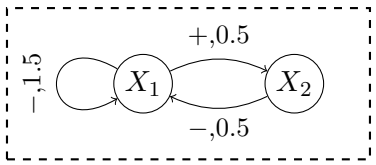
Netzwerkanalyse SS 2015
Alexander Bockmayr
Therese Lorenz

Exercise Sheet 4

May 18, 2015

Exercise 1. *Tutorial*
Consider the gene regulatory network from Exercise 3.3, which has the following IAG and state table.



X_1	X_2	X_1'	X_2'
0	0	$\mathbf{K}_{11+12}$	0
0	1	$\mathbf{K}_{11}$	0
1	0	$\mathbf{K}_{11+12}$	$\mathbf{K}_{21}$
1	1	$\mathbf{K}_{11}$	$\mathbf{K}_{21}$
2	0	$\mathbf{K}_{12}$	$\mathbf{K}_{21}$
2	1	0	$\mathbf{K}_{21}$

Draw the asynchronous state transition graph T for logical parameters with values $\mathbf{K}_{21} = 1$ and $\mathbf{K}_{11} = \mathbf{K}_{12} = \mathbf{K}_{11+12} = 2$. Determine all attractors.

Exercise 2. *Tutorial*
Consider the same gene regulatory network. Draw the asynchronous state transition graphs for the following sets of logical parameters and determine the attractors.

1. $\mathbf{K}_{21} = 1$, $\mathbf{K}_{11} = \mathbf{K}_{12} = 0$ and $\mathbf{K}_{11+12} = 2$.
2. $\mathbf{K}_{21} = 1$, $\mathbf{K}_{11} = \mathbf{K}_{12} = 1$ and $\mathbf{K}_{11+12} = 2$.

Exercise 3. *Tutorial*
The following CTL formulas are given:

a) $AF(X_2 = 1)$ b) $AG(X_2 = 1)$ c) $EX(AG(X_2 = 1))$

1. Consider the network from Exercise 1. For each formula give the set of states for which it is true.
2. Consider the first network from Exercise 2. For each formula give the set of states for which it is true.
3. Consider the second network from Exercise 2. For each formula give the set of states for which it is true.

Exercise 4. *Homework* 4 P.

Which of the following pairs of CTL formulas are equivalent?

a) EFp and EGp

b) $EFp \vee EFq$ and $EF(p \vee q)$

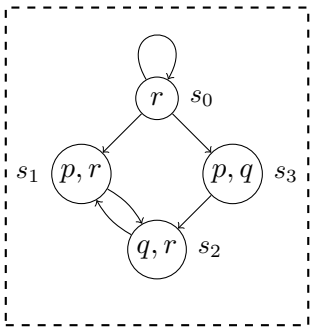
c) $AFp \vee AFq$ and $AF(p \vee q)$

d) AFp and $A[p\ U\ true]$

e) $EF(\neg p)$ and $\neg AFp$

Exercise 5. *Homework* 4 P.

Consider the transition system $(S, \to, L)$ where:



- The set of states is $S = \{s_0, s_1, s_2, s_3\}$.
- The state transitions are

$$(s_0, s_0),\ (s_0, s_1),\ (s_0, s_3),\ (s_1, s_2),\ (s_2, s_1),\ (s_3, s_2).$$

- The labeling function is given by

$$L(s_0) = \{r\},\ L(s_1) = \{p, r\},\ L(s_2) = \{q, r\},\ L(s_3) = \{p, q\}.$$

Which of the CTL formulas below are satisfied in state s_0?

a) $AF(q \wedge r)$

b) $AG(p \to AF(p \wedge r))$

c) $A[r\ U\ q]$

d) $AG(p \to AG(p \vee q))$

e) $AG\ EF(\neg r)$

Please justify all your answers and send the solutions to the fourth and fifth exercise until Friday, 22nd, 10:00 a.m. to `Therese.Lorenz@fu-berlin.de`.