue);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              //! Lambda-expression
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     //! Tuple expression
                                                                                                                                             a record. */
                                                                                                                                                                                                                                                                                                                                                                                                                                        update.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           --
                                                                                                                                                                                      069
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    700
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 710
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       720
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         730
```

```
return CVCL::ValidityChecker::create (flags);
                                                                                                                                                                                                                                                                                                                                                                                                                        return CVCL::ValidityChecker::create();
                                                                                                                                                                                      Statistics& getStatistics(); //! Print collected statistics to stdout
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ValidityChecker (CLFlags flags)
                                                                                                             /*0}*/ // End of Context methods
                                       Context* getCurrentContext() = 0;
//! Get the current context
                                                                                                                                                                                                                                                                   void printStatistics();
                                                                                                                                                                                                                                                                                                                                            ValidityChecker ()
                                                                                                                                                                                                                                                                                                           %extend{
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   <u>``</u>
                                                                                                                                                                                                                           840
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               850
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   \param scopeLevel should be less than or equal to the current scope level.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           \ensuremath{//} Returns the current scope level. Initially, the scope level is 1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * <strong>internal</strong> checkpoint. Do not use unless you know
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       //! Restore the current context to its state at the last checkpoint
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 \param stackLevel should be greater than or equal to 0 and less
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            If scopeLevel is less than 1, then the current context is reset and the scope level is set to 1.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /*! (brief Checkpoint the current context and increase the \star strong>internal</br>/strong> scope level. Do not use unless you
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /*! @brief Restore the current context to its state at the last
                                                                                                                                                                                                                                                                                                                                                                                                                                                         //! Checkpoint the current context and increase the scope level
                                                                                                             //! Construct a proof of the query closure |- Gamma => phi /*! Returns Null if last query was Invalid. */
                                                                                                                                                                                                                                                                                                                                            //! Returns the current stack level. Initial level is 0.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         //! Restore the current context to the given scopeLevel.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        //! Restore the current context to the given stackLevel.
                                                                                                                                                                                                                                                               /*0}*/ // End of Validity checking methods
* Returns Null if last query was invalid.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      than or equal to the current scope level.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             void poptoScope(int scopeLevel) = 0;
                                                                                                                                                                                          const Proof& getProofClosure();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  void popto(int stackLevel) = 0;
                                                                         const Expr& getClosure();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * know what you're doing!
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   int scopeLevel() = 0;
                                                                                                                                                                                                                                                                                                                                                                                    int stackLevel() = 0;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              void pushScope() = 0;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * what you're doing!
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                void popScope() = 0;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              void push() = 0;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               void pop() = 0;
                                                                                                                                                                                      790
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    830
```

A.2 Checking Infrastructure

public final void setEnabled(final boolean isEnabled)

this.enabled = isEnabled;

* @return True, if the check is enabled.

20

public final boolean isEnabled() (

return this.enabled;

A.2.1 BaseCheck //SId: Basecheck.java,v 1.2 2006/04/12 15:00:27 gsc Exp \$ package kiel.checking; import kiel.dataStructure.GraphicalObject; /**

```
public void setProperties(final CheckingProperties props) (
                                                                                                                                                                                                                                                                     return name.substring(name.lastIndexOf('.') + 1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     public void setCvclProcess(final Process cvclProc) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * @param props The robustness properties to be set.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * @param cvclProc The process object.
                                                                                                                                                                                                                       name = this.getClass().getName();
                                                                                                                                             public final String getRuleName() {
                                                                                                                                                                                                                                                                                                                                                                                                                                       * Sets the robustness properties.
                                                               * Greturn The name of the rule.
                            * Returns the name of the rule.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * Sets the CVCL process.
                                                                                                                                                                                           String name;
                                                                                                                                                9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        70
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   80
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * @param o The current object in the depth first search of the statechart.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          \star This method is called from a Gsee RobustnessChecker. 
 \star @param checker The checker where the Gsee RobustnessProblems will be
* Description: This interface defines a method to be implemented by all
                                                                                                                                                                                                     * @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>
                                                                                                                                                                                                                                            * @version $Revision: 1.2 $ last modified $Date: 2006/04/12 15:00:27 $
                                                                                                                                                           * @author <a href="mailto:kbe@informatik.uni-kiel.de">Ken Bell</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                public abstract void apply(StateChartCheckerBase checker,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * True, if the check is enabled.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          private boolean enabled = true;
                                                                                                                                                                                                                                                                                                                                                                    public abstract class BaseCheck {
                                          * custom robustness checks.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              GraphicalObject o);
                                                                             * Copyright: (c) 2006
                                                                                                                       * Company: Uni Kiel.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * added.
                                                                                                                       10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               20
```

```
/**

GraphicalObject 0);

/**

* Caremines if this rule should be invoked on the

* current @see GraphicalObject.

* @param o The current object in the depth first traversal.

* @return Returns true if the rule should be applied to object o.

*/

public abstract boolean isValidTarget (final GraphicalObject o);

