Formal Models SS 2016: Assignment 6

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