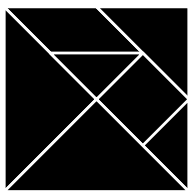
Optimized Translation of Clafer Models to Alloy



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University of Waterloo

CS744 Course Project. July 19, 2011

Course Project

CS 744: Advanced Compiler Design

Data flow analysis, redundancy elimination, optimizations

Individual project

Duration: 2 months

Clafer Update

Analysis of variability models

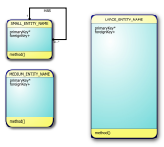
Translation to Alloy (uses SAT solvers)

clafer2alloy translator: a year ago

Some work on formal semantics

Examples of variability models

The Toolchain



Clafer Model

$\rightarrow$

Clafer Translator

$\rightarrow$

Alloy Model

$\rightarrow$

Alloy Analyzer

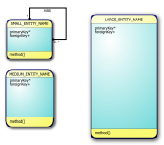
$\rightarrow$

$P \wedge Q$

Formula

Demo

Problems


Clafer Model

$\rightarrow$


Clafer Translator

$\rightarrow$


Alloy Model

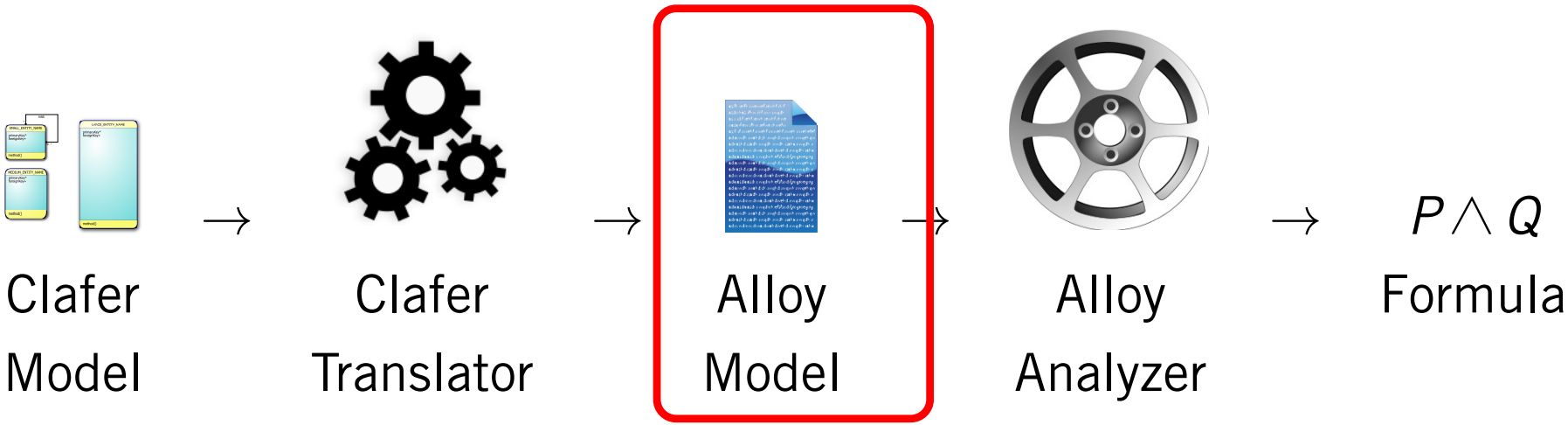
$\rightarrow$


Alloy Analyzer

$\rightarrow$ $P \wedge Q$ Formula

Translation rules heavily influence reasoning time in Alloy

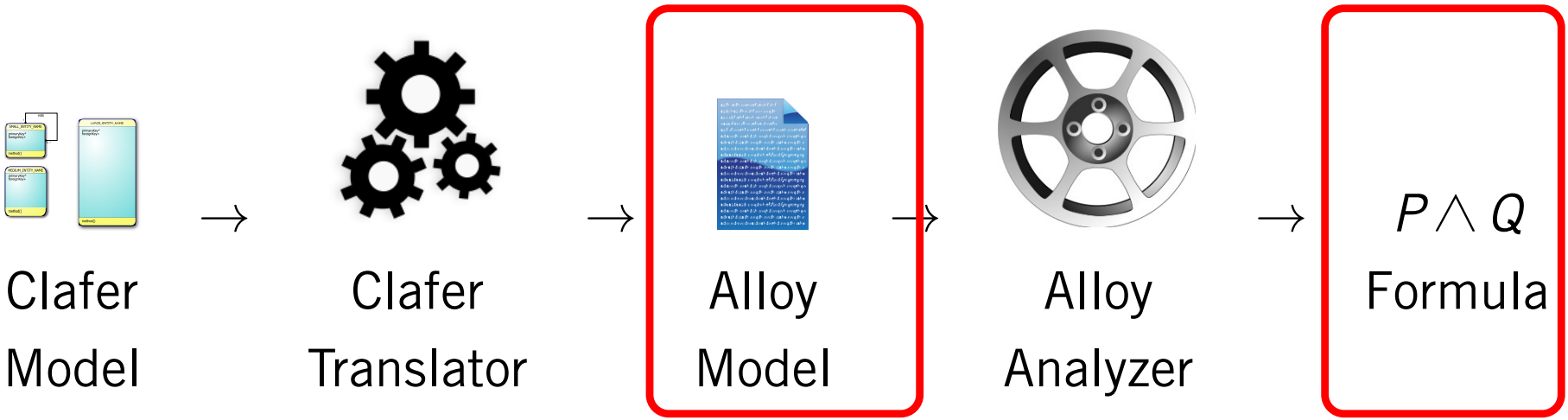
Problems



Translation rules heavily influence reasoning time in Alloy

Large Alloy files (complex models)

Problems

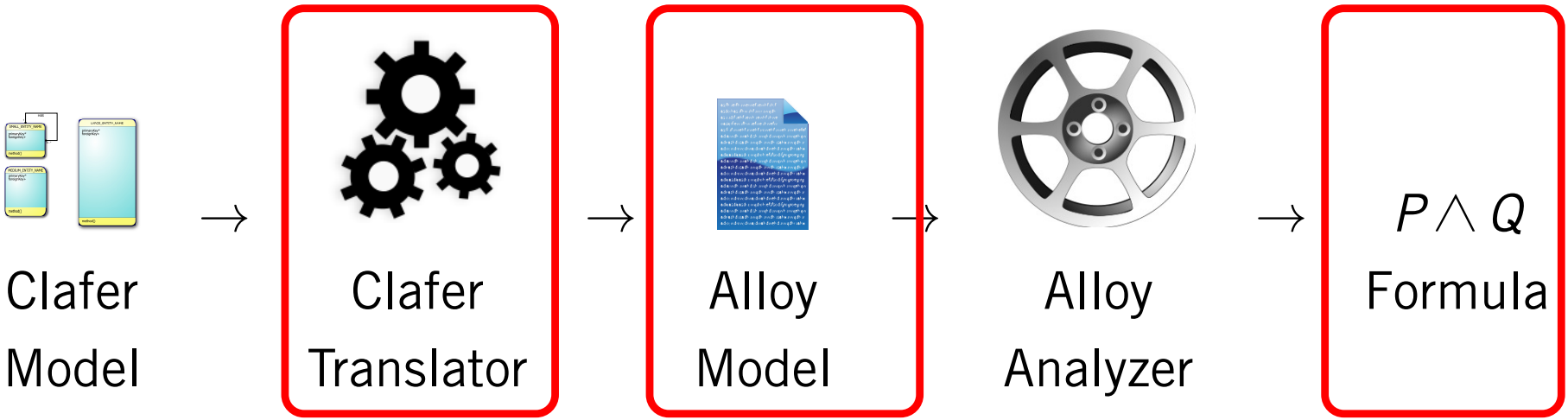


Translation rules heavily influence reasoning time in Alloy

Large Alloy files (complex models)

Ineffective Alloy representation (complex formulas)

Problems



Translation rules heavily influence reasoning time in Alloy

Large Alloy files (complex models)

