Software Design, Modelling and Analysis in UML

Lecture 22: Wrapup

2014-02-12

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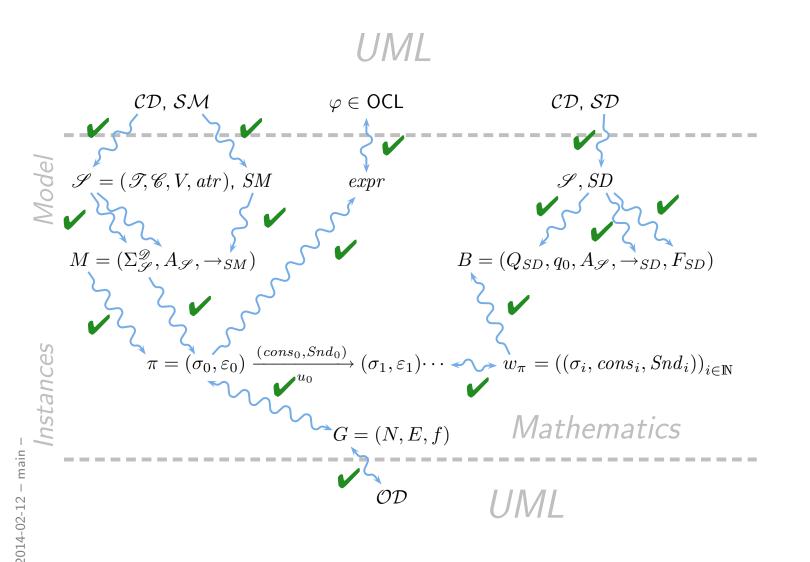
ADVERTISEMENT:

- **NEW** FORMAL METHODS FOR C!
  (SEMINAR)

- REAL-TIME SYSTEMS

- MASTER TEAM PROJECT
  MASTER'S THESIS

Content

UML

$\mathcal{CD}, \mathcal{SM}$ $\varphi \in$ OCL $\mathcal{CD}, \mathcal{SD}$

Model

$\mathscr{S} = (\mathscr{T}, \mathscr{C}, V, atr), SM$ $expr$ $\mathscr{S}, SD$

$M = (\Sigma_{\mathscr{S}}^{\mathscr{D}}, A_{\mathscr{S}}, \rightarrow_{SM})$ $B = (Q_{SD}, q_0, A_{\mathscr{S}}, \rightarrow_{SD}, F_{SD})$

Instances

$\pi = (\sigma_0, \varepsilon_0) \xrightarrow[u_0]{(cons_0, Snd_0)} (\sigma_1, \varepsilon_1) \cdots$ $w_{\pi} = ((\sigma_i, cons_i, Snd_i))_{i \in \mathbb{N}}$

$G = (N, E, f)$

Mathematics

$\mathcal{OD}$

UML

- Motivation
- Semantical Model
- OCL
- Object Diagrams
- Class Diagrams
- State Machines
- Live Sequence Charts
- ~~Real-Time~~
- ~~Components~~
- Inheritance
- Meta-Modeling
- (MDA, MDSE)

Wrapup: Motivation

- **Lecture 1: Motivation and Overview**

- Lecture 2: Semantical Model

- Lecture 3: Object Constraint Language (OCL)
- Lecture 4: OCL Semantics

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- Lecture 22: Wrapup & Questions

Wrapup: Motivation

Lecture 1:

- **Educational Objectives:** you should
    - be able to explain the term **model**.
    - know the idea (and hopes and promises) of **model-driven** SW development.
    - be able to explain how **UML** fits into this general picture.

    - know **what** ~~we'll do~~ we've done in the course, and **why**.
    - thus be able to decide whether you want to stay with us...

    - How can UML help with software development?
    - Where is which sublanguage of UML useful?
    - For what purpose? With what drawbacks?

Wrapup: Examining Motivation

- what is a model? for example?

- "a model is an image or a pre-image" — of what? please explain!

- when is a model a good model?

- what is model-based software engineering?
    - MDA? MDSE?
    - what do people hope to gain from MBSE? Why? Hope Justified?
    - what are the fundamental pre-requisites for that?