/**
```

9

* @param isEnabled

A.2.2 StateChartCheckerBase

```
* Directory containing the jar file with the checks to be loaded.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * True in GUI version, false in commandline version.
* Holds instances of dynamically loaded checks.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         private boolean showResultsInGUI = false;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   private int robustnessLevel =
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               private CheckerOutputGUI gui;
                                                                                                                                                                                                                                                                                                                                                                               * Stores generated warnings.
                                                                                                                                                                                      * Stores the found errors.
                                                                                                                                                                                                                                                                                                                                                                                                                                                       private ArrayList warnings;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             private String rulePackage;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        private Process cvclProcess;
                                                                                                                                                                                                                                                                    private ArrayList errors;
                                                                          private ArrayList rules;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  private int tabbedIndex;
                                                                                                                                                                                                                                                                                                                                                                                                                   *
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                **/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 8
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     80
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        \star < \! p \! > Description: This class manages the checking of a statechart. It uses a
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * @see StateChartDepthFirstAdapter to visit all nodes of the data structure.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    public class StateChartCheckerBase extends AbstractTableModel implements
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * @version $Revision: 1.2 $ last modified $Date: 2006/04/12 15:00:27 $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       \star The depth first adapter to visit all nodes of the datastructure.
                                                //$Id: StateChartCheckerBase.java,v 1.2 2006/04/12 15:00:27 gsc Exp $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * @author <a href="mailto:kbe@informatik.uni-kiel.de">Ken Bell</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * The checks to be performed are loaded dynamically.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  private StateChartDepthFirstAdapter depthfirst;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             import kiel.util.StateChartDepthFirstAdapter;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         import javax.swing.table.AbstractTableModel;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     private boolean dispatchRegions = true;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          import kiel.dataStructure.GraphicalObject;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 import kiel.dataStructure.StateChart;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     import kiel.util.IStateChartVisitor;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        import kiel.util.KielFrameRefresh;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          *  Copyright: (c) 2006 
                                                                                                                                                                                                                                          import java.net.URLClassLoader;
                                                                                                                                                                                                                                                                                                                                                                                                                                   import java.util.jar.Manifest;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       import javax.swing.JComponent;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  *  Company: Uni Kiel .
                                                                                                                                                                                                                                                                                                                                                                                         import java.util.jar.JarFile;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        IStateChartVisitor {
                                                                                                                                                                                                                                                                                                                     import java.util.Collection;
                                                                                                                                                                                                                                                                                 import java.util.ArrayList;
                                                                                                                                                                                                                                                                                                                                                     import java.util.Iterator;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        import javax.swing.JTable;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            import kiel.util.LogFile;
                                                                                           package kiel.checking;
                                                                                                                                                                  import java.io.File;
                                                                                                                                                                                                   import java.net.URL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              *
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```
* Greturn The collection of all errors that occured during the last run of
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * Greturn The collection of all warnings that occured during the last run
                                                                                                                                                                                                                           depthfirst.traverse(this, stateChart.getRootNode(), dispatchRegions);
                                                                                                                                                                                                                                                                                                                                                                                                         return ((getErrors().size() == 0) && (getWarnings().size() == 0));
                                   public final boolean checkDataStructure(final StateChart chart) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if ((rule.isEnabled()) && (rule.isValidTarget(o))) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    public final void dispatch(final GraphicalObject o)
                                                                                                                                                                                    depthfirst = new StateChartDepthFirstAdapter();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * @param o The object to perform all checks on.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           for (int i = 0; i < rules.size(); i++) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        rule = (BaseCheck) rules.get(i);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             public final String getStateChartType()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              return stateChart.getModelSource();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         public final Collection getWarnings() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * Returns the type of the StateChart. * @return The type of the StateChart.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              public final Collection getErrors() {
                                                                                                                                                                                                                                                                                              this.fireTableDataChanged();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        rule.apply(this, o);
                                                                                                                                                                                                                                                              if (showResultsInGUI) {
                                                                                                                                                                                                                                                                                                                                     setTextInLabel();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * of checkDataStructure.
                                                                                                                                                    stateChart = chart;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * checkDataStructure.
                                                                                                             warnings.clear();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   return warnings;
                                                                             errors.clear();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       BaseCheck rule;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             **/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  170
                                                                                                                                                                                    150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * Performs a depth first search to visit all subnodes of the passed node.
                                                                                                                                                                                                                                                                                              public StateChartCheckerBase (final String dir, final boolean doShow)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             public StateChartCheckerBase(final String dir, final boolean doShow,
                                                                                                                                                                                                                           * @param doShow True in GUI version, false in commandline version.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * @param doShow True in GUI version, false in commandline version.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * Greturn Returns Irue if no errors and no warnings were found.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * The constructor with an extra process argument.
                                                                                                                                                                                    * Oparam dir The sourcedir of the jar file.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * Oparam dir The sourcedir of the jar file.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       gui = new CheckerOutputGUI(this);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            gui = new CheckerOutputGUI(this);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * @param chart The current StateChart.
                                                                                                                                                                                                                                                                                                                                  KielFrameRefresh.register(this);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             KielFrameRefresh.register(this);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * @param cvclProc The CVCl process.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          final Process cvclProc) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             warnings = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               warnings = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                showResultsInGUI = doShow;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               showResultsInGUI = doShow;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      errors = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           errors = new ArrayList();
private StateChart stateChart;
                                                                                                                                                                                                                                                                                                                                                                                                               rules = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        rules = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (showResultsInGUI) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (showResultsInGUI) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    cvclProcess = cvclProc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       setTextInLabel();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                setTextInLabel();
                                                                                                                                                                                                                                                                                                                                                                        cvclProcess = null;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           rulePackage = dir;
                                                                                                                                                                                                                                                                                                                                                                                                                                                  rulePackage = dir;
                                                                                                             * The constructor.
                                                                                                                                             100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 140
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LogFile.DETAIL, "Loading of rule:" + classname
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           this.rulePackage.lastIndexOf(File.separatorChar) + 1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CheckingProperties.getRobustnessLog().log(LogFile.ERROR, "No valid jarfile specified.");
                                                                                                                                if (o instanceof BaseCheck && cvclProcess != null)
URLClassLoader ucl = new URLClassLoader(url, this
                                                                                                                                                                    ((BaseCheck) o).setCvclProcess(cvclProcess);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CheckingProperties.getRobustnessLog().log(LogFile.ERROR,
                                                                                                                                                                                                                                                                                                              CheckingProperties.getRobustnessLog().log(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * Loads the statuses of all rules in the current rulePackage.
                                .getClass().getClassLoader());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            b.setEnabled(CheckingProperties.getRuleStatus(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               this.rulePackage.lastIndexOf('.'))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * Greturn The level of semantic robustness checks
                                                                                                                                                                                                                                                                                                                                                                             + " successful.");
                                                                    c = ucl.loadClass(classname);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          for (int i = 0; i < rules.size(); i++) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   + "." + b.getRuleName()));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            "Rule loading failed.");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       public final int getRobustnessLevel() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             this.rulePackage.substring(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           b = (BaseCheck) rules.get(i);
                                                                                                     o = c.newInstance();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     private void loadRuleStatuses() {
                                                                                                                                                                                                                                                                          rules.add(o);
                                                                                                                                                                                                                                      if (0 != null) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          } catch (Exception e) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      loadRuleStatuses();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    return robustnessLevel;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         BaseCheck b;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    \
*
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    **/
                                                                                                                                                                                                                                      250
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 270
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 280
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             290
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     260
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * The rules are dynamically load from a jar file and instances of the found
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * This method loads the rules from the directory passed to the constructor.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CheckingProperties.getRobustnessLog().log(LogFile.ERROR,
                                                                                                                                                                       * Greturn Does the actual instance dispatch objects of type Region?
                                                                                                                                                                                                                                                                                                                                                                                                                                               * @param doDispatch Denote if the instance should dispatch Region.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "Starting to load rules from: " + this.rulePackage);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 URL[] url = { (new File(jar.getName())).toURL() };
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Iterator iter = m.getEntries().keySet().iterator();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                public final void setDispatchRegions(final boolean doDispatch)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CheckingProperties.getRobustnessLog().log(LogFile.DETAIL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            "Jarfile contains no manifest.");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   classname = (String) iter.next();
                                                                                                                                                                                                                                public final boolean isDispatchRegions() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  jar = new JarFile(rulePackage);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       this.dispatchRegions = doDispatch;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               while (iter.hasNext()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      m = jar.getManifest();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               public final void loadRules() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (m == null) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * checks are stored in the
                                                                                                                                                                                                                                                                          return dispatchRegions;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (jar!= null) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            String classname = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               JarFile jar = null;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Manifest m = null;
  return errors;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    rules.clear();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Object o;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Class c;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       try (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     *
                                                                                                                                                                                                     200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    220
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               240
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* Greturn The text to be displayed in the cell with the given coordinates.
                                                                                                                                                                                                                            p = (CheckingProblem) (warnings.get(rowIndex - errors.size()));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * Greturn The string, which is shown in the header of the outputtable.
                                                                   public final Object getValueAt(final int rowIndex, final int colIndex)
                                                                                                                                                                                                                                                                                                                                   result = "[Warning " + (rowIndex - errors.size() + 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   result = "[" + (rowIndex - errors.size() + 1) + "] ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       result = "[Error " + (rowIndex + 1) + "] ";
                                                                                                                                                                                                                                                               if (CheckingProperties.showClassification()) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if (CheckingProperties.showClassification()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            (uneckingProperties.showCounters()) {
   result = "[" + (rowIndex + 1) + "] ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            p = (CheckingProblem) (errors.get(rowIndex));
                                                                                                                                                                                                                                                                                                if (CheckingProperties.showCounters()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (CheckingProperties.showCounters()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (CheckingProperties.showCounters()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } else {
  if (CheckingProperties.showCounters())
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        public final String getColumnName(final int col) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                 result = "[Warning] ";
                                                                                                                                                                                     if (rowIndex >= errors.size()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              result = "[Error] ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               return result + p.getProblem();
                                                                                                                                                                                                                                                                                                                                                                             ... -
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   result = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       result = "";
                                                                                                                                                    CheckingProblem p;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               return "Messages";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } else {
                                                                                                                                                                                                                                                                                                                                                                                                              } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      } else {
                                                                                                                 String result;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * @param col .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } else {
                                                                                                                                                                                                                                                                                                                                      350
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              360
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               380
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     370
                                                                                                                                                                                                                                                                                                                                                                       \star @param w The destination writer, where the messages will be written to.
                                                                                                                                                                                                                                                                                                   * This method prints the errors and warnings, that were generated during
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * This method transforms the given cell coordinates to the appropriate
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * The count of rows is calculated by adding the size of the errors and
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * Greturn One column is needed for displaying the problems in a table.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                "Warning " + (i + 1) + ": " + r.getProblem());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * robustness problem and returns the message of the problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "Error " + (i + 1) + ": " + r.getProblem());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CheckingProperties.getSemLog().log(LogFile.ERROR,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CheckingProperties.getSemLog().log(LogFile.ERROR,
                                                                                                          public final void setRobustnessLevel(final int level) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * Greturn The count of rows the table has to display.
                                                                                                                                                                                                                                                                                                                                                                                                                                                 public final void printMessages(final Object w) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     for (int i = 0; i < warnings.size(); i++) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            r = (CheckingProblem) warnings.get(i);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   for (int i = 0; i < errors.size(); i++) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      r = (CheckingProblem) errors.get(i);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             return errors.size() + warnings.size();
* Set the level of the checks manually.
                             * Oparam level The level of the checks.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         public final int getColumnCount() {
                                                                                                                                                 this robustnessLevel = level;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   public final int getRowCount() {
                                                                                                                                                                                                                                                                                                                                   * checkDataStructure.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CheckingProblem r;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * @param rowIndex Th
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * @param colindex .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * warnings vector.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      return 1;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               \*
                                                                                                                                                                                                                                                                                                300
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          310
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            330
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      340
```

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* This method builds the warning and error messages.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * Oreturn Index of the appropriate tab in KIELFrame.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     public final void setTabbedIndex(final int ti) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                               result += warnings.size() + " Warnings";
                                                                                                                                                                                                                                                                                                                                                                            if (warnings.size() == 1) {
    result += warnings.size() + " Warning";
                                                                                                                                                                                                                                                                                                                     result = errors.size() + " Errors, ";
                                                                                                                                                                                                                                                             result = errors.size() + " Error, ";
                                                                                     * @return The warning and error messages.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * @param ruleName The name of the rule.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   public final int getTabbedIndex() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     public final ArrayList getRules() {
                                                                                                                                          public final String getSummary() {
   String result = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * Oparam ti The index of the tab.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * Enables or disables a rule.
                                                                                                                                                                                                                                  if (errors.size() == 1) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      this.tabbedIndex = ti;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * Setter for the rules.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * Getter for the rules.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         return tabbedIndex;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * @return The rules.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       return result;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   return rules;
                                                                                                                                                                                                                                                                                           } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                      } else {
                           440
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     470
                                                                                                                                                                                                                                                                                                                     450
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              460
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              480
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 p = (CheckingProblem) warnings.get(index - errors.size());
                                                                                                                                                                     public final ArrayList getProblemsByIndex(final int index) ( CheckingProblem \mathfrak{p}_{i}
                                                                                                                                                                                                                                                             if (index > (errors.size() + warnings.size())) {
                                                                                                                                                                                                                                                                                                                                                                                                p = (CheckingProblem) errors get(index);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 \star This method sets the warning and error messages.
                                                                                     * Greturn The Graphicalobject of the Problem.
                                                         * @param index The index of the Problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * Greturn The table if the gui is shown.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               public final JComponent getComponent() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    public final JTable getOutputTable() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * Greturn The component from the gui.
                                                                                                                                                                                                                                                                                                                                                                            if (index < errors.size()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         gui.setLabelText(getSummary());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           private void setTextInLabel() (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    return p.getObjects();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                return gui.getTable();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   return gui.getComponent();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (showResultsInGUI) {
                                                                                                                                                                                                                                                                                           return null;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     return null;
                                                                                                                                                                                                                                                                                                                                                                                                                                      } else {
                                                                                                                                                                                                                                                                                                                     } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           *
390
                                                                                                                                                                                                                                                                                         400
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                410
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         420
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   430
```

```
* The node is dispatched if either the parameter doVisitResions is
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * Oparam doVisitRegions Denoting wheter to dispatch regions to the visitor
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * Oparam intf The visitor whose dispatch method is called when a node is
                                                                                                                                                                                                                                                               * @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>
                                                                                                                                                                                                                                                                                               \star @version $Revision: 1.5 \$ last modified $Date: 2006/03/27 15:52:08 \$
                                                                          * Description: State chart visitor using the depth first search to
                                                                                                                                                                                                                           * @author <a href="mailto:kbe@informatik.uni-kiel.de">Ken Bell</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                stack.addAll(((CompositeState) n).getSubnodes());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    public final boolean traverse (final IStateChartVisitor intf,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (doVisitRegions || (!(n instanceof Region))) {
  intf.dispatch(n);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           final Node root, final boolean doVisitRegions) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * true or the node is not a region.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * @param root The start node of the search
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * Greturn Can be modified for later usage.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (n instanceof CompositeState) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ArrayList stack = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                          public class StateChartDepthFirstAdapter
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  n = (Node) stack.remove(0);
                                                                                                             \star traverse the datastructure
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        while (stack.size() > 0)
