"Real-Timed Automata"
Exercise 1

The following exercises must be submitted 05.05.2014 before the lecture.

1. For each of the following timed languages $L_i$ over the alphabet $\Sigma = \{a, b, c, d\}$, give a timed automaton $A_i$ such that $L(A_i) = L_i$:
   
   (a) $L_1 = \{(abcd)^*, \bar{t} | \forall i. t_{4i+3} < t_{4i+1} + 1\}$,
   
   (b) $L_2 = \{(abcd)^*, \bar{t} | \forall i. t_{4i+4} < t_{4i+2} + 2\}$,
   
   (c) $L_3 = L_1 \cap L_2$.

2. Are the following timed languages over the alphabet $\Sigma = \{a, b\}$ recognizable by a timed automaton? Justify your answer!
   
   (a) $L_4 = \{(a^m b^n, t_1 \ldots t_{m+n}) | \forall i. 1 \leq i \leq m + n - 1 : t_{i+1} = t_i + 1, 1 \leq m \leq n\}$
   
   (b) $L_5 = \{(a^n, t_1 \ldots t_n) | \forall i. 1 \leq i \leq n - 1 : t_{i+1} = t_i + \frac{1}{2}, n \geq 1\}$
   
   (c) $L_6 = \{(a^n, t_1 \ldots t_n) | \forall i. 1 \leq i \leq n - 1 : t_i = t_{i+1} + 1, n \geq 1\}$

3. Which timed language does the following timed automaton recognize?
   
   
   
   
   

4. Is the complement of the timed language recognized by the automaton in 3. recognizable by a timed automaton? Justify your answer!

5. For the following two clock valuations $\nu_1$ and $\nu_2$, give the corresponding clock region as well as the direct time successor of the clock region. We assume $c_{\text{max}}$ to be 2.
   
   (a) $\nu_1(x_1) = 0.5, \nu_1(x_2) = 1.7, \nu_1(x_3) = 0.7$
   
   (b) $\nu_2(x_1) = 2.0, \nu_2(x_2) = 1.9, \nu_2(x_3) = 0.1$