- what are purposes of modelling guidelines?
    - could you illustrate this with examples?
    - how can we establish/enforce them? can tools or procedures help?

- what's the qualitative difference between the modelling guideline "all association ends have a multiplicity" and "all state-machines are deterministic"?

- . . .

Wrapup: Examining Motivation

- what is UML (definitely)? why?

- what is it (definitely) not? why?

- how does UML relate to programming languages?

- what are the intentions of UML?

- what is the history of UML? Why could it be useful to know that?

- where can (what part of) UML be used in MBSE?

  - for what purpose? to improve what?

- we discussed a notion of "UML mode" by M. Fowler.

  - what is that? why is it useful to think about it?

Wrapup: Examining "The Big Picture"

- what kinds of diagrams does UML offer?

- what is the purpose of the X diagram?

- what do the diagrams X and Y have in common?

- what is a UML model (our definition)? what does it mean?

- what is the difference between well-formedness ruless
  and modelling guidelines?

- what is meta-modelling?

  - could you explain it on the example of UML?

- what is a class diagram in the context of meta-modelling?

- what benefits do people see in meta-modelling?

- the standard is split into the two documents "Infrastructure" and
  "Superstructure". what is the rationale behind that?

- in what modelling language is UML modelled?

Wrapup: Modelling Structure

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Wrapup: Modelling Structure

Lecture 2:

- **Educational Objectives:** Capabilities for these tasks/questions:
  - Why is UML of the form it is?
  - Shall one feel bad if not using all diagrams during software development?
  - What is a signature, an object, a system state, etc.?
    What's the purpose in the course?
  - How do Basic Object System Signatures relate to UML class diagrams?

Lecture 3 & 4:

- **Educational Objectives:** Capabilities for these tasks/questions:
  - Please explain/read out this OCL constraint. Is it well-typed?
  - Please formalise this constraint in OCL.
  - Does this OCL constraint hold in this (complete) system state?
  - Can you think of a system state satisfying this constraint?
  - Please un-abbreviate all abbreviations in this OCL expression.
  - In what sense is OCL a three-valued logic? For what purpose?
  - How are $\mathscr{D}(C)$ and τ_C related?

Wrapup: Modelling Structure

Lecture 5:

- **Educational Objectives:** Capabilities for following tasks/questions.
  - What is an object diagram? What are object diagrams good for?
  - When is an object diagram called partial? What are partial ones good for?
  - How are system states and object diagrams related?
  - What does it mean that an OCL expression is satisfiable?
  - When is a set of OCL constraints said to be consistent?
  - Can you think of an object diagram which violates this OCL constraint?
  - Is this UML model $\mathcal{M}$ consistent wrt. $Inv(\mathcal{M})$?

Lecture 6:

- **Educational Objectives:** Capabilities for following tasks/questions.
  - What is a class diagram?
  - For what purposes are class diagrams useful?
  - Could you please map this class diagram to a signature?
  - Could you please map this signature to a class diagram?
  - What is a stereotype? What does it mean? For what can it be useful?

Wrapup: Modelling Structure

Lecture 7:

- **Educational Objectives:** Capabilities for following tasks/questions.

  - Is this OCL expression well-typed or not? Why?
  - How/in what form did we define well-definedness?
  - What is visibility good for? Where is it used?

Lecture 8 & 9:

- **Educational Objectives:** Capabilities for following tasks/questions.

  - Please explain/illustrate this class diagram with associations.
  - Which annotations of an association arrow are (semantically) relevant? In what sense? For what?
  - What's a role name? What's it good for?
  - What's "multiplicity"? How did we treat them semantically?
  - What is "reading direction", "navigability", "ownership", . . . ?
  - What's the difference between "aggregation" and "composition"?

Wrapup: Modelling Structure

Lecture 9:

- **Educational Objectives:** Capabilities for following tasks/questions.
  - What are purposes of modelling guidelines? (Example?)
  - When is a class diagram a good class diagram?
  - Discuss the style of this class diagram.