                                                                                                                                                 * Copyright: (c) 2006
                                                                                                                                                                                           * Company: Uni Kiel
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                stack.add(root);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return true;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Node n;
                                   10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    30
                                                                                                                                                                                                                                                                                                                                                                                                          20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               4
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         50
                                                                                                                                                                                                                                                                                                                                   this.rulePackage.lastIndexOf(File.separatorChar) + 1,
                                                                                                                                                                                                                                                                                               CheckingProperties.setRuleStatus(this.rulePackage.substring(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               //$Id: StateChartDepthFirstAdapter.java,v 1.5 2006/03/27 15:52:08 gsc Exp $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              A.2.3 StateChartDepthFirstAdapter
                                                                                                                                                                                                                                                                                                                                                                   this.rulePackage.lastIndexOf('.'))
                                                                public final void setEnabled(final String ruleName,
                                                                                                                                                                                                                                                               if (item.getRuleName().equals(ruleName)) {
                                                                                                                                                                                                                                                                                                                                                                                                             + "." + ruleName, isEnabled);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * Clears the errors and warnings in the table.
                                                                                                                                                                                     for (int i = 0; i < rules.size(); i++) (
                                                                                                                                                                                                                           item = (BaseCheck) rules.get(i);
                                                                                                                                                                                                                                                                                                                                                                                                                                                 item.setEnabled(isEnabled);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           import kiel.dataStructure.CompositeState;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        public final void clearUserInput() (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  JTable table = getOutputTable();
                                                                                                             final boolean is Enabled) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  this.fireTableDataChanged();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               import kiel.dataStructure.Region;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              public final void refresh()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     table.clearSelection();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           import kiel.dataStructure.Node;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               this.setTextInLabel();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * Clears all user input.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 import java.util.ArrayList;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              warnings.clear();
* @param isEnabled .
                                                                                                                                                    BaseCheck item;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           errors.clear();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             package kiel.util;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                *
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        *
                                                                          490
                                                                                                                                                                                                                                                                                                                                                                                                                                                 200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           510
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  520
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A.2.4 CheckerOutputGUI

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table.setSelectionMode(ListSelectionModel.MULIPLE_INTERVAL_SELECTION);
                                                                                                                                                                                                                                                                                                                                                                                                                                                  \star It sets the title of the frame, creates and adds the table to itself. 
 \star @param c The StateChartCheckerBase.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * @param t Text to be displayed in the label above the table.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         panel.add(new JScrollPane(table), BorderLayout.CENTER);
private void createTable(final StateChartCheckerBase c) {
                                                                                                                                                                                                                         table.getColumnModel().getColumn(0).setCellRenderer(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                public CheckerOutputGUI(final StateChartCheckerBase c)
                                                                                                              /* Set the selection mode to full row selection*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         public final void setLabelText(final String t) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     panel.add(label, BorderLayout.NORTH);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     panel.setLayout(new BorderLayout());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      public final JComponent getComponent() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * Greturn The instance of the table.
                                                                                                                                                                                                                                                               new MyCellRenderer(c));
                                                                                                                                                                                     /* Set the cell renderer. */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         public final JTable getTable() (
                                                                                                                                                                                                                                                                                                                                                                                                                 * The constructor of the frame.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * Greturn Return the Scrollpane
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       label = new JLabel("");
                                                                          table = new JTable(c);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 panel = new JPanel();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                label.setText(t);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       createTable(c);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             return table;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                return panel;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * Get the table.
                                                                                                                                                                                                                                                                                                                                                                                                                                                  9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         70
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    80
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               8
                                                                          50
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * Description: This class displays the problems found by a robustness
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * @version $Revision: 1.1 $ last modified $Date: 2006/04/10 10:22:22 $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * @author <a href="mailto:kbe@informatik.uni-kiel.de">Ken Bell</a>
                                                                                    //$Id: CheckerOutputGUI.java,v 1.1 2006/04/10 10:22:22 gsc Exp $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * The label displys the number of errors and warnings.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * This method is used to create and setup the table
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * The panel that holds the table and the label.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * Oparam c The StateChartCheckerBase.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * The table that displays the data.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * which is displayed in the frame.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     import javax.swing.ListSelectionModel;
                                                                                                                                                                                                                                                                                                                                                                                       import javax.swing.JScrollPane;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    public class CheckerOutputGUI {
                                                                                                                                                                                                                                                                                import javax.swing.JComponent;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * Copyright: (c) 2006
                                                                                                                                                                                                     import java.awt.BorderLayout;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * Company: Uni Kiel
                                                                                                                                                                                                                                                                                                                import javax.swing.JLabel;
                                                                                                                                                                                                                                                                                                                                                                                                                              import javax.swing.JTable;
                                                                                                                                                                                                                                                                                                                                                       import javax.swing.JPanel;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                private JTable table;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         private JPanel panel;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               private JLabel label;
                                                                                                                              package kiel.checking;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * checker.
                                                                                                                                                                                                                                                                                                                                                                                                                              2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                30
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A.2.5 CheckingProblem

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* Oparam o An ArrayList containing the source of the problem.
                                                                                                                                                                                                                                                                                                                                                                       public CheckingProblem(final ArrayList o, final String p) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          public final void setFirstObject(final GraphicalObject o) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * @param p Set the description of the problem manually.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      public final GraphicalObject getFirstObject() {
    return (GraphicalObject) objects.get(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             public final void setProblem(final String p) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * Greturn A short description of the problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * Greturn Returns the source of the problem.
                                                                                                                                                                                                                                                                                            * @param p A description of the problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * Set the source of a problem manually.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * @param o The source of the problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                          this.objects = new ArrayList(o);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  public final String getProblem() (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  this.objects.set (0, o);
this.objects.add(o);
                                                                                                                                                                                                                                                                                                                                                                                                                  this.problem = p;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        this.problem = p;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         return problem;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            70
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * occured when parsing the datastructure. Instances will be stored in an
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * Description: This class holds the informations about problems that
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * @version $Revision: 1.1 $ last modified $Date: 2006/04/10 10:22:22 $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   public CheckingProblem(final GraphicalObject o, final String p) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * @author <a href="mailto:kbe@informatik.uni-kiel.de">Ken Bell</a>
                                                                                                                             //$id: CheckingProblem.java,v 1.1 2006/04/10 10:22:22 gsc Exp $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  \star Holds the object which is the source of the problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * Holds the object that are the source of the problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * The constructor of the robustness problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * Holds a short description of the problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * instance of @see StateChartCheckerBase.
                                                                                                                                                                                                                                                                                                                                              import kiel.dataStructure.GraphicalObject;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * @param o The source of the problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              this.objects = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * @param p A problem description.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     //private GraphicalObject object;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          public class CheckingProblem (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          private ArrayList objects;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * Copyright: (c) 2006
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             < <p>Cp>Company: Uni Kiel.
                                                                                                                                                                                                                                                                  import java.util.ArrayList;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       private String problem;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  this.problem = p;
                                                                                                                                                                                package kiel.checking;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            **/
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public final Component getTableCellRendererComponent(final JTable aTable,
                                                                                                                                                                                                                                                                                                                                                                                                    * @param aTable The table of which the given cell has to be rendered.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        final boolean hasFocus, final int row, final int column) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      this.setForeground(CheckingProperties.getWarningColor());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    setSize(aTable.getColumnModel().getColumn(column).getWidth(),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (aTable.getRowHeight(row) != getPreferredSize().height) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            aTable.setRowHeight(row, getPreferredSize().height);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          this.setForeground(CheckingProperties.getErrorColor());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           this.setBackground(aTable.getSelectionBackground());
                                                                                                                     public MyCellRenderer(final StateChartCheckerBase c) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * @param isSelected Denoting if the cell is selected.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * @param hasFocus Denoting if the cell has the focus.
                                                                                                                                                                                                                                                                                                                                                                                                                                             * @param value The value that has to be displayed.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  final Object value, final boolean isSelected,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  \star @param column The columnindex of the cell.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (row < checker.getErrors().size()) {</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * @param row The rowindex of the cell.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    this.setForeground(Color.BLACK);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * Greturn A instance of the renderer.
                                         * @param c The StateChartCheckerBase.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    this.setBackground(Color.WHITE);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          getPreferredSize().height);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 this.setText (value.toString());
* Constructor of a CellRenderer.
                                                                                                                                                                                                                                           setWrapStyleWord(true);
                                                                                                                                                                                              setLineWrap(true);
                                                                                                                                                           this.checker = c;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (isSelected) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                return this;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  40
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * Description: The cell renderer for the table of errors and warnings.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * @author <a href="mailto:kbe@informatik.uni-kiel.de">Ken Bell</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    //sid: MyCellRenderer.java,v 1.1 2006/04/10 10:22:22 gsc Exp $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * @param o An ArrayList containing graphical objects.
                                                                                                                     * Greturn The sources of the problem in an ArrayList.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            public final void setObjects(final ArrayList o) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            import javax.swing.table.TableCellRenderer;
                                                                                                                                                                                           public final ArrayList getObjects() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      A.2.6 MyCellRenderer
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   private StateChartCheckerBase checker;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * The StateChartCheckerBase.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      import javax.swing.JTextArea;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    import java.awt.Component;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                import javax.swing.JTable;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      this.objects = o;
                                                                                                                                                                                                                                           return objects;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          import java.awt.Color;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       package kiel.checking;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * @version
                                                                                                                                                           *
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A.2.7 CheckingProperties

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private static LogFile synLog = new LogFile("Syntactic Robustness",
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             private static LogFile semLog = new LogFile("Semantic Robustness",
                                                                  private static LogFile corrLog = new LogFile("Correctness",
                                                                                                                                                                                                                                                                                    public static LogFile getCorrLog() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * Greturn The syntactic checker log.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * Static class, do not instantiate.
                                                                                                                                                                                                                  * Greturn The semantic checker log.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * Greturn The semantic checker log.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  public static LogFile getSynLog() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             public static LogFile getSemLog() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 private CheckingProperties() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * The syntactic checker log.
* The semantic checker log.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * The semantic checker log.
                                                                                                          getCorrLogLevel());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                getSemLogLevel());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        getSynLogLevel());
                                                                                                                                                                                                                                                                                                                             return corrLog;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      return semLog;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 return synLog;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           **/
20
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>
                                                                                                                                                                                                                                                                                                                                    * Description: Used to load and store user defineable properties.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * @version $Revision: 1.1 $ last modified $Date: 2006/04/10 10:22:22 $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               private static final String DEFAULTRESOURCE = "checking.properties";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          \star This the key for the resouce file containing the default values.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          CheckingProperties.class.getResource(DEFAULTRESOURCE),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            private static LogFile checkingLog = new LogFile("Checking", 0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * @author <a href="mailto:kbe@informatik.uni-kiel.de">Ken Bell</a>
   //$Id: CheckingProperties.java,v 1.1 2006/04/10 10:22:22 gsc Exp $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  checkingLog.setLogLevel(getRobustnessLogLevel());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       prefs = Preferences.getInstance("checking",
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     public static LogFile getRobustnessLog() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * These are the internal properties.
                                                                                                                                                                                         import kiel.util.preferences.Preferences;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               public final class CheckingProperties {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               private static Preferences prefs;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * Greturn The robustness log.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                checkingLog);
                                                                                                                                                                                                                                                                                                                                                                                                            * Copyright: (c) 2006
                                                                                                                                                                                                                                                                                                                                                                                                                                                  * Company: Uni Kiel.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        return checkingLog;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * The robustness log.
                                                                                                                                                                                                                               import kiel.util.LogFile;
                                            package kiel.checking;
                                                                                                                       import java.awt.Color;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        static {
                                                                                                                                                                                                                                                                                                                                       10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     40
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    30
```

```
private static final String SHOWCLASSIFICATION = "showClassification";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 public static Color getErrorColor() {
    return prefs.getRGBColor(CHECKING + DELIMITER + ERRORCOLOR);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              private static final String SHOWTRANSITIONS = "showTransitions";
                                                                                                                                                                                                                                                                                        private static final String SHOWNODENAME = "showNodeName";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  private static final String SHOWCOUNTERS = "showCounters";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                private static final String SHOWPRIORITY = "showPriority";
                                                                                                          private static final String SHOWNODEID = "showNodeID";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  \star @return The color of warnings. 
 \star/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * @return The color of errors.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * Reloads the properties file.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           protected static void reload()
prefs.reload();
                                                                                                                                                                              **/
                                                                                                                                                                                                                                                                                                                                                             *
                                                                                                                                                                           150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      170
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         private static final String CHECKINGLOGLEVEL = "CheckingLogLevel";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        private static final String CORRECTNESSLOGLEVEL = "CorrLogLevel";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  private static final String SYNTACTICLOGLEVEL = "SynLogLevel";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      private static final String SEMANTICLOGLEVEL = "SemLogLevel";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                private static final String WARNINGSCOLOR = "warningColor";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               private static final String RULESENABLED = "ruleEnabled";
                                                                                                                                                                                                                                                                                                                                                                                                                                     private static final String ERRORCOLOR = "errorColor";
                                                                                                                                                                                                                                                   private static final String CHECKING = "checking";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             private static final String CVCLMODE = "cvclMode";
* This is the key for property key delimiter.
                                                                 private static final String DELIMITER = ".";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         **
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     *
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       <u>*</u>
                                                                                                                                            100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              140
```

```
return prefs.getString(CHECKING + DELIMITER + SHOWCLASSIFICATION)
return prefs.getInt(CHECKING + DELIMITER + SYNTACTICLOGLEVEL);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         public static boolean showTransitions() {
    return prefs.getString(CHECKING + DELIMITER + SHOWTRANSITIONS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              return prefs.getString(CHECKING + DELIMITER + SHOWCOUNTERS)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    return prefs.getString(CHECKING + DELIMITER + SHOWNODENAME)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        return prefs.getString(CHECKING + DELIMITER + SHOWNODEID)
                                                                                                                                                                                                                                        return prefs.getString(CHECKING + DELIMITER + CVCLMODE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                public static boolean showClassification() (
                                                                                                                                       * @return Whether to use CVCL lib or bin.
                                                                                                                                                                                                          public static boolean isCvclModeBin() (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      public static boolean showNodeName() (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               public static boolean showCounters() (
                                                                                                                                                                                                                                                                            .equalsIgnoreCase("bin");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      public static boolean showNodeID() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            .equals("true");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            .equals("true");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        .equals("true");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     .equals("true");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  .equals("true");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * @return .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * @return .
                                                                                                                                                                                                                                                                                                                                                                                                                    * Greturn .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * @return .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * @return .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              *
                                                                                                                                                                                                                                        250
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            270
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              280
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             290
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            return prefs.getInt(CHECKING + DELIMITER + CORRECTNESSLOGLEVEL);
                        return prefs.getRGBColor(CHECKING + DELIMITER + WARNINGSCOLOR);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return prefs.getInt(CHECKING + DELIMITER + CHECKINGLOGLEVEL);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       return prefs.getint(CHECKING + DELIMITER + SEMANTICLOGLEVEL);
                                                                                                                                                                                                                                                                                                                                      return prefs.getBooleanAndAddIfMissing(CHECKING + DELIMITER
                                                                                                                                                                                                                                                                                                             public static boolean getRuleStatus(final String ruleName) (
                                                                                                                                                                                                                                                                                                                                                                             + RULESENABLED + DELIMITER + ruleName, true);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               public static void setRuleStatus(final String ruleName,
                                                                                                                                                                         * Reads the rule status from the properties.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            public static int getRobustnessLogLevel() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * Sets the rule status in the properties.
                                                                                                                                                                                                             * @param ruleName The name of the rule.
public static Color getWarningColor() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * Oparam ruleName The name of the rule.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     prefs.setBoolean(ruleName, value);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        public static int getCorrLogLevel() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      public static int getSemLogLevel() {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  public static int getSynLogLevel() (
                                                                                                                                                                                                                                              * Greturn The status of the rule.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           final boolean value) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * @param value The value.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * @return .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * @return .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * @return .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * @return .
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              \*
                                                                                                                                                                                                       200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            210
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```