Ineffective Alloy representation (complex formulas)

Slow clafer2alloy translator

Solution

Refactored and modular code architecture

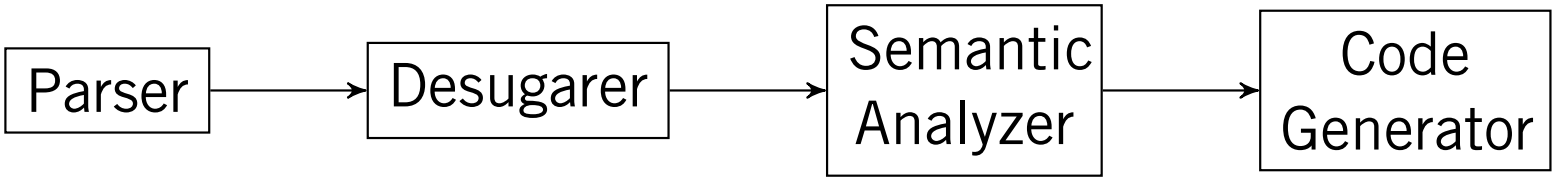
Intermediate language representation

Optimization of translation rules

User has control over the translation process

The Translator

(Old) clafer2alloy Translator



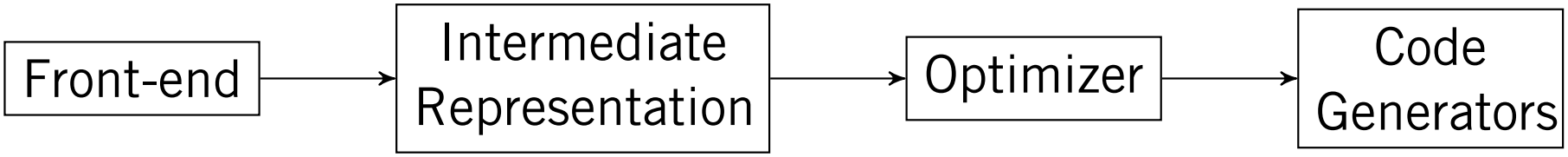
Monolithic

Haskell

Available online

Released source code

(New) clafer Translator



User can turn on/off modules (has extra knowledge)

