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Sommersemester 2012

Real-Time Systems

http://swt.informatik.uni-freiburg.de/teaching/SS2012/rtsys

Exercise Sheet 1

Early submission: Monday, 2012-05-07, 12:00 Regular submission: Tuesday, 2012-05-08, 12:00

Exercise 1 (3/20 Points)

In the introductory lecture, we tried to give examples for clearly real-time, clearly non real-time, and "on the one hand/on the other hand" systems.
Please give one good own example for each of these categories and explain briefly why it is a (good) example.

Exercise 2 (10/20 Points)

Recall the airbag example from the introductory lecture (cf. Figure 1). One functional requirement on the controller software was that the system consisting of crash sensor, airbag, and the controller running this software should ensure:

> "When a crash is detected, fire the airbag within 300ms $+/-\varepsilon$ after the crash."

(i) Give **two** different sets of observables which could be adequate for formalising the above given requirement. Explain. (2)

(ii) Explain your understanding of the requirement in natural language as precise as you can.
Formalise your understanding of the requirement using first-order logic.
Explain why your formalisation is correct. (2)

(iii) Give three evolutions of the system such that

a) one non-trivially satisfies the requirement,

b) one trivially (what do you understand under trivially?) satisfies the requirement,

c) one does not satisfy the requirement.

Explain. (3)

(iv) For one of your three system evolutions prove that it satisfies/does not satisfy the requirement. *Hint: use the formal definition of the interpretation of first-order logic.* (2)

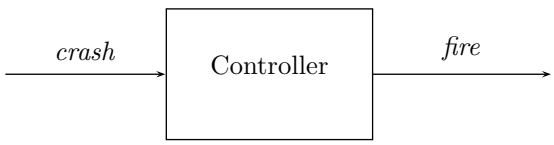

Figure 1: Illustrative picture.

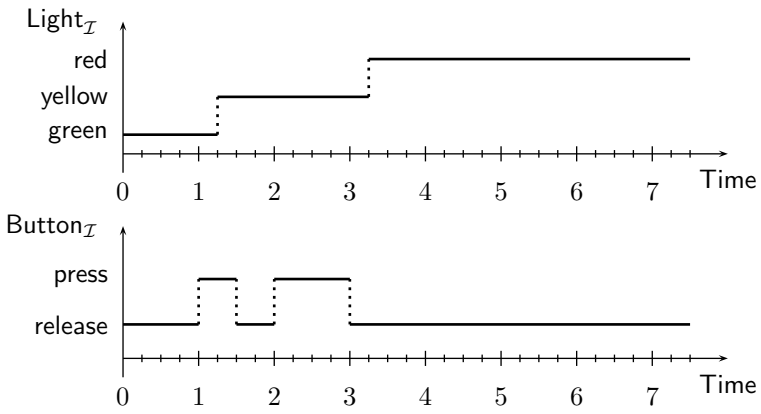

Figure 2: Interpretation of 'Light' and 'Button'.

Exercise 3 (5/20 Points)

A traffic light for pedestrians is modelled by the observables 'Light' of data type {red, yellow, green} and 'Button' of data type {press, release}.
Consider an interpretation $\mathcal{I}$ of these observables as given by the timing diagrams in Figure 2.
Formalise the following requirements using first-order logic:

- The button is not pressed when the lights show green. (1)
- The yellow lights is used at least once. (1)
- If the button is pressed, it takes at most 120 time units until green is shown. (1)
- Green phases are at least 10 time units long. (1)
- Within 3600 time units, the lights should not show green for more than 1000 time units. (1)

Hint: Explain your understanding of the requirement in natural language as precise as you can. Formalise your understanding. Explain.

Exercise 4 [1] (2/20 Points)

A traffic light for pedestrians is modelled by the observables 'Light' of data type {red, yellow, green} and 'Button' of data type {press, release}.
Consider an interpretation $\mathcal{I}$ of these observables as given by the timing diagrams in Figure 2.

(i) Calculate the truth value of the state assertion (Light = green at $t_1 = 0.5$ and $t_2 = 3.0$.
Hint: Compute $\mathcal{I}[\![P]\!](t)$. (2)

(ii) Draw the interpretation of the state assertion

$$\mathsf{Light} = \mathsf{green} \wedge \neg(\mathsf{Button} = \mathsf{release})$$

on the interval $[0, 7]$. (1)

References

[1] Ernst-Rüdiger Olderog and Henning Dierks. *Real-Time Systems - Formal Specification and Automatic Verification*. Cambridge University Press, 2008.