```
# rule is checked: [true] or [false]
                         checking.showClassification=true
                                                                             checking.showTransitions=false
                                                                                                                                                                                    # statuses of robustness rules
                                                      checking.showCounters=true
                                                                                                       checking.showPriority=true
checking.showNodeName=true
                                                                                                                                                           ##################
                                                                                                                                                           9
                                                                                                                          public static boolean showPriority() {
    return prefs.getString(CHECKING + DELIMITER + SHOWPRIORITY)
    .equals("true");
                                                                             * Greturn .
                                                                                                       *
                                                                                                                                                                                                                 300
```

A.2.8 Checking Properties

```
# [ERROR], [STRUCTURE], [INFO], [DETAIL], [DEBUG], or [ALL]
                                                                                                                                                                                                                                                                                                                                                                                                                                                   # if set to [lib] on Windows, KIEL will still use [bin] # [lib] or [bin]
****
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      # custom settings for error and warning messages
                                                                                                                                                                                                                                                                                                                                                                                                # whether to use JCVCL library or CVCL binary
                                                                                # unless you know exactly what you are doing.
                                                                                                                                                                                                                                        # Specify the color in the format "R, G, B"
                                                                                                                                                                                                                                                                                                                                                                                                                              # JCVCL library not possible on Windows,
                                                                                                                                                                                                                                                                                                                       checking.warningColor=178,140,0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              checking. CheckingLogLevel=10
                                                                                                                                                                                                                                                                                      checking.errorColor=255,0,0
                                                # do not edit this file !
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       checking.CorrLogLevel=10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              checking.SemLogLevel=10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        checking.SynLogLevel=10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          checking.cvclMode=bin
                                                                                                                                                                                   ###################
                                                                                                                                                                                                                                                                                                                                                                         ##################
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ##################
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ##################
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               # [true] or [false]
                                                                                                                                                                                                                                                               # [int, int, int]
                                                                                                                                                                                                               # color settings
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         # the log levels
                                                                                                                                                                                                                                        10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          30
```

checking.showNodeID=true

A.3 Semantic Robustness Checks

* Number of arguments used of string formatting of error and warning

private final int numOfArgs = 5;

* messages.

A.3.1 DwellingCheck