Easy to add new code generators

Optimizations

No Unused Abstract Clafers

```
abstract display
  server ?

OnBoardComputer
```

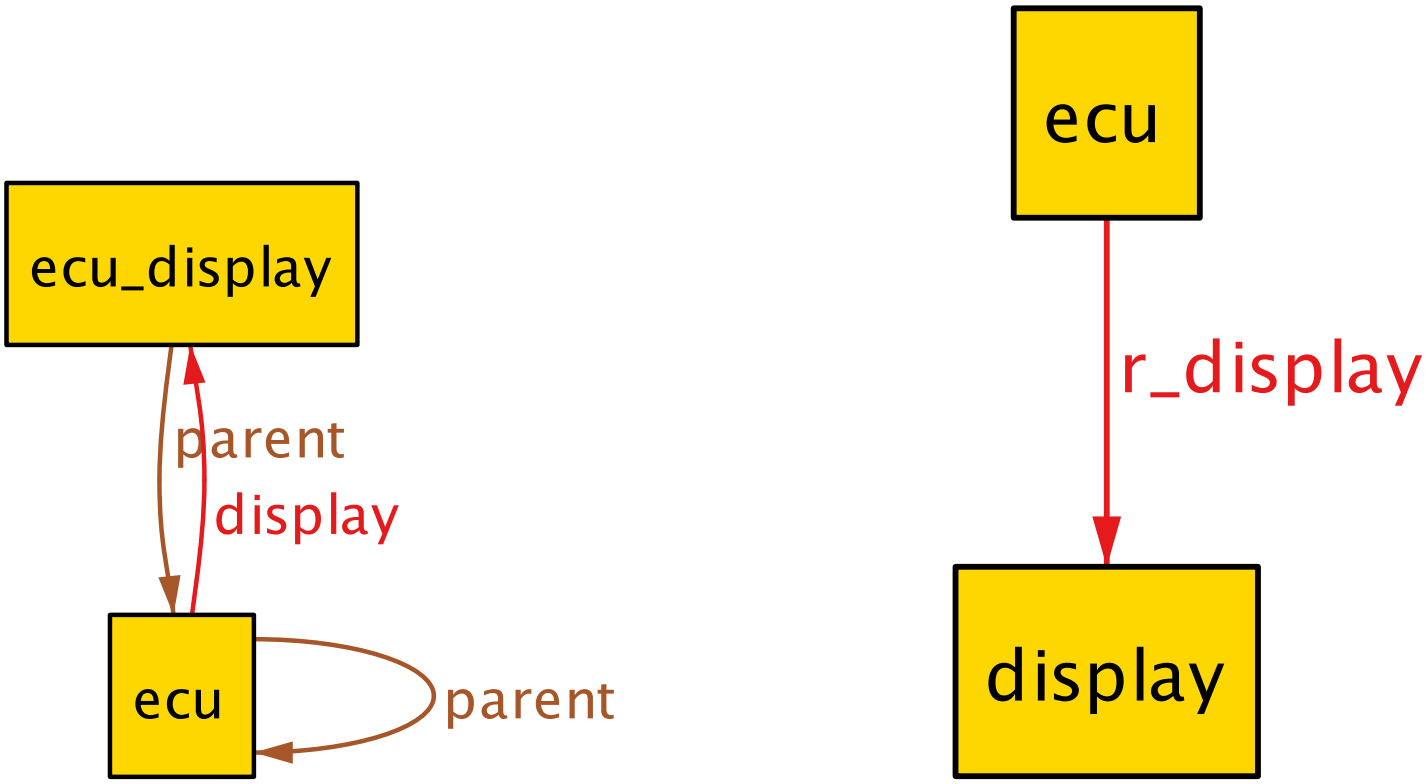