Lecture 20 & 21:

- **Educational Objectives:** Capabilities for following tasks/questions.
  - What's the effect of inheritance on System States?
  - What does the Liskov Substitution Principle mean regarding structure?
  - What is the subset, what the uplink semantics of inheritance?
  - What's the idea of Meta-Modelling?

Wrapup: Modelling Behaviour, Constructive

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Main and General:

- **Educational Objectives:** Capabilities for following tasks/questions.

    - What does this State Machine mean?

    - What happens if I inject this event?

    - Can you please model the following behaviour.

      (And **convince** readers that your model is correct.)

Wrapup: Modelling Behaviour, Constructive

Lecture 10:

- **Educational Objectives:** Capabilities for following tasks/questions.
  - What's the difference between reflective and constructive descriptions of behaviour?
  - What's the Basic Causality Model?
  - What does the standard say about the dispatching method?
  - What is (intuitively) a run-to-completion step?

Lecture 11:

- **Educational Objectives:** Capabilities for following tasks/questions.
  - Can you please model the following behaviour.
  - What is: trigger, guard, action?
  - Please unabbreviate this abbreviated transition annotation.
  - What is an ether? Example? Why did we introduce it?
  - What's the difference: signal, signal event, event, trigger, reception, consumption?
  - What's a system configuration?
  - When is an object stable (intuitively, formally)?

Wrapup: Modelling Behaviour, Constructive

Lecture 12 & 13:

- **Educational Objectives:** Capabilities for following tasks/questions.
  - What is a transformer? Example? Why did we introduce it?
  - What is a re-use semantics? What of the framework would we change to go to a non-re-use semantics?
  - What labelled transition system is induced by a UML model?
  - What is: discard, dispatch, commence?
  - What's the meaning of stereotype "signal,env"?
  - Does environment interaction necessarily occur?
  - What happens on "division by 0"?

Lecture 14 & 15:

- **Educational Objectives:** Capabilities for following tasks/questions.
  - What is a step (definition)? Run-to-completion step (definition)? Microstep (intuition)?
  - Do objects always finally become stable?
  - In what sense is our RTC semantics not compositional?

Wrapup: Modelling Behaviour, Constructive

Lecture 16:

- **Educational Objectives:** Capabilities for following tasks/questions.
  - What's a kind of a state? What's a pseudo-state?
  - What's a region? What's it good for?
  - What is: entry, exit, do, internal transition?
  - What's a completion event? What has it to do with the ether?

Lecture 17:

- **Educational Objectives:** Capabilities for following tasks/questions.
  - What's a state configuration?
  - When are two states orthogonal? When consistent?
  - What's the depth of a state? Why care?
  - What is the set of enabled transitions in this system configuration and this state machine?

Lecture 18:

- **Educational Objectives:** Capabilities for following tasks/questions.

  - What's a history state? Deep vs. shallow?

  - What is: junction, choice, terminate?

  - What is the idea of "deferred events"?

  - What is a passive object? Why are passive reactive objects special? What did we do in that case?

  - What's a behavioural feature? How can it be implemented?

Wrapup: Modelling Behaviour, Reflective

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Wrapup: Modelling Behaviour, Reflective

Lecture 18, & 19:

- **Educational Objectives:** Capabilities for following tasks/questions.
  - Is each LSC description of behaviour necessarily reflective?
  - There exists another distinction between "inter-object" and "intra-object" behaviour. Discuss in the context of UML.
  - What does this LSC mean?
  - Are this UML model's state machines consistent with the interactions?
  - Please provide a UML model which is consistent with this LSC.
  - What is: activation (mode, condition), hot/cold condition, pre-chart, cut, hot/cold location, local invariant, legal exit, hot/cold chart etc.?

Wrapup: Inheritance

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Wrapup: Inheritance

- **Educational Objectives:** Capabilities for following tasks/questions.

  - What's the effect of inheritance on LSCs, State Machines, System States?

  - What's the Liskov Substitution Principle?

  - What is commonly understood under (behavioural) sub-typing?

  - What is the subset, what the uplink semantics of inheritance?

  - What is late/early binding?

  - What's the idea of Meta-Modelling?

Meta

Hmm...

- Open book or closed book...?

– 22 – 2014-02-12 – main –