```
* The validity checker used to check for overlapping transition predicates.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * All transitions directly and indirectly outgoing from a state.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     private ArrayList incommingTransitions = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 private ArrayList outgoingTransitions = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               public boolean isValidTarget(final GraphicalObject o)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      public void setCvclProcess(final Process cvclProc) (
                                                                                                                                                                                                                                                                                            private ArrayList problemLocation = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  myVC = new MyValidityCheckerBin(cvclProc);
                                                                                                                                                                                                        * Contains a state and two transitions.
                                                                                                                                                                                                                                                                                                                                                                                                                     * All transitions comming into a state.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   || c.equals(SimpleState.class);
                                                                                private MyValidityCheckerBase myVC;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   return c.equals(ANDState.class)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           || c.equals(ORState.class)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * @param cvclProc @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Class c = o.getClass();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * @param o @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * Greturn Gsee BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  70
                                    20
                                                                                                                                                                                                                                                                                                                                                                                                                                                             9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           80
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * Description: Ensures dwelling in all states, i.e., no outgoing immediate
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * @version $Revision: 1.2 $ last modified $Date: 2006/04/12 15:31:15 $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  + "An incomming and an \"immediate\" outgoing transition "
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * transition and an incomming trantition may have overlapping lables,
                                                   //$Id: DwellingCheck.java, v 1.2 2006/04/12 15:31:15 gsc Exp $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * dynamically loaded by @see StateChartCheckerBase.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      private final String message = "\{0\}\{1\}\{2\}\{3\}\{4\}"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          public final class DwellingCheck extends BaseCheck
                                                                                              package kiel.checking.semanticRobustnessChecks;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               import kiel.checking.StateChartCheckerBase;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    import kiel.dataStructure.GraphicalObject;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          + "have overlapping labels.";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               import kiel.dataStructure.CompoundLabel;
                                                                                                                                                                                                                                                                                                                                                                                                                                       import kiel.checking.CheckingProperties;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    import kiel.dataStructure.SimpleState;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        import kiel.dataStructure.Suspension;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            import kiel.dataStructure.Transition;
                                                                                                                                                                                                                                                                                                                                                                                           import kiel.checking.CheckingProblem;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    import kiel.dataStructure.ANDState;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           import kiel.dataStructure.ORState;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               import kiel.dataStructure.State;
                                                                                                                                                                                                                                                                                                                                                   import kiel.checking.BaseCheck;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   import kiel.dataStructure.Node;
                                                                                                                                                                               import java.text.MessageFormat;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * Copyright: (c) 2006
                                                                                                                                                                                                                       java.util.ArrayList;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * Company: Uni Kiel
                                                                                                                                                                                                                                                           import java.util.Iterator;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    import kiel.util.LogFile;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * The error string.
                                                                                                                                                                                                                   import ;
                                                                                                                                                                                                                                                                                                                                                                                                                                10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 30
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```

* @see BaseCheck

8

```
if (myVC.areOverlapping((CompoundLabel) incomming.getLabel(),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (incomming != outgoing) { // avoid identical transitions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * This method is used internally by a check to generate the according
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * @param checker The checker where the problem will be added to.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       private void generateProblem(final StateChartCheckerBase checker,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    (CompoundLabel) outgoing.getLabel())) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             generateProblem(checker, problemLocation);
                                                                                CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 outgoing = (Transition) outgoing Iter.next();
                                                                                                                                                                                                                                                                                                                                                                                                                                  incomming = (Transition) incommingIter.next();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               args[0] = s.substring(s.lastIndexOf('.') + 1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       outgoingIter = outgoingTransitions.iterator();
                                                                                                                  "WARNING: Transition " + outgoing
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                args[1] = " \"" + n.getName() + "\"";
                                                                                                                                                                                                                                                                                                                                                        incommingIter = incommingTransitions.iterator();
                                                                                                                                                       + " ignored, StringLabel");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       problemLocation.add(incomming);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        problemLocation.add(outgoing);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * @param objects The sources of the problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         problemLocation.clear();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (CheckingProperties.showNodeName()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              problemLocation.add(o);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Object[] args = new Object[numOfArgs];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         while (outgoingIter.hasNext()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (n.getName().equals(""))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              String s = n.getClass().getName();
                                                                                                                                                                                                                                                                                                                                                                                             while (incommingIter.hasNext()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * instance of a RobustnessProblem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Node n = (Node) objects.get(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               final ArrayList objects) (
                                                                                                                                                                                                outgoingIter.remove();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if (n instanceof State) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  args[1] = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          170
140
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   160
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          } else if (!(incomming.getLabel() instanceof CompoundLabel)) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         // remove "non immediate" transitions from outgoingTransitions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    outgoingTransitions.addAll(s.getOutgoingTransitions());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Iterator incommingIter = incommingTransitions.iterator();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        incommingTransitions.addAll(s.getIncomingTransitions());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (outgoing.getLabel() instanceof CompoundLabel) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Iterator outgoingIter = outgoingTransitions.iterator();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (!((CompoundLabel) outgoing.getLabel()).
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        incomming = (Transition) incommingIter.next();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "WARNING: Transition " + incomming
                                                                                                                  public void apply (final StateChartCheckerBase checker,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CheckingProperties.getSemLog().log(LogFile.DETAIL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               outgoing = (Transition) outgoingIter.next();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       // remove suspensions from incommingTransitions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  + " ignored, StringLabel");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              getTrigger().isImmediate()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (incomming instanceof Suspension) {
                                                                                                                                                                                                                                  // is only null on first pass in lib mode
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      "DwellingCheck, State: " + s);
                                                                                                                                                                                                                                                                                                            myVC = new MyValidityCheckerLib();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                outgoing Iter.remove();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   while (incommingIter.hasNext()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          get ALL outgoing transitions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   while (outgoingIter.hasNext()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         incommingIter.remove();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      incommingIter.remove();
                                                                                                                                                       final GraphicalObject o) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 incommingTransitions.clear();
* @param checker @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      outgoingTransitions.clear();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             s = s.getParent();
                                           * @param o @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               while (s != null) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Transition incomming;
                                                                                                                                                                                                                                                                       if (myVC == null) {
                                                                                                                                                                                                                                                                                                                                                                                                                                  State s = (State) o;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Transition outgoing;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          2.2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         : :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              130
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* The validity checker used to check for overlapping transition predicates.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * Description: Checks for overlapping transitions, i.e., one transition
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * Number of arguments used of string formatting of error and warning
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * @version $Revision: 1.2 $ last modified $Date: 2006/04/24 12:20:41 $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       + "Two outgoing transitions have overlapping labels.";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   public final class TransitionOverlapCheck extends BaseCheck (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             private ArrayList problemLocation = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              private final String message = "\{0\}\{1\}\{2\}\{3\}\{4\}"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * being shadowed by another, dynamically loaded
                                                                                                                                                                                                                                                                                                                                                            import kiel.dataStructure.NormalTermination;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * Contains a state and two transitions.
                                                                                                         import kiel.checking.StateChartCheckerBase;
                                                                                                                                                                                                                                                     import kiel.dataStructure.GraphicalObject;
                                                                       import kiel.checking.CheckingProperties;
                                                                                                                                                                                 import kiel.dataStructure.CompoundLabel;
                                                                                                                                                                                                                import kiel.dataStructure.ForkConnector;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  private MyValidityCheckerBase myVC;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * by @see StateChartCheckerBase.
                               import kiel.checking.CheckingProblem;
                                                                                                                                                                                                                                                                                                                                                                                                                                import kiel.dataStructure.Transition;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    private final int numOfArgs = 5;
                                                                                                                                                                                                                                                                                    import kiel.dataStructure.Junction;
                                                                                                                                               import kiel.dataStructure.Choice;
                                                                                                                                                                                                                                                                                                                                                                                                 import kiel.dataStructure.State;
                                                                                                                                                                                                                                                                                                                          import kiel.dataStructure.Node;
import kiel.checking.BaseCheck;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * Copyright: (c) 2006
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * Company: Uni Kiel
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      import kiel.util.LogFile;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * The error string.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * messages.
                                                                                                                                                                                                                                                                                                                          20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            40
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  //sid: TransitionOverlapCheck.java,v 1.2 2006/04/24 12:20:41 gsc Exp $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    objects, MessageFormat.format(message, args)));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        A.3.2 TransitionOverlapCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               checker.getWarnings().add(new CheckingProblem(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            && CheckingProperties.showNodeID()) {
                                                                                                                                                                                                                                                                                                                                                         args[2 + 1] = "(ID: " + n.getID() + ")";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                } else if (CheckingProperties.showNodeName()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     || CheckingProperties.showNodeID())
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    package kiel.checking.semanticRobustnessChecks;
                                                                                                                                                                                                                                                                                                                          if (CheckingProperties.showNodeID()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  import java.security.InvalidParameterException;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (CheckingProperties.showNodeName()
                                                                 args[1] = " Pseudo State";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 args[2 + 2] = ": ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 import java.text.MessageFormat;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             import javax.swing.JOptionPane;
                                                                                                                                                                                                                                                                                                                                                                                                                                args[2 + 1] = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      args[2 + 2] = ":
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         args[2 + 2] = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      import java.util.ArrayList;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              args[2] = " ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        .mport java.util.Iterator;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       args[2] = "";
                                                                                                                                                                                                       args[1] = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   args[2] = "";
                                                                                                                                                                              args[0] = "";
                           } else {
                                                                                                                                        } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    } else {
                                                                                                                                                                                                                                                                                                                                                                                                 } else {
                                  190
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    220
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t1.getLabel(), (CompoundLabel) t2.getLabel())) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "WARNING: Transition " + t1 + " ignored, StringLabel");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   // make sure overlap check actually makes sense for t1 and t2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            JOptionPane.showMessageDialog(null, e.getMessage(),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                || (t2.getTarget() instanceof Junction))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  junctionHandler(t1, t2, (Node) o, checker);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     || (tl.getTarget() instanceof Junction)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       } else if (myVC.areOverlapping((CompoundLabel)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                generateProblem(checker, problemLocation);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          || (t2.getTarget() instanceof Choice)
                                                                                                                  outgoingTransitions.addAll (n.getOutgoingTransitions());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                           Iterator outgoingIter = outgoingTransitions.iterator();
                                                                                                                                                                                                                                     // remove transitions that do not have a CompoundLabel
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              "Semantic Robustness Checker",
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if ((tl.getTarget() instanceof Choice)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     t2 = (Transition) outgoingTransitions.get(j);
                                                                                                                                                                                                                                                                                                                                                                                       if (!(t1.getLabel() instanceof CompoundLabel)) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       } catch (InvalidParameterException e) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       JOptionPane.ERROR_MESSAGE);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          t1 = (Transition) outgoingTransitions.get(i);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  // iterate pairwise over all outgoing transitions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        problemLocation.clear();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  problemLocation.add(t1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           problemLocation.add(t2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if (makesSense(t1, t2, (Node) o)) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             problemLocation.add(o);
                                                                                                                                                                                                                                                                                                                                                        t1 = (Transition) outgoingIter.next();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       int size = outgoingTransitions.size();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            for (j = i + 1; j < size; j++) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  for (int i = 0; i < size - 1; i++) {
                                                                                                                                                                                                                                                                                                                while (outgoingIter.hasNext()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                   outgoing Iter. remove ();
   n = n.getParent();
                                                                                 } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                int j;
                                     110
                                                                                                                                                                                                                                                                                                                                                                                                                               120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  140
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     // Choice and Junction get special handling below (junctionHandler)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       outgoingTransitions.addAll(n.getOutgoingTransitions());
                                        * All transitions directly and indirectly outgoing from a state.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return (o instanceof Node) && !(o instanceof ForkConnector);
                                                                                                                  private ArrayList outgoingTransitions = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       public boolean isValidTarget(final GraphicalObject o) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          public void apply (final StateChartCheckerBase checker,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 CheckingProperties.getSemLog().log(LogFile.DETAIL,
                                                                                                                                                                                                                                                                                                                                                     public void setCvclProcess(final Process cvclProc) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "TransitionOverlapCheck, State: " + n);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    // for States, get ALL outgoing transitions
                                                                                                                                                                                                                                                                                                                                                                                              myVC = new MyValidityCheckerBin(cvclProc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       // is only null on first pass in lib mode
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    myVC = new MyValidityCheckerLib();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            final GraphicalObject o) (
                                                                                                                                                                                                                                                                       * @param cvclProc @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          outgoingTransitions.clear();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * @param checker @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (n instanceof State) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  while (n != null) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * @param o @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * @param o @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * Greturn Gsee BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (myVC == null) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Node n = (Node) o;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Transition t1;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Transition t2;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * @see BaseCheck
                                                                                                                                                                                                                                     * Gsee BaseCheck
                                                                                                                                                                                                                                                                                                                   \
*
                                                                                                                                                                                                                                                                                                                                                                                          70
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            90
9
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  80
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       100
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== ((Transition) transitions2.get(0)).getSource()) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             == ((Transition) transitions1.get(0)).getSource())
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                stackTrans.getTarget().getOutgoingTransitions());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             stackTrans.getTarget().getOutgoingTransitions());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            || stackTrans.getTarget() instanceof Choice) {
final Node n, final StateChartCheckerBase checker) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         || stackTrans.getTarget() instanceof Choice)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            compTrans1.add(new ArrayList(transitions1));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (stackTrans.getTarget() instanceof Junction
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (stackTrans.getTarget() instanceof Junction
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      // for t1, build all possible transition chains
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   // for t2, build all possible transition chains
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 stackTrans = (Transition) stack.remove(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       stackTrans = (Transition) stack.remove(0);
                                                                               ArrayList transitions1 = new ArrayList();
                                                                                                                           ArrayList transitions2 = new ArrayList();
                                                                                                                                                                                                                                                                                           ArrayList compTrans1 = new ArrayList();
                                                                                                                                                                                                                                                                                                                                      ArrayList compTrans2 = new ArrayList();
                                                                                                                                                                   ArrayList labels1 = new ArrayList();
                                                                                                                                                                                                              ArrayList labels2 = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            transitions1.add(0, stackTrans);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         transitions2.add(0, stackTrans);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    transitions1.remove(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  transitions2.remove(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if (transitions2.size() > 0) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (transitions1.size() > 0) (
                                                                                                                                                                                                                                                      ArrayList stack = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (stackTrans.getSource()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (stackTrans.getSource()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           transitions1.remove(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   while (stack.size() > 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         while (stack.size() > 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        stack.addAll(0,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             stack.addAll(0,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Transition stackTrans;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CompoundLabel 1;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     stack.add(t1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              stack.add(t2);
                                                                                                                                                                                                                                                                                                                                                                              Iterator iter;
                                                                                                                                                                                                                                                                                                                                                                                                                          Transition t;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } else {
                                                                                                                           210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              220
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       240
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              250
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      // NormalTerminations are not "in competition" with other transitions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (t1.getPriority().getValue() > t2.getPriority().getValue()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * Takes care of the special case when at least one of the transitions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         private void junctionHandler(final Transition t1, final Transition t2,
                                                                                                                                                                                                                                                                                                                                   private boolean makesSense(final Transition t1, final Transition t2,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * (default transition), but not the labels of both transitions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          boolean direct = (t1.getSource() == n || t2.getSource() == n);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        isDefaultTrans = ((tl.getLabel().toString().equals("")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           isDefaultTrans = ((t2.getLabel().toString().equals("")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            || t2.getLabel().toString().equals("tick")));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   || t1.getLabel().toString().equals("tick")));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * label of lower priority transition may be empty or "tick"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                || t1.getLabel().toString().equals("tick"))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   || t2.getLabel().toString().equals("tick"))
                                                                                                                                                                                                                                                                                                                                                                                                                                                              // at least one transiton must be directly outgoing from
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    && !(t2.getLabel().toString().equals("")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           && !(tl.getLabel().toString().equals("")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 boolean normalTerm = (tl instanceof NormalTermination)
                                                                            * Determines if it makes sense to call overlap check.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * Oparam checker The current StateChartCheckerBase.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           return direct && !isDefaultTrans && !normalTerm;
                                                                                                                                                                                                                                                      * Greturn True is overlap check should be called.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         || (t2 instanceof NormalTermination);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   < t2.getPriority().getValue()) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    } else if (tl.getPriority().getValue()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (t1.getSource() == t2.getSource()) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            boolean isDefaultTrans = false;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * @param t2 The second transition.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * @param tl The first transition.
                                                                                                                           * Oparam tl The first Transition.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * target is a Choice of Junction.
                                                                                                                                                                   * @param t2 The second Transiton.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * @param n The current Node.
                                                                                                                                                                                                              * Oparam n The current Node.
                                                                                                                                                                                                                                                                                                                                                                          final Node n) {
                                                                                   160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      170
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      200
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objects, MessageFormat.format(message, args)));
                                                                                                                                                                     args[0] = s.substring(s.lastIndexOf('.') + 1);
                                                                                                                                                                                                                                                                                                                                 args[1] = " \"" + n.getName() + "\"";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   checker.getWarnings().add(new CheckingProblem(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     && CheckingProperties.showNodeID()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  args[2 + 1] = "(ID: " + n.getID() + ")";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } else if (CheckingProperties.showNodeName()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            || CheckingProperties.showNodeID())
                                                                                                                                                if (CheckingProperties.showNodeName()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (CheckingProperties.showNodeID()) {
                                                                                      Object[] args = new Object[numOfArgs];
                                                                                                                                                                                                                                          if (n.getName().equals("")) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (CheckingProperties.showNodeName()
                                                            String s = n.getClass().getName();
                                                                                                                                                                                                                                                                                                                                                                                                                        args[1] = " Pseudo State";
                            Node n = (Node) objects.get(0);
                                                                                                                                                                                                             if (n instanceof State) (
                                                                                                                                                                                                                                                                    args[1] = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             args[2 + 2] = ": ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   args[2 + 2] = ": ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            args[2 + 1] = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          args[2 + 2] = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            args[0] = "";
args[1] = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     args[2] = " ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              args[2] = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          args[2] = "";
                                                                                                                                                                                                                                                                                                    } else {
                                                                                                                                                                                                                                                                                                                                                                                              } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   } else {
                                                                                                                                                310
                                                                                                                                                                                                                                                                                                                                                                                                                                                     320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               330
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   340
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * This method is used internally by a check to generate the according
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * @param checker The checker where the problem will be added to.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    private void generateProblem(final StateChartCheckerBase checker,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      (myVC.areOverlappingMulti(labels1, labels2)) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   generateProblem(checker, problemLocation);
                                                                                                                                                                                                                                                                                                       transitions2 = (ArrayList) compTrans2.get(j);
                            compTrans2.add(new ArrayList(transitions2));
                                                                                                                                                                                                                                          transitions1 = (ArrayList) compTrans1.get(i);
                                                                                                                                                                                                                                                                       for (int j = 0; j < compTrans2.size(); j++) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        problemLocation.add(t.getSource());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            problemLocation.add(t.getSource());
                                                                                                                                                                             // iterate pairwise over both transition lists
                                                                                                                                                                                                             for (int i = 0; i < compTrans1.size(); i++) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              1 = (CompoundLabel) t.getLabel();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     1 = (CompoundLabel) t.getLabel();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 t = (Transition) iter.next();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        t = (Transition) iter.next();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * @param objects The sources of the problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       iter = transitions1.iterator();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            iter = transitions2.iterator();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     problemLocation.add(t);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         problemLocation.add(t);
                                                                                                                                                                                                                                                                                                                                                                 problemLocation.clear();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 while (iter.hasNext()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        while (iter.hasNext()) {
                                                            transitions2.remove(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * instance of a RobustnessProblem.
                                                                                                                                                                                                                                                                                                                                                                                           problemLocation.add(n);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    final ArrayList objects) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              labels1.add(1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  labels2.add(1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                  labels1.clear();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            labels2.clear();
} else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ΊĘ
                                                                                                                   260
                                                                                                                                                                                                                                                                                                                                                                                                                          270
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   290
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```

A.3.3 RaceConditionsCheck

* The write/write error string.