OnBoardComputer

No Unused Abstract Clafers

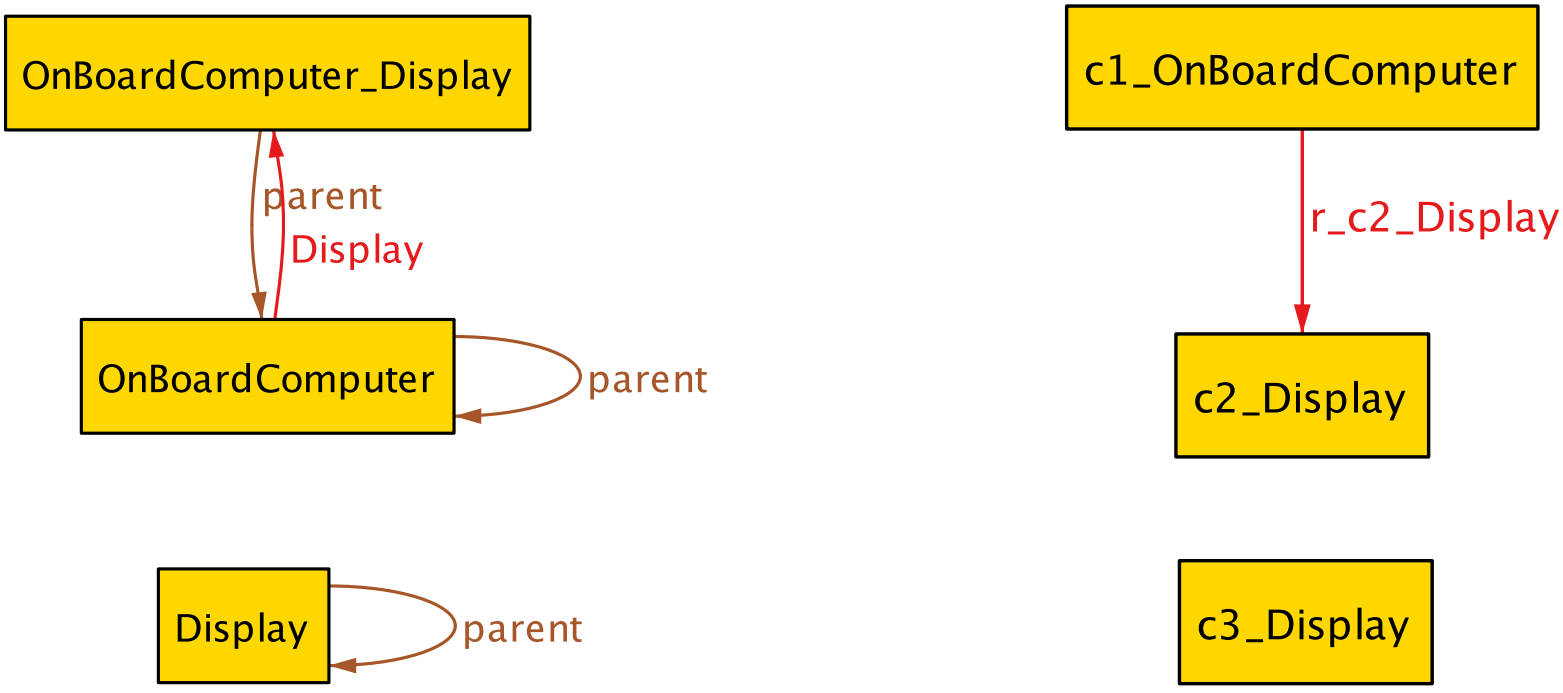
```
abstract display
  server ?

OnBoardComputer
```

```
OnBoardComputer
```

