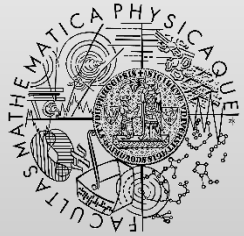
OCL: Object Constraint Language

http://d3s.mff.cuni.cz

Pavel Parízek



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Charles University

Motivation

- UML models (class diagrams, ...)
  - Main limitations: incomplete, ambiguous
  - Some domain knowledge is not captured
- How to specify additional constraints
  - Natural language (plain text)
  - Formal languages (some logic)

Constraints in UML diagrams

- Precise exact statement (sentence)
  - Captures some condition or restriction
- Attached to elements (classes, fields, ...)
  - Context: entity in diagram for which the constraint is evaluated and time of evaluation
- Graphical notation
  - Textbox connected to entity with a dashed line

What is OCL

- Formal specification language
- Extension for UML

- Main features
  - Declarative and very strongly typed
  - Constraints written as precise text
  - Supports object query expressions

Official information

- Maintainers
  - Object Management Group (OMG)
- Resources
  - Specification: http://www.omg.org/spec/OCL/
  - https://en.wikipedia.org/wiki/Object_Constraint_Language

What can be specified in OCL

- Initial values of properties (object fields)
- Derivation rules (constraints for values)
- Operation preconditions and postconditions
- Operation bodies (side-effects)
- Invariants for objects (classes)

Initial values

- Syntax
  - **`context`** `TypeName::PropertyName : Type`
  - **`init`** *<expression representing the initial value>*

- Example
  - **`context`** `Thesis::state`
  - **`init:`** `ThesisStatus::assigned`

Derivation rules

- Purpose
  - Restricts value of some property (object field)
- Syntax
  - **`context`** `TypeName::PropertyName : Type`
  - **`derive:`** *<expression representing the derivation rule>*
- Example
  - **`context`** `Lecturer::courses`
  - **`derive`** `self.teaching->size()`

Operation pre/post-conditions

- Syntax
  - **context** TypeName::OperName (p1 : Type1, ..., pN : TypeN): ReturnType
  - **pre:** *<precondition expression>*
  - **post:** *<postcondition expression>*

- Example
  - **context** Student::enrollToCourse(c:Course): Boolean
  - **pre:** c.enrolledStudents < c.limit
    and self.enrolled->excludes(c)
  - **post:** c.enrolledStudents = c.enrolledStudents@pre + 1
    and self.enrolled->includes(c)
    and result = c.students->includes(self)

Operation bodies

- Purpose
  - Capturing side-effects
    - How the operation changes values of properties

- Syntax
  - **`context`** `TypeName::OperName (p1 : Type1, ..., pN : TypeN): ReturnType`
  - **`body:`** *<expression>*

Invariants

- Purpose
  - Constraint for every instance of the class (type)
- Syntax
  - **`context`** `TypeName`
  - **`inv:`** *<invariant expression>*
- Example
  - **`context`** `Student`
  - **`inv:`** `self.yearOfStudy > 5 implies self.payingFee`

OCL features

- Type system
- Collections

Type system

- Generic types: `OclAny`, `OclInvalid`
- Basic types: `Boolean`, `Integer`, `String`, …
  - Common operators and functions
- Collection types: `Set`, `Bag`, `OrderedSet`, `Sequence`
  - Instances created through navigation over associations in UML class diagrams
- User-defined types
  - Elements of UML diagrams

Collections

- How they are created
  - Navigation via properties (association ends or attributes) produces a new collection object
  - Chain `a.p1.p2.[...].pN` of properties `p1`, ..., `pN` from variable `a`
- Collection constants
  - Syntax: `TypeName{ value1, value2, ..., valueN }`
- Operations
  - Filtering by predicate: `select`, `reject`
  - Quantifiers: `forAll`, `exists`
  - Loop with accumulator: `iterate`
  - Transitive closure by recursive application of an expression: `closure`
  - Other: `count`, `includes`, `excludes`, `isEmpty`, `size`

Collections – examples

- **context** Course
- **inv:** self.passed->reject(s|self.enrolled ->includes(s))->size()=0

- **context** Lecturer
- **inv:** self.courses->forAll(c|c.guaranteedBy ->includes(self))

- **context** Course
- **inv:** self.enrolled->iterate(s : Student ; somePassed : Boolean = false | somePassed or s.pointsFor(self) >= 50)

Remarks

- Likely, OCL is not used that much in practice
- Take-away message (knowledge)
  - General concepts, transferable to some other specification languages and frameworks