Prof. Dr. A. Podelski, Dr. B. Westphal
L. Musliu

Wintersemester 2017/18

Real-Time Systems

http://swt.informatik.uni-freiburg.de/teaching/WS2017-18/rtsys

Exercise Sheet 2

Early submission: Monday, 2017-11-06, 14:00 Regular submission: Tuesday, 2017-11-07, 14:00

Exercise 1 — DC Syntax (5/20 Points)

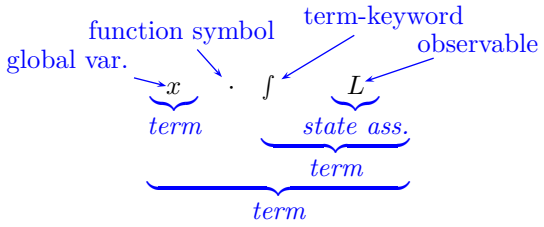
A traffic light for pedestrians is modelled by the observables $\mathsf{Light} : \{\mathsf{red}, \mathsf{yellow}, \mathsf{green}\}$ and $\mathsf{Button} : \{0, 1\}$, where value 1 corresponds to pressing the button that requests the road traffic to be stopped.

(i) DC formulae are constructed using different kinds of "building blocks" like predicate symbols, etc., state assertions, terms, and formulae, and (what we called) terminal symbols or keywords.

Label each building block of the following DC formula with its kind. (3)

$$\int 1 \wedge \mathsf{Button} = 1 = 1 \wedge \ell > x$$

Here is an example:



(ii) In the lecture, we introduced *priority groups* to save parentheses in DC formulae.

Extend the following term

$$\theta := x \cdot \int \neg\mathsf{Button} \wedge \mathsf{Light} = \mathsf{green}$$

by as many parentheses as possible (but no double parentheses, i.e., not '((x))') to make the effect of the syntactical structure and the priority groups visible. (1)

(iii) Rewrite the term θ from Task (ii) into prefix normal form. (1)

Exercise 2 — DC Semantics (13/20 Points)

Recall the traffic lights model from Exercise 1. For the following tasks, consider the interpretation $\mathcal{I}$ of its observables as given by the timing diagram in Figure 1 on Page 2.

(i) Calculate the truth value of the state assertion

$$(\mathsf{Light} = \mathsf{green})$$

at $t_1 = 0.1$ and $t_2 = 3.25$.

Hint: Compute $\mathcal{I}[\![\cdot]\!](t)$ and give the details on how you compute it. (2)

(ii) Draw the interpretation of the state assertion

$$\neg\mathsf{Button} \wedge \mathsf{Light} = \mathsf{green}$$

on the interval $[0, 8]$ using a timing diagram. (1)

(iii) Let $\mathcal{V}(x) = 5$. Calculate the real value of the term θ from Exercise 1.(ii) in the interval $[1, 5]$. (2)

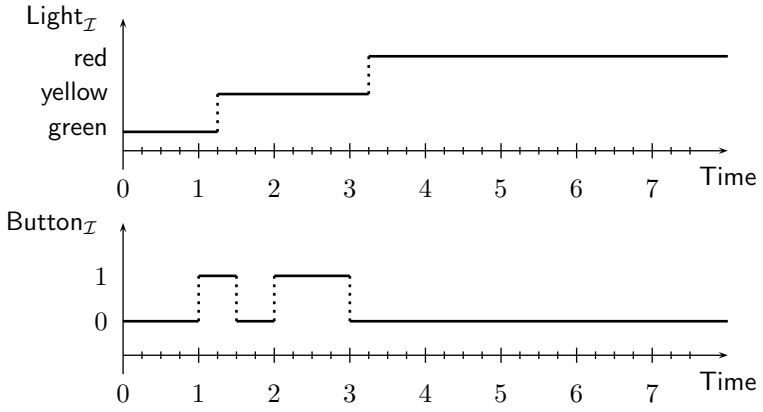


Figure 1: Interpretation of 'Light' and 'Button'.

(iv) Consider the following DC formulae. For each formula, describe informally on which intervals the formula evaluates to tt, that is, which requirement on intervals the formula states, and compute the formula's truth value in the specific interval $[0, 4]$.

a)
$$\int \mathsf{Button} \wedge \mathsf{Light} = \mathsf{yellow} \leq 1 \tag{2}$$

b)
$$\lceil 1 \rceil \,;\, \int \mathsf{Light} = \mathsf{green} = \ell \,;\, \lceil 1 \rceil \tag{2}$$

c)
$$(\mathit{true} \,;\, \int \mathsf{Light} = \mathsf{green} = \ell) \,;\, \mathit{true} \tag{2}$$

(v) Are the chop points for the formula in Task (iv).b) unique? (1)

(vi) What is the shortest distance between two chop points with which the formula from Task (iv).b) evaluates to tt? (1)

Exercise 3 — Realisability (2/20 Points)

Is the formula
$$\Diamond(\lceil 1 \rceil \,;\, \int \mathsf{Light} = \mathsf{green} = \ell \,;\, \lceil 1 \rceil)$$
realisable from 0? (2)
Hint: Just stating "yes" or "no" is (of course) not a proper solution of this task. Convince (yourself and) your tutor of the correctness of your answer.