No Redundant Hierarchical Constraints



Improved Name Resolution



Global Cardinality Constraints

OnBoardComputer `0..1`
  Display `1`

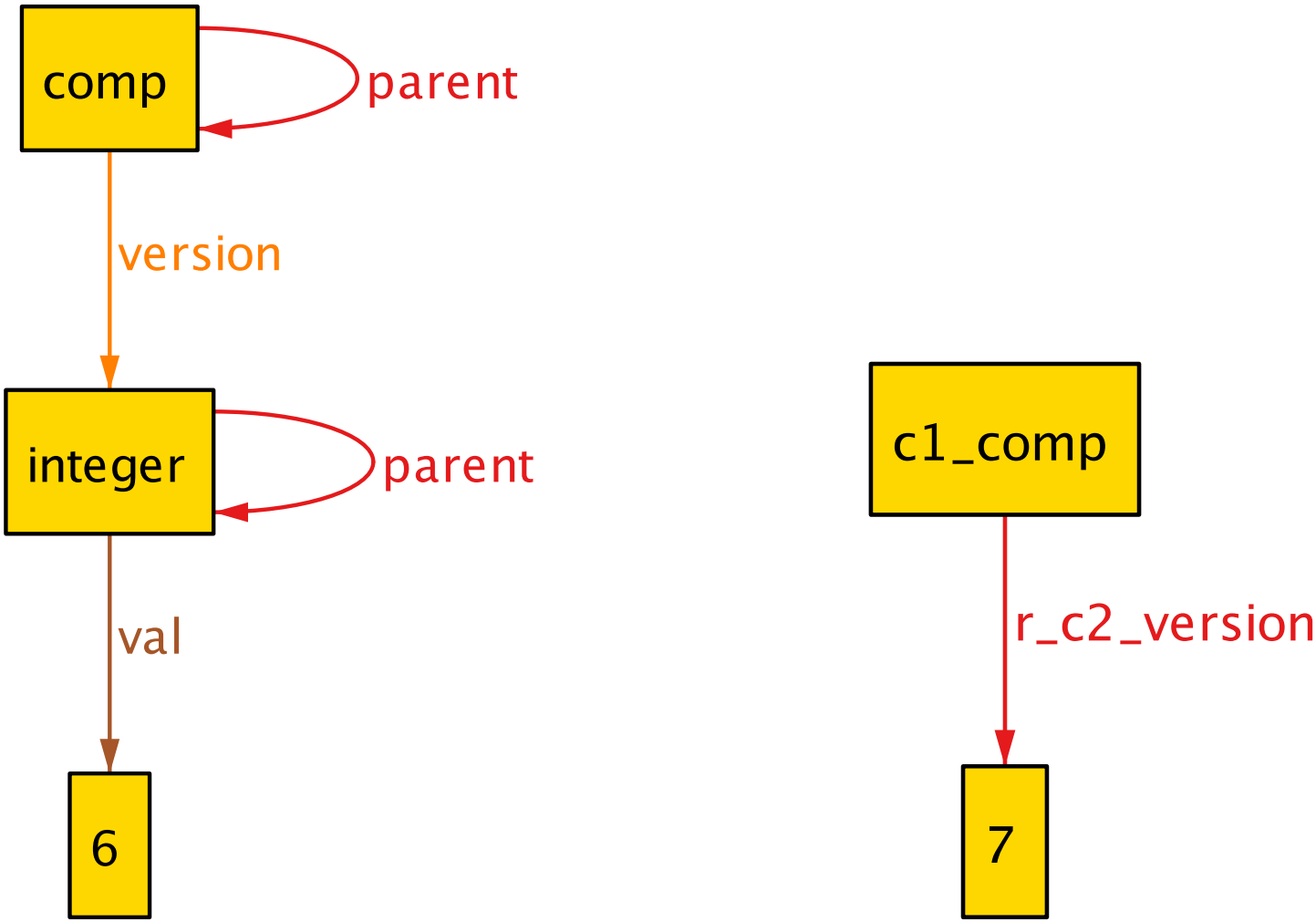
OnBoardComputer `0..1`
Display `0..1`

Global Cardinality Constraints

OnBoardComputer `0..1`
  Display `1`

OnBoardComputer `0..1`
  Display `0..1`

Integers as Attributes



References are Relations

```
ecu

display
  server -> ecu
```

```
sig display extends clafer
{ server : one clafer }
{ server in ecu }
```

```
one sig display
{ server : one ecu }
```

References are Relations

```
ecu

display
  server -> ecu
```

```
sig display extends clafer
{ server : one clafer }
{ server in ecu }
```

```
one sig display
{ server : one ecu }
```

References are Relations

```
ecu

display
  server -> ecu


sig display extends clafer
{ server : one clafer }
{ server in ecu }


one sig display
{ server : one ecu }
```

Unrolled Inheritance

```
abstract comp
  version : integer

display extends comp
```

```
display
  version : integer
```

Unrolled Inheritance

```
abstract comp
  version : integer

display extends comp
```

```
display
  version : integer
```

Model Statistics

```
ecu 1..2
  display -> integer 2..3
  [display > 2]
```

```
All clafers: 2 | Abstract: 0 | Concrete: 1 | References: 1
Constraints: 1
Global scope: 1..3
All names unique: False
```

Model Statistics

```
ecu 1..2
  display -> integer 2..3
  [display > 2]
```

```
All clafers: 2 | Abstract: 0 | Concrete: 1 | References: 1
Constraints: 1
Global scope: 1..3
All names unique: False
```

Parameters

Unrolling inheritance

Timeout for model translation

Layout resolver options

Checking duplicated names

Name resolver behavior

Keeping unused clafers

Evaluation

Input Models

Baseline: SLE'10 paper

Feature Models (instantiation)

Meta-Models (instantiation)

FBMTs (liveness, instantiation)

The Linux Kernel

Input Models

Baseline: SLE'10 paper

Feature Models (instantiation)

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Input Models

Baseline: SLE'10 paper

Feature Models (instantiation)

Meta-Models (instantiation)

FBMTs (liveness, instantiation)

The Linux Kernel

Results

Speed: 2-5 times faster

Possible to handle huge models

Conclusion

Conclusion

Clafer models can be expressive and analyzable

Alloy Analyzer is slow for big models

Possible further optimizations

User knowledge is very useful

Thanks for listening!

Questions?

gsd.uwaterloo.ca/clafer