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Software Design, Modeling, and Analysis in UML

http://swt.informatik.uni-freiburg.de/teaching/WS2015-16/sdmauml

Exercise Sheet 2

Early submission: Monday, 2015-11-09, 12:00 Regular submission: Tuesday, 2014-11-10, 10:00

Exercise 1 – OCL Abbreviations (5/20 Points)

Consider the following basic object signature for a WSN:

$$\mathscr{S} = (\{Float\}, \{Device\}, \{m : Device_{0,1}, s : Device_{*}, v : Float\}, \{Device \mapsto \{m, s, v\}\})$$

with m modelling the master of a node, s its slaves, and v its sensor reading.

(i) Fully un-abbreviate the following OCL expression: $\mathit{self}.s \mathsf{\ ->\ size}$ (1)

(ii) Fully un-abbreviate the following OCL expression: $\mathit{self}.s < \mathit{self}.m \mathsf{\ ->\ } v$.
Is it a proper OCL expression? (2)

(iii) Fully un-abbreviate the following OCL expression:
$\mathsf{context}\ Device\ \mathsf{inv} : s \mathsf{\ ->\ forAll}(i \mid i.v \geq v)$ (2)

Hint: for (ii), if yes, state why, if not, explain why not.

Exercise 2 – Formalising Requirements in OCL (10/20 Points)

Consider the basic object signature for WSN from Exercise 1 with the structure

$$\mathscr{D}(Float) = \mathbb{R}, \qquad \mathscr{D}(Device) = \{1_D, 2_D, 3_D, \dots\}.$$

(Or, if you like, use your own proposal from the previous exercise sheet – just state which one you're using, and in case you use your own proposal, please provide it in your submission for self-containedness.)

Consider the following requirements on system states. Formalise each requirement in the OCL fragment introduced in the lecture. "Test" each of your formalisations *expr* by providing two system states σ_1 and σ_2 such that σ_1 satisfies the requirement and σ_2 does not and prove $I[\![expr]\!](\sigma_1, \emptyset) = \mathsf{true}$ and $I[\![expr]\!](\sigma_2, \emptyset) = \mathsf{false}$ using the OCL semantics from the lecture.

(i) The sensor reading ranges from 0.0 to 10.0. (2)

(ii) A node n_1 is master of a node n_2 if and only if n_2 is slave of n_1. (2)

(iii) The sensor readings of all slaves of one master do not differ by more than 3. (2)

(iv) Is it possible to characterise with an OCL expression the set of system states which comprise at least one node?
If yes, tell how, if no, explain why not. (2)

(v) Consider the OCL requirement

$$expr = \mathsf{context}\ Device\ \mathsf{inv} : v \leq m.v$$

Provide a system state σ such that $I[\![expr]\!](\sigma, \emptyset) = \bot$ and prove that your σ has this property.

Give an intuition of why $I[\![expr]\!](\sigma, \emptyset)$ yields $\bot$.

Can you fix the OCL expression such that there is no system state for which the fixed OCL expression evaluates to $\bot$? (2)

Hint: You may use object diagrams to represent your system states (cf. Exercise 3).

Exercise 3 – Object Diagrams (5/20 Points)

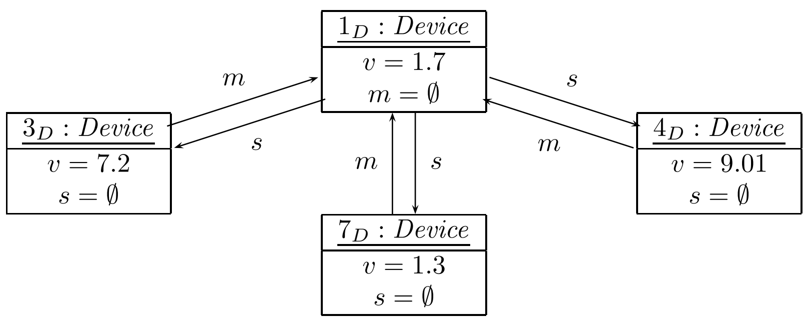

Figure 1: Object Diagram for Exercise 2.

(i) Which system state σ does Figure 1 describe? Spell it out using the function-notation for system states which we used before introducing object diagrams. (2)

(ii) Is the object diagram in Figure 1 complete? Explain. (1)

(iii) Present one (non-trivial) positive example and one negative example system state from your solution of Tasks (i)–(iii) in Exercise 2 as object diagram. (2)

Exercise 4 (5 Bonus)

Is I (as defined in Annex A of the OCL standard document OMG (2006)) a function or not?

Hint: Recall the mathematical definition of "function" and then prove or disprove I to be one.

References

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