```
private final String message1 = "A Write/Write Race Condition might occur
                                                                                                                                                                                                                                                                                          private final String message2 = "A Write/Read Race Condition might occur
                                                                                                                                                                                                                                                                                                                                     + "between transiton action {0} and transition condition {1}{2}.";
                                                                                                                                                                                                                                                                                                                                                                                                                                      \star Number of arguments used of string formatting of error and warning
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * All valued signals and variables read by a transition condition.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * All transitions directly and indirectly outgoing from a state.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * All transitions directly and indirectly outgoing from a state.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          private ArrayList outgoingTransitions = new ArrayList();
                                              + "between two transiton actions {0} and {1}{2}.";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              private ArrayList problemLocation = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    public boolean isValidTarget(final GraphicalObject
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * The parent of the source of the race condition.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       private ArrayList readVars = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               private BooleanComparator parent = null;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * Contains a state and two transitions.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           private ArrayList parallelTransitions;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 private final int numOfArgs = 3;
                                                                                                                                                                                              * The write/read error string.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * @param o @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * Greturn Gsee BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * messages.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      9
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  80
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * Description: Checks for uniqueness of transition pririties, dynamically
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>

« @version $Revision: 1.6 $ last modified $Date: 2006/04/23 14:37:15 $
            //$Id: RaceConditionsCheck.java, v 1.6 2006/04/23 14:37:15 gsc Exp $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          oublic final class RaceConditionCheck extends BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             import kiel.dataStructure.action.GenerateValuedEvent;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   import kiel.dataStructure.boolexp.BooleanComparator;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  import kiel.dataStructure.boolexp.BooleanExpression;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    import kiel.dataStructure.action.IntegerAssignment;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          import kiel.dataStructure.intexp.IntegerExpression;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 import kiel.dataStructure.boolexp.BooleanBrackets;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         import kiel.dataStructure.boolexp.BooleanVariable;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          import kiel.dataStructure.eventexp.CombineSignal;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        import kiel.dataStructure.eventexp.IntegerSignal;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        import kiel.dataStructure.intexp.IntegerVariable;
                                                                   package kiel.checking.semanticRobustnessChecks;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            import kiel.dataStructure.boolexp.BooleanNot;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  import kiel.dataStructure.boolexp.BooleanAnd;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * loaded by @see StateChartCheckerBase.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               import kiel.dataStructure.boolexp.BooleanOr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     import kiel.checking.StateChartCheckerBase;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       import kiel.dataStructure.eventexp.Signal;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         import kiel.dataStructure.GraphicalObject;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        import kiel.dataStructure.CompositeState;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          import kiel.dataStructure.CompoundLabel;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   import kiel.dataStructure.action.Action;
                                                                                                                                                                                                                                                                                                                                                                                                                                                       import kiel.checking.CheckingProperties;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       import kiel.dataStructure.boolexp.Pre;
                                                                                                                                                                                                                                                                                                                                                                                                        import kiel.checking.CheckingProblem;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    import kiel.dataStructure.Transition;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      import kiel.dataStructure.Region;
                                                                                                                                                                                                                                                                                                                                                              import kiel.checking.BaseCheck;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       import kiel.dataStructure.Node;
                                                                                                                                                            import java.text.MessageFormat;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * Copyright: (c) 2006
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * Company: Uni Kiel
                                                                                                                                                                                                              import java.util.ArrayList;
                                                                                                                                                                                                                                                                 import java.util.Iterator;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      import kiel.util.LogFile;
                                                                                                                                                                                                                                                                                                                                                                                                                                                       10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             40
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                20
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pTrans.addAll(stackNode.getOutgoingTransitions());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           stack.addAll(((CompositeState) stackNode)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * Find all transitions that can potentially occur in parallel with
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (stackNode instanceof CompositeState) {
"WARNING: Transition " + parallel
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          private ArrayList getParallelTransitions(final Transition base) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             parallelRegions = source.getParent().getSubnodes();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                for (int i = 0; i < parallelRegions.size(); i++) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (!parallelRegions.get(i).equals(source)) {
    stack.add(parallelRegions.get(i));
                                                                                                                                                                                                                    CheckingProperties.getSemLog().log(LogFile.DEBUG, "WARNING: Transition " + outgoing
                                      + " ignored, StringLabel");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 stackNode = (Node) stack.remove(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  .getSubnodes());
                                                                                                                                                                                                                                                                                                 + " ignored, StringLabel");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             while (stack.size() > 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * Greturn All transitions parallel to base
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ArrayList pTrans = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (source instanceof Region) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ArrayList stack = new ArrayList();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      source = source.getParent();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Node source = base.getSource();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ArrayList parallelRegions;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               while (source != null) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * Transition base.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Node stackNode;
                                                                                                                                                       }
} else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             return pTrans;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * @param base
                                                                                                                                                                                    150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     170
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  // care only about transitions that have an action
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         .getEffect().getActions().length != 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               LogFile.DEBUG, "Parallel: " + parallel);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                parallelTransitions = getParallelTransitions(outgoing);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (parallel.getLabel() instanceof CompoundLabel) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    parallel = (Transition) parallelTransIter.next();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   haveWWRace(outgoing, parallel, checker);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    parallelTransIter = parallelTransitions.iterator();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (((CompoundLabel) parallel.getLabel())
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   haveWRRace(outgoing, parallel, checker);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  // care only about transitions that have an action
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         .getEffect().getActions().length != 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              CheckingProperties.getSemLog().log(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (outgoing.getLabel() instanceof CompoundLabel) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    outgoingTransitions.addAll(n.getOutgoingTransitions());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CheckingProperties.getSemLog().log(LogFile.DETAIL,
                                                                                                                                                                                                                                                                                                 public void apply(final StateChartCheckerBase checker,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 while (parallelTransIter.hasNext()) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (((CompoundLabel) outgoing.getLabel())
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        outgoing = (Transition) outgoingIter.next();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           outgoingIter = outgoingTransitions.iterator();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                "Outgoing: " + outgoing);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       "RaceConditionCheck, State: " + n);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     while (outgoingIter.hasNext()) {
                                                                                                                                                                                                                                                                                                                                        final GraphicalObject o) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       outgoingTransitions.clear();
                                                                                                                                                                                    * @param checker @see BaseCheck
   return (o instanceof Node);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Iterator parallelTransIter;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 // get outgoing transitions
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Iterator outgoingIter;
                                                                                                                                                                                                                          * @param o @see BaseCheck
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Transition parallel;
                                                                                                                                                                                                                                                                                                                                                                                                                                                  Transition outgoing;
                                                                                                                                                                                                                                                                                                                                                                                                           Node n = (Node) o;
                                                                                                                                                * @see BaseCheck
                                                                                                                                                100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               140
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* Determines whether two transitions have a possible write/read race
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Action[] tlActions = ((CompoundLabel) tl.getLabel()).getEffect()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              problemLocation.add(readVars.get(j + 1));
                                                                                                                                                                                                                                                                                                                                                                                                               private void haveWRRace (final Transition t1, final Transition t2,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             generateProblem(checker, problemLocation, 2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } else if (tlActions[i] instanceof GenerateValuedEvent)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       for (int j = 0; j < readVars.size(); j = j + 2) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               problemLocation.add(readVars.get(j));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       problemLocation.add(readVars.get(j));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        setVars(((CompoundLabel) t2.getLabel()).getCondition());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          for (int j = 0; j < readVars.size(); j = j + 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          (GenerateValuedEvent) tlActions[i]).
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     getVariable().toString()))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          (IntegerAssignment) tlActions[i]).
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 getEvent().toString())) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if (tlActions[i] instanceof IntegerAssignment) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (readVars.get(j).toString().equals((
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (readVars.get(j).toString().equals((
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            problemLocation.add(tlActions[i]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        problemLocation.add(tlActions[i]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            (readVars.get(j + 1) == null) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if (readVars.get(j + 1) == null) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        for (int i = 0; i < tlActions.length; <math>i++) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                           final StateChartCheckerBase checker) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            problemLocation.add(t1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         problemLocation.add(t1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 problemLocation.add(t2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 problemLocation.add(t2);
                                                                                                                                                                                                                                                                                                                                    * @param checker The StateChartCheckerBase.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     problemLocation.clear();
                                                                                                                                                                                                                                             * Oparam tl The first transition.
                                                                                                                                                                                                                                                                                     * Oparam t2 The second transtion.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 .getActions();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 readVars.clear();
                                                                                                                                                                                                         * condition.
                                                                                                                                                                                                      250
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         260
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            270
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            280
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            290
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   == ((IntegerAssignment) t2Actions[j]).getVariable()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 == ((GenerateValuedEvent) t2Actions[j]).getEvent()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                // ignore CombineSingnals
if (!((GenerateValuedEvent) tlActions[i]).getEvent()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  && t1.toString().compareTo(t2.toString()) < 0) {</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            && t1.toString().compareTo(t2.toString()) < 0) (</pre>
* Determines whether two transitions have a possible write/write race
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              && t2Actions[j] instanceof GenerateValuedEvent) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 generateProblem(checker, problemLocation, 1);
                                                                                                                                                                                                                                                                                                                                                                        Action[] tlActions = ((CompoundLabel) tl.getLabel()).getEffect()
                                                                                                                                                                                                                                                                                                                                                                                                                                                       Action[] t2Actions = ((CompoundLabel) t2.getLabel()).getEffect()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if ((IntegerAssignment) tlActions[i]).getVariable()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            && t2Actions[j] instanceof IntegerAssignment) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     // makes sure there are no duplicate errors
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          // makes sure there are no duplicate errors
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if ((GenerateValuedEvent) tlActions[i]).getEvent()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   } else if (tlActions[i] instanceof GenerateValuedEvent
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            generateProblem(checker, problemLocation, 1);
                                                                                                                                                                                                                                             private void haveWWRace(final Transition t1, final Transition t2,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              problemLocation.add(tlActions[i]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     problemLocation.add(t2Actions[j]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              \ensuremath{//} iterate pairwise over all the actions of t1 and t2
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (tlActions[i] instanceof IntegerAssignment
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       instanceof CombineSignal)) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            problemLocation.add(tlActions[i]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 problemLocation.add(t2Actions[j]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 for (int j = 0; j < t2Actions.length; <math>j++) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         for (int i = 0; i < tlActions.length; i++) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  problemLocation.add(t1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          problemLocation.add(t2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        problemLocation.clear();
                                                                                                                                                                                                                                                                                        final StateChartCheckerBase checker)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             problemLocation.add(t1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     problemLocation.add(t2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       problemLocation.clear();
                                                                                                                                                                  * Oparam checker The StateChartCheckerBase.
                                                                               * Oparam tl The first transition.
                                                                                                                      * Oparam t2 The second transtion.
                                                                                                                                                                                                                                                                                                                                                                                                                   .getActions();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  .getActions();
                                           * condition.
                                                                                                                                                                                                         *
                                                                                                                                                              200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     220
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        240
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* This method is used internally by a check to generate the according
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * @param checker The checker where the problem will be added to.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          private void generateProblem(final StateChartCheckerBase checker,
                                                                                                                                                                                                                             * Finds all integer variables read in a transition condition.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         setIntVars((IntegerExpression) p.getExpression());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             args[2] = ", at transitions " + objects.get(0)
                                                                                                                                                                                                                                                                                                                                public void setIntVars(final IntegerExpression ix)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               final ArrayList objects, final int type) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if (CheckingProperties.showTransitions()) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   } else if (ix instanceof IntegerVariable) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * @param objects The sources of the problem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                + " and " + objects.get(1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Object[] args = new Object[numOfArgs];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            * @param type Write/write or write/read.
                                                                                                                                                                                                                                                                   * @param ix The KIEL IntegerExpression.
                                                                                                                                                                                                                                                                                                                                                                                                      if (ix instanceof IntegerSignal) (
                                                                  setIntVars(bc.getRightExp());
                             setIntVars(bc.getLeftExp());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      } else if (ix instanceof Pre) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * instance of a RobustnessProblem.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   args[1] = objects.get(2 + 1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      readVars.add(parent);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         readVars.add(parent);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                args[0] = objects.get(2);
                                                                                                                                                                                                                                                                                                                                                                                                                                   readVars.add(ix);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         readVars.add(ix);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Pre p = (Pre) ix;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                args[2] = "";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (type == 1) (
  parent = bc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      } else {
                                                                                                                                                                                                                                                                                                   350
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         370
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      360
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   380
                             problemLocation.add(readVars.get(j + 1));
                                                                                                generateProblem(checker, problemLocation, 2);
                                                                                                                                                                                                                                                                                                                                                                                                      * Finds all boolean variables read in a transition condition.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      BooleanComparator bc = (BooleanComparator) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               BooleanBrackets bb = (BooleanBrackets) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      } else if (bx instanceof BooleanComparator) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   public void setVars(final BooleanExpression bx)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } else if (bx instanceof BooleanBrackets) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      } else if (bx instanceof BooleanVariable) {
                                                                                                                                problemLocation.clear();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   } else if (bx instanceof BooleanNot) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                } else if (bx instanceof BooleanOr) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            else if (bx instanceof BooleanAnd)
                                                                                                                                                                                                                                                                                                                                                                                                                                   * @param bx The KIEL BooleanExpression.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               BooleanAnd ba = (BooleanAnd) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      BooleanNot bn = (BooleanNot) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   BooleanOr bo = (BooleanOr) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         } else if (bx instanceof Pre) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               setVars (p.getExpression());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (bx instanceof Signal) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   setVars(bo.getRight());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  setVars (ba.getRight());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               setVars(ba.getLeft());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      setVars(bo.getLeft());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            setVars (bb.getBody());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         setVars(bn.getBody());
} else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         readVars.add(null);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      readVars.add(null);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Pre p = (Pre) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      readVars.add(bx);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         readVars.add(bx);
                                                                                                                                                                                                                                                                   300
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      310
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A.4 Validity Checker Link-Up

A.4.1 MyValidityCheckerBase

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* @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * Determines whether the predicates of two transition-groups overlap.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   public abstract boolean areOverlappingMulti(final ArrayList labels1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  \star @version $Revision: 1.1 $ last modified $Date: 2006/04/10 10:22:22 $
//Sid: MyValidityCheckerBase.java,v 1.1 2006/04/10 10:22:22 gsc Exp $ package kiel.checking.semanticRobustnessChecks;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * Determines whether the predicates of two transitions overlap.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      public abstract boolean areOverlapping(final CompoundLabel cll,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * Greturn True if the transition predicates overlap.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * Greturn True if the transition predicates overlap.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  \star @param labels1 The first group of transitions. 
 \star @param labels2 The second group of transitions.
                                                                                                                                                                                                                                                                                                                                                        * Description: Validity Checker base class.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       public abstract class MyValidityCheckerBase
                                                                                                                                                                                                                              import kiel.dataStructure.CompoundLabel;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * @param cll The first transition. * @param cl2 The second transition.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    final CompoundLabel c12);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             final ArrayList labels2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                * Copyright: (c) 2006
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * Company: Uni Kiel
                                                                                                                                      import java.util.ArrayList;
                                                                                                                                                                                                                                                                                                                                                                                                      10
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A.4.2 MyValidityCheckerBin

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\star @version $Revision: 1.2 \$ last modified $Date: 2006/04/12 09:29:05 \$
                                                                         public final class MyValidityCheckerBin extends MyValidityCheckerBase (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         private BufferedReader cvclOutput = null;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    private PrintWriter cvclInput = null;
                                                                                                                                                                                                                                                                       private BooleanExpression el;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  private BooleanExpression e2;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            private BooleanExpression cl;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    private BooleanExpression c2;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              private Process cvcl = null;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         private String cvclQuery;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           private String cvclDecls;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           **/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   9
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          80
                                                                                                                           //$Id: MyValidityCheckerBin.java,v 1.2 2006/04/12 09:29:05 gsc Exp $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * Description: Validity Checker using CVCL binary.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   import kiel.dataStructure.boolexp.BooleanComparator;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           import kiel.dataStructure.boolexp.BooleanExpression;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  import kiel.dataStructure.boolexp.BooleanTrueDummy;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              kiel.dataStructure.boolexp.BooleanBrackets;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    kiel.dataStructure.boolexp.BooleanVariable;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                kiel.dataStructure.boolexp.GreaterOrEqual;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                import kiel.dataStructure.eventexp.IntegerSignal;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      import kiel.dataStructure.intexp.IntegerConstant;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  import kiel.dataStructure.intexp.IntegerVariable;
                                                                                                                                                                      package kiel.checking.semanticRobustnessChecks;
                                                                                                                                                                                                                                                                                                                                                                                                      import java.security.InvalidParameterException;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   import kiel.dataStructure.boolexp.BooleanFalse;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          import kiel.dataStructure.boolexp.BooleanTrue;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    kiel.dataStructure.eventexp.TrueSignal;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        import kiel.dataStructure.boolexp.GreaterThan;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             import kiel.dataStructure.boolexp.LessOrEqual;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      kiel.dataStructure.boolexp.BooleanAnd;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    import kiel.dataStructure.boolexp.BooleanNot;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         import kiel.dataStructure.boolexp.BooleanOr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      import kiel.dataStructure.boolexp.NotEqual;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     import kiel.dataStructure.boolexp.LessThan;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    import kiel.dataStructure.eventexp.Signal;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            import kiel.dataStructure.boolexp.Equal;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             import kiel.checking.CheckingProperties;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            kiel.dataStructure.eventexp.Tick;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  import kiel.dataStructure.CompoundLabel;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              import kiel.dataStructure.boolexp.Pre;
                                                                                                                                                                                                                                                                                                                            import java.io.InputStreamReader;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                import javax.swing.JOptionPane;
                                                                                                                                                                                                                                                import java.io.BufferedReader;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * Copyright: (c) 2006
                                                                                                                                                                                                                                                                                                                                                                                                                                       import java.util.ArrayList;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * Company: Uni Kiel
                                                                                                                                                                                                                                                                                 java.io.IOException;
                                                                                                                                                                                                                                                                                                                                                              import java.io.PrintWriter;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       import kiel.util.LogFile;
                                                                                                                                                                                                                                                                                        import
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             import
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       import
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    import
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            import
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  import
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* @author Gunnar Schaefer

