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Software Design, Modeling, and Analysis in UML

`http://swt.informatik.uni-freiburg.de/teaching/winter-term-2011-2012/sdmauml/sdmauml`

Exercise Sheet 1

Early submission: Monday, 2011-11-07, 9:00 Regular submission: Tuesday, 2011-11-08, 12:00

Regarding the form of submission, we have the following preferences:

- *perfect*: a PDF by mail
- *fine*: any other common document format (such as ODF or DOC) by mail
- *kind*: a scanned version of the handwritten proposal by mail — there is a magic print-copy-scan-machine in the pool room which can send the scan to you by mail
- *tolerated*: paper submission

Exercise 1 – Model (5/20 Points)

Choose one of the following three tasks:

(i) Find an alternative, reasonable definition of *model* which is different from the two ones shown in the lecture. (Does maybe the Object Management Group (OMG) have one?)

Cite it correctly (i.e., give accurate references) and discuss: Why is your choice adequate for this exercise? How does it relate to the two definitions from the lecture?

(ii) In, for instance, propositional logic, a satisfying valuation of the propositions is called a *model* of a formula.

Discuss the relation of this notion of model to the notion of model we use in the lecture.

(iii) Discuss whether

- the natural language description of a product in an advertisement,
- a project plan in form of a Gantt chart,
- the sentence

“identifiers in the program must not contain any uppercase letter (A-Z)”

is a model in the sense of the course.

Exercise 2 – Signature, System State (5/20 Points)

Assume we want to model a *wireless sensor network* (WSN) and its tree topology.
Each *device* (or *node*) in a network

- knows the address of zero or one *master*,
- knows the addresses of a number *slaves*,
- has a received signal strength indication (*RSSI*) value of integer type.

Provide a basic object signature and structure suitable to model WSN. Explain your model, in particular using exemplary system states.
Hint: we can model knowledge of addresses by links.

Exercise 3 – OCL (10/20 Points)

Consider the basic object signature and structure for WSN from Exercise 2.
Consider the following requirements on system states. Formalise each requirement in the OCL fragment from the lecture and provide two system states σ_1, σ_2 such that $I[\![\phi]\!](\sigma_1, \emptyset) = \mathit{true}$ and $I[\![\phi]\!](\sigma_2, \emptyset) = \mathit{false}$, where ϕ is your formalisation of the requirement and (of course) prove that your σ_1, σ_2 are correct solutions.

(i) The RSSI value ranges from 0 to 10. (2pts)

(ii) Node n_1 is master of node n_2 if and only if n_2 is slave of n_1 (2pts)

(iii) The RSSI values of all slaves of one master do not differ by more than 2. (2pts)

(iv) Assume an OCL requirement of the form

$$\text{context } \mathit{Node} \text{ inv} : \mathit{rssi} \leq \mathit{master}.\mathit{rssi}$$

is supposed to formalise the requirement, that the RSSI value of a slave is lower than the RSSI value of its master (please adjust the class and attribute names according to your signature from Exercise 2).

Provide σ_1 and σ_2 as before and in addition a third system state σ_3 such that $I[\![\phi]\!](\sigma_3, \emptyset) = \bot$. (Prove that your σ_3 is also correct.)

Can you fix the OCL expression such that it never evaluates to "undefined"? (3pts)

(v) Is it possible to formalise the requirement that there exists at least one node in OCL?
If yes, tell how, if no, explain why not. (1pts)

Exercise 4 (0/20 Points + 5 Bonus)

Is I (as defined in Annex A of the OCL standard document [OMG, 2006]) a function or not?
Hint: First recall the definition of "function" and then prove or disprove I to be one.

References

[OMG, 2006] OMG (2006). Object Constraint Language, version 2.0. Technical Report formal/06-05-01.