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"Semantic Robustness Checker", JOptionPane.ERROR_MESSAGE);
                                                                                                                                                                                                                                                                                                                                                                                  JOptionPane.showMessageDialog(null, "CVCL binary not responding",
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    public boolean areOverlappingMulti(final ArrayList labels1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                "isSAT: " + cvclResult.endsWith("Invalid."));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CheckingProperties.getSemLog().log(LogFile.DETAIL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               el = cll.getTrigger().getEventExpression();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      + " AND " + conditionConvert (c1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * @param labels2 The @see MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         for (int i = 0; i < labels1.size(); i++) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      for (int i = 0; i < labels2.size(); i++) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          cl1 = (CompoundLabel) labels1.get(i);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    cl2 = (CompoundLabel) labels2.get(1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * @param labels1 @see MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ex1 += " AND " + triggerConvert(e1)
                                                                                                                                                                                                                                                                                                                   cvclResult = cvclOutput.readLine();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   return cvclResult.endsWith("Invalid.");
"cvclQuery: " + cvclQuery);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * Greturn Gsee MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         final ArrayList labels2) (
                                                                  cvclInput.println(cvclDecls);
                                                                                                                                           cvclInput.println(cvclQuery);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                c1 = c11.getCondition();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   "ex1: " + ex1);
                                                                                                       cvclInput.println("PUSH;");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   cvclDecls = ""; //resetting
                                                                                                                                                                             cvclInput.println("POP;");
                                                                                                                                                                                                                                                                                                                                                 } catch (IOException e) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * @see MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 String ex1 = "TRUE";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                String ex2 = "TRUE";
                                                                                                                                                                                                              cvclInput.flush();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               CompoundLabel cll;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CompoundLabel c12;
                                                                                                                                                                                                                                                                                                                                                                                                                                                           return false;
                                                                                                                                                                                                                                                                                    try (
                                                                                                                                                                          150
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           160
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                170
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    new InputStreamReader(cvcl.getInputStream()));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  cvclInput = new PrintWriter(cvcl.getOutputStream());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             + "(" + conditionConvert(c1) + ")" + " AND "
                                                                                                                                                                                                                                                * True if currently parsing body of a pre() expression.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               + "(" + triggerConvert(e1) + ")" + " AND "
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              + "(" + triggerConvert(e2) + ")" + " AND "
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             public boolean areOverlapping (final CompoundLabel cll,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CheckingProperties.getSemLog().log(LogFile.DETAIL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             public MyValidityCheckerBin(final Process cvclProc) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                e2 = c12.getTrigger().getEventExpression();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 el = cll.getTrigger().getEventExpression();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   + "(" + conditionConvert(c2) + ")"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * @param c12 The @see MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * @param cl1 @see MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      "cvclDecls: " + cvclDecls);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * Greturn Gsee MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   cvclOutput = new BufferedReader(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * @param cvclProc The CVCL process
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               final CompoundLabel c12) (
                                                                                                                                                                                                                                                                                 * Does not support nested pre's.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      cvclDecls = ""; //resetting
                                                                                                                                                                                                                                                                                                                                                    private boolean isPre = false;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 cvclQuery = "QUERY NOT ("
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * @see MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 c1 = cll.getCondition();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   c2 = c12.getCondition();
                                                                                                                                                                                                                                                                                                                                                                                                                                                        * The default constructor.
                                                                                                       private String cvclResult;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    cvcl = cvclProc;
                                                                                                                                                                                                                                                                                                                   *
                                                                                                                                     100
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          110
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           120
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   130
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       140
```

```
throw new InvalidParameterException("\"" + bx.getClass().getName()
                                                                                                                                                                                                                                                                                       <u>.</u>``
                                                                                                                                                                                                                                                                                       cvclDecls += "pre_e_" + bx.toString() + " : BOOLEAN;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 cvclDecls += "pre_e_" + bx.toString() + " : BOOLEAN;
                                     //does not support nested pre's
                                                                                                                                                                                                                                                                                                                                                                                              cvclDecls += "e_" + bx.toString() + " : BOOLEAN; ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        cvclDecls += "e_" + bx.toString() + " : BOOLEAN; ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    + "\" is not a supported trigger expression.");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             return "(" + triggerConvert(bb.getBody()) + ")";
                                                                        String s = triggerConvert(p.getExpression());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           return triggerConvert(ba.getLeft()) + " AND "
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       return "NOT " + triggerConvert(bn.getBody());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       OR.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        BooleanBrackets bb = (BooleanBrackets) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     } else if (bx instanceof BooleanBrackets) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return triggerConvert(bo.getLeft()) + "
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } else if (bx instanceof BooleanVariable)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   return "pre_e_" + bx.toString();
                                                                                                                                                                                                                                                                                                                         return "pre_e_" + bx.toString();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             + triggerConvert(ba.getRight());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  } else if (bx instanceof BooleanAnd) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               } else if (bx instanceof BooleanNot) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               } else if (bx instanceof BooleanOr) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              return "e_" + bx.toString();
                                                                                                                                                                                                                                                                                                                                                                                                                                    return "e_" + bx.toString();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             + triggerConvert(bo.getRight());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    BooleanNot bn = (BooleanNot) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        BooleanAnd ba = (BooleanAnd) bx;
                                                                                                                                                                                                           } else if (bx instanceof Signal) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        BooleanOr bo = (BooleanOr) bx;
Pre p = (Pre) bx;
                                                                                                          isPre = false;
                                     isPre = true;
                                                                                                                                                                                                                                                    if (isPre) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if (isPre) {
                                                                                                                                             return s;
                                                                                                                                                                                                                                                                                                                                                               } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              **/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            290
                                                                                                                                                                                                                                                 250
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 260
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             270
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            280
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           "Semantic Robustness Checker", JOptionPane.ERROR_MESSAGE);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  JOptionPane.showMessageDialog(null, "CVCL binary not responding",
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * Converts a KIEL Trigger BooleanExpression into an according JCVCL Expr
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 //maybe true, maybe false => acts like a boolean signal
                                                                                                                                                                                                                                                                                    cvclQuery = "QUERY NOT (" + ex1 + " AND " + ex2 + ");";
                                                                                                                                          CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    public String triggerConvert (final BooleanExpression bx)
                                                                                                                                                                                                                                                                                                                                                                                                                                    CheckingProperties.getSemLog().log(LogFile.DETAIL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CheckingProperties.getSemLog().log(LogFile.DETAIL,
                                                                                                                                                                                                                                                                                                                                                         CheckingProperties.getSemLog().log(LogFile.DEBUG,
e2 = cl2.getTrigger().getEventExpression();
                                                                                                       + " AND " + conditionConvert(c2);
                                                                        ex2 += " AND " + triggerConvert(e2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                cvclResult = cvclOutput.readLine();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return cvclResult.endsWith("Invalid.");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        "cvclResult: " + cvclResult);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * @param bx The KIEL BooleanExpression.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   "cvclQuery: " + cvclQuery);
                                                                                                                                                                                                                                                                                                                                                                                                 "cvclDecls: " + cvclDecls);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } else if (bx instanceof Pre) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * Greturn An according JCVCL Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 } else if (bx instanceof Tick)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    cvclInput.println(cvclQuery);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (bx instanceof TrueSignal)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           cvclInput.println(cvclDecls);
                               c2 = c12.getCondition();
                                                                                                                                                                         "ex2: " + ex2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           cvclInput.println("PUSH;");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   cvclInput.println("POP;");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   } catch (IOException e) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         cvclInput.flush();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         return "TRUE";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       return "TRUE";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             return false;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 try (
                                                                                                                                                                                                                  200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           210
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             220
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         240
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```
throw new InvalidParameterException("\"" + bc.getClass().getName()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     "\" is not a supported comparator expression.");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * Converts a KIEL IntegerExpression into an according JCVCL Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           return "NOT (" + intExConvert (bc.getLeftExp()) + " = "
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           cvclDecls += "pre_c_" + ix.toString() + " : INT;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   public String intExConvert(final IntegerExpression ix)
                                                                          public String compConvert (final BooleanComparator bc)
                                                                                                                                                                                                                                                                                                                                                                 return intExConvert(bc.getLeftExp()) + " >= "
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                return intExConvert(bc.getLeftExp()) + " <= "
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            return intExConvert(bc.getLeftExp()) + " < "
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     + intExConvert(bc.getRightExp()) + ")";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 return intExConvert (bc.getLeftExp()) + " >
                                                                                                                                                                                                      return intExConvert(bc.getLeftExp()) + "
                                                                                                                                                                                                                                                                                                                          } else if (bc instanceof GreaterOrEqual) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      + intExConvert (bc.getRightExp());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         } else if (ix instanceof IntegerSignal) {
                                                                                                                                                                                                                                                + intExConvert(bc.getRightExp());
                                                                                                                                                                                                                                                                                                                                                                                                        + intExConvert(bc.getRightExp());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               + intExConvert(bc.getRightExp());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       + intExConvert(bc.getRightExp());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              return "pre_c_" + ix.toString();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          } else if (bc instanceof GreaterThan) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     } else if (bc instanceof LessOrEqual) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     } else if (bc instanceof LessThan) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                } else if (bc instanceof NotEqual) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (ix instanceof IntegerConstant) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * @param ix The KIEL IntegerExpression.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               return ix.toIntExpString();
* Greturn An according JCVCL Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * Greturn An according JCVCL Expr.
                                                                                                                                                               if (bc instanceof Equal) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (isPre) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                } else {
                                                                                                                                                                                                                                                                                                                                                                     350
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   380
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              360
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       370
* Converts a KIEL Condition BooleanExpression into an according JCVCL Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 throw new InvalidParameterException("\"" + bx.getClass().getName()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              \star Converts a KIEL BooleanComparator into an according JCVCL Expr. \star &param bc The KIEL BooleanComparator.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           + "\" is not a supported condition expression.");
                                                                                                                                                               public String conditionConvert(final BooleanExpression bx) (
                                                                                                                                                                                                                                                                                       cvclDecls += "c_" + bx.toString() + " : BOOLEAN; ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            return "(" + conditionConvert(bb.getBody()) + ")";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              return conditionConvert (ba.getLeft()) + " AND "
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       return "NOT " + conditionConvert(bn.getBody());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 return conditionConvert (bo.getLeft()) + " \circR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            return compConvert((BooleanComparator) bx);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          else if (bx instanceof BooleanBrackets) {
    BooleanBrackets bb = (BooleanBrackets) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     else if (bx instanceof BooleanComparator) (
                                                                                                                                                                                                                                                                                                                                                                                                        } else if (bx instanceof BooleanTrueDummy)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            + conditionConvert (bo.getRight());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     + conditionConvert (ba.getRight());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     } else if (bx instanceof BooleanFalse) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      } else if (bx instanceof BooleanNot) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } else if (bx instanceof BooleanAnd) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                } else if (bx instanceof BooleanOr) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    } else if (bx instanceof BooleanTrue)
                                                                                                                                                                                                                                                if (bx instanceof BooleanVariable) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        BooleanAnd ba = (BooleanAnd) bx;
                                   * @param bx The KIEL BooleanExpression.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    BooleanNot bn = (BooleanNot) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          BooleanOr bo = (BooleanOr) bx;
                                                                                                                                                                                                                                                                                                                          return "c_" + bx.toString();
                                                                                 * Greturn An according JCVCL Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         return "FALSE";
                                                                                                                                                                                                                                                                                                                                                                                                                                               return "TRUE";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        return "TRUE";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              **/
                                                                                                                                                                                                                                                                                                                          300
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            330
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* @author <a href="mailto:gsc@informatik.uni-kiel.de">Gunnar Schaefer</a>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    \star @version $Revision: 1.1 $ last modified $Date: 2006/04/10 10:22:22 $
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      public final class MyValidityCheckerLib extends MyValidityCheckerBase (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * Description: Validity Checker using JCVCL library and JNI.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     private ValidityChecker vc = ValidityChecker.create();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             import kiel.dataStructure.intexp.IntegerExpression;
   import kiel.dataStructure.boolexp.BooleanTrueDummy;
                                                import kiel.dataStructure.boolexp.BooleanVariable;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   import kiel.dataStructure.intexp.IntegerConstant;
                                                                                                                                   import kiel.dataStructure.boolexp.GreaterOrEqual;
                                                                                                                                                                                                                                                                                                                                                                                              import kiel.dataStructure.eventexp.IntegerSignal;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      import kiel.dataStructure.intexp.IntegerVariable;
                                                                                                                                                                                                              import kiel.dataStructure.boolexp.LessOrEqual;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      import kiel.dataStructure.eventexp.TrueSignal;
                                                                                                                                                                        import kiel.dataStructure.boolexp.GreaterThan;
                                                                                                                                                                                                                                                                                                        import kiel.dataStructure.boolexp.NotEqual;
                                                                                                                                                                                                                                                               import kiel.dataStructure.boolexp.LessThan;
                                                                                                                                                                                                                                                                                                                                                                                                                                        import kiel.dataStructure.eventexp.Signal;
                                                                                          import kiel.dataStructure.boolexp.Equal;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 import kiel.dataStructure.eventexp.Tick;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  import kiel.util.jcvcl.ValidityChecker;
                                                                                                                                                                                                                                                                                                                                                 import kiel.dataStructure.boolexp.Pre;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             private BooleanExpression e2;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              private BooleanExpression el;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               private BooleanExpression cl;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * Copyright: (c) 2006
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         import kiel.util.jcvcl.Expr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * Company: Uni Kiel
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   import kiel.util.LogFile;
                                                                                                                               20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   30
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    40
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       throw new InvalidParameterException("\"" + ix.getClass().getName()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         String s = intExConvert((IntegerExpression) p.getExpression());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       //$Id: MyValidityCheckerLib.java,v 1.1 2006/04/10 10:22:22 gsc Exp $
                                                                                                                                                                                                                                                       cvclDecls += "pre_c_" + ix.toString() + " : INT; ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   //does not support nested pre's
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                + "\" is not a supported integer expression.");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             //maybe true, maybe false => acts like a boolean signal
                                                                                                                                                                                                                                                                                                                                                                                           cvclDecls += "c_" + ix.toString() + " : INT; ";
cvclDecls += "c_" + ix.toString() + " : INT; ";
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             A.4.3 MyValidityCheckerLib
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            import kiel.dataStructure.boolexp.BooleanComparator;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     import kiel.dataStructure.boolexp.BooleanExpression;
                                                                                                                                                                        } else if (ix instanceof IntegerVariable) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  import kiel.dataStructure.boolexp.BooleanBrackets;
                                                                                                                                                                                                                                                                                                        return "pre_c_" + ix.toString();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 package kiel.checking.semanticRobustnessChecks;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   import java.security.InvalidParameterException;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  import kiel.dataStructure.boolexp.BooleanFalse;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              import kiel.dataStructure.boolexp.BooleanTrue;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         import kiel.dataStructure.boolexp.BooleanAnd;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           import kiel.dataStructure.boolexp.BooleanNot;
                                         return "c_" + ix.toString();
                                                                                                                                                                                                                                                                                                                                                                                                                                    return "c_" + ix.toString();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 import kiel.dataStructure.boolexp.BooleanOr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   } else if (ix instanceof Pre) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   import kiel.checking.CheckingProperties;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                import kiel.dataStructure.CompoundLabel;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Pre p = (Pre) ix;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            import java.util.ArrayList;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      isPre = false;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   isPre = true;
                                                                                                                                                                                                                  if (isPre) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   return s;
                                                                                                                                                                                                                                                                                                                                                 } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               10
390
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+ "] //\ [" + cvclE2 + "] /\\ [" + cvclC2 + "]");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        public boolean areOverlappingMulti(final ArrayList labels1,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CheckingProperties.getSemLog().log(LogFile.DETAIL, "CVCL query: [" + cvclEl + "] //\ [" + cvclCl
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return isSat (vc.andExpr(vc.andExpr(cvclE1, cvclC1),
                                                                                                                                                                                        public boolean areOverlapping (final CompoundLabel cll,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     CheckingProperties.getSemLog().log(LogFile.DEBUG, "cvclE1: " + cvclE1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * @param labels2 The @see MyValidityCheckerBase
                                                                                                                                                                                                                                                                                   e1 = cll.getTrigger().getEventExpression();
e2 = cl2.getTrigger().getEventExpression();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * @param labels1 @see MyValidityCheckerBase
                                                                                          * @param c12 The @see MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           (vc.andExpr(cvclE2, cvclC2)));
                                                            * @param cl1 @see MyValidityCheckerBase
                                                                                                                              * Greturn Gsee MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * Greturn Gsee MyValidityCheckerBase
                                                                                                                                                                                                                       final CompoundLabel c12) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         final ArrayList labels2) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             cvclC1 = conditionConvert(c1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           cvclC2 = conditionConvert(c2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  "cvclC1: " + cvclC1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               "cvclC2: " + cvclC2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      "cvclE2: " + cvclE2);
                                                                                                                                                                                                                                                                                                                                                                                                                                              cvclE1 = triggerConvert(e1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               cvclE2 = triggerConvert(e2);
* @see MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  * @see MyValidityCheckerBase
                                                                                                                                                                                                                                                                                                                                                   c1 = cll.getCondition();
                                                                                                                                                                                                                                                                                                                                                                                 c2 = c12.getCondition();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   CompoundLabel cl1;
CompoundLabel cl2;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         160
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * True if currently parsing body of a pre() expression.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            CheckingProperties.getSemLog().log(LogFile.DETAIL,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * @return True if the expression is satisfiable.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * Checks the satisfiability of the expression.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 boolean isSat = [vc.query(ex.negate());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 public boolean isSat(final Expr ex) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * @param ex The expression to check.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * Does not support nested pre's.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             "isSAT: " + isSat);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               private boolean isPre = false;
                                                                                             private BooleanExpression c2;
                                                                                                                                                                                                                                                        private Expr cvclE1;
                                                                                                                                                                                                                                                                                                                                                                                                               private Expr cvclE2;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          private Expr cvclCl;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    private Expr cvclC2;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return isSat;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   vc.push();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  vc.pop();
                                                                                                                                                                                                                       \*
                                                                                                                                                                                                                                                                                                                                                                                    *
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               **/
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* Converts a KIEL Condition BooleanExpression into an according JCVCL Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        throw new InvalidParameterException("\"" + bx.getClass().getName()
                                                                                                                                                                                                                                                                                                   return vc.varExpr("e_pre_" + bx.toString(), vc.boolType());
                                       return vc.varExpr("e_pre_" + bx.toString(), vc.boolType());
                                                                                                               return vc.varExpr("e_" + bx.toString(), vc.boolType());
                                                                                                                                                                                                                                                                                                                                                                              return vc.varExpr("e_" + bx.toString(), vc.boolType());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                "\" is not a supported trigger expression.");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             return vc.varExpr("c_" + bx.toString(), vc.boolType());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              public Expr conditionConvert(final BooleanExpression bx)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       return vc.notExpr(triggerConvert(bn.getBody()));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         return vc.andExpr(triggerConvert(ba.getLeft()),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                return vc.orExpr(triggerConvert(bo.getLeft()),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 px;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } else if (bx instanceof IntegerSignal) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          } else if (bx instanceof BooleanBrackets) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                triggerConvert (ba.getRight());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    triggerConvert (bo.getRight());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 BooleanBrackets bb = (BooleanBrackets)
                                                                                                                                                                                                                           } else if (bx instanceof BooleanVariable)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     return triggerConvert (bb.getBody());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              } else if (bx instanceof BooleanAnd) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } else if (bx instanceof BooleanNot) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     } else if (bx instanceof BooleanOr) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         (bx instanceof BooleanVariable) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  BooleanAnd ba = (BooleanAnd) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   BooleanNot bn = (BooleanNot) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               * @param bx The KIEL BooleanExpression.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         BooleanOr bo = (BooleanOr) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   * @return An according JCVCL Expr.
if (isPre) (
                                                                                                                                                                                                                                                                  if (isPre) {
                                                                              } else {
                                                                                                                                                                                                                                                                                                                                          } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      J.T
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            240
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      260
                                                                                                                                                                                                                                                               220
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              230
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * Converts a KIEL Trigger BooleanExpression into an according JCVCL Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           //maybe true, maybe false => acts like a boolean signal
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      //does not support nested pre's
                                                                                                                                                                                                                                                                                                                                             ex1 = vc.andExpr(ex1, vc.andExpr(cvclE1, cvclC1));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ex2 = vc.andExpr(ex2, vc.andExpr(cvclE2, cvclC2));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                 CheckingProperties.getSemLog().log(LogFile.DEBUG,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   oublic Expr triggerConvert(final BooleanExpression bx) {
                                                                                                                                                                                    el = cl1.getTrigger().getEventExpression();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               e2 = cl2.getTrigger().getEventExpression();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Expr e = triggerConvert(p.getExpression());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          for (int i = 0; i < labels2.size(); <math>i++) {
                                                                                                               for (int i = 0; i < labels1.size(); i++) {
                                                                                                                                                   cl1 = (CompoundLabel) labels1.get(i);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              cl2 = (CompoundLabel) labels2.get(i);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * @param bx The KIEL BooleanExpression.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             return isSat(vc.andExpr(ex1, ex2));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } else if (bx instanceof Signal) {
                                                                                                                                                                                                                                                                                                      cvclCl = conditionConvert(cl);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     cvclC2 = conditionConvert(c2);
                                                                                                                                                                                                                                                                  cvclE1 = triggerConvert(e1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 cvclE2 = triggerConvert(e2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } else if (bx instanceof Tick) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       } else if (bx instanceof Pre) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (bx instanceof TrueSignal) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * Greturn An according JCVCL Expr.
                                                                                                                                                                                                                        c1 = c11.getCondition();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         c2 = c12.getCondition();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              "ex2: " + ex2);
                                                                                                                                                                                                                                                                                                                                                                                                                     "ex1: " + ex1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  return vc.trueExpr();
   Expr ex1 = vc.trueExpr();
                                          Expr ex2 = vc.trueExpr();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   return vc.trueExpr();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Pre p = (Pre) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              isPre = false;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      isPre = true;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     return e;
                                                                                                                                                                                                                           170
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         180
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        190
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    200
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  210
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throw new InvalidParameterException("\"" + bc.getClass().getName()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            return vc.varExpr("c_pre_" + ix.toString(), vc.intType());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                return vc.varExpr("c_pre_" + ix.toString(), vc.intType());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              + "\" is not a supported comparator expression.");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             return vc.varExpr("c_" + ix.toString(), vc.intType());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  return vc.notExpr(vc.eqExpr(intExConvert(bc.getLeftExp()),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              * Converts a KIEL IntegerExpression into an according JCVCL Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            return vc.varExpr("c_" + ix.toString(), vc.intType());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             return vc.ratExpr(((IntegerConstant) ix).getValue());
                                    return vc.geExpr(intExConvert(bc.getLeftExp()),
                                                                                                                                                                                                                                                                                                                                                                           return vc.leExpr(intExConvert(bc.getLeftExp()),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               return vc.ltExpr(intExConvert(bc.getLeftExp()),
                                                                                                                                                                                                           return vc.gtExpr(intExConvert(bc.getLeftExp()),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 public Expr intExConvert(final IntegerExpression ix)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          intExConvert(bc.getRightExp()));
                                                                                                                                                                                                                                                       intExConvert (bc.getRightExp());
                                                                                   intExConvert(bc.getRightExp()));
                                                                                                                                                                                                                                                                                                                                                                                                                          intExConvert (bc.getRightExp());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              intExConvert (bc.getRightExp());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } else if (ix instanceof IntegerVariable) {
} else if (bc instanceof GreaterOrEqual) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } else if (ix instanceof IntegerSignal) {
                                                                                                                                                                                                                                                                                                                                   } else if (bc instanceof LessOrEqual) {
                                                                                                                                                                   } else if (bc instanceof GreaterThan)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          } else if (bc instanceof NotEqual) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       } else if (bc instanceof LessThan) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (ix instanceof IntegerConstant) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      \star @param ix The KIEL IntegerExpression.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * Greturn An according JCVCL Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (isPre) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (isPre) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              } else {
                                                                                                                                                                                                                                                                                                                                                                               320
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      340
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  330
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             350
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 throw new InvalidParameterException("\"" + bx.getClass().getName()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * Converts a KIEL BooleanComparator into an according JCVCL Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         + "\" is not a supported condition expression.");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              return vc.notExpr(conditionConvert(bn.getBody()));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return vc.andExpr(conditionConvert(ba.getLeft()),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      return vc.orExpr(conditionConvert(bo.getLeft()),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            return vc.eqExpr(intExConvert(bc.getLeftExp()),
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         return compConvert((BooleanComparator)bx);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                public Expr compConvert(final BooleanComparator bc)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  BooleanBrackets bb = (BooleanBrackets) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    intExConvert(bc.getRightExp());
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              } else if (bx instanceof BooleanComparator) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      conditionConvert(ba.getRight()));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              conditionConvert(bo.getRight()));
                                                                                                                                                                                                                                                                                                                                                                                                                   else if (bx instanceof BooleanBrackets) {
                                       else if (bx instanceof BooleanTrueDummy)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return conditionConvert (bb.getBody());
                                                                                                                                                                                                                                                                                           } else if (bx instanceof BooleanFalse) {
                                                                                                                                                               else if (bx instanceof BooleanTrue) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       } else if (bx instanceof BooleanAnd) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              } else if (bx instanceof BooleanNot) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  else if (bx instanceof BooleanOr) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * @param bc The KIEL BooleanComparator.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  BooleanAnd ba = (BooleanAnd) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         BooleanNot bn = (BooleanNot) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      BooleanOr bo = (BooleanOr) bx;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                * Greturn An according JCVCL Expr.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (bc instanceof Equal) {
                                                                                                                                                                                                                                                                                                                                       return vc.falseExpr();
                                                                                   return vc.trueExpr();
                                                                                                                                                                                                               return vc.trueExpr();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } else {
                                                                                                                                                                                                                                                                                                                                   270
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          280
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              290
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     300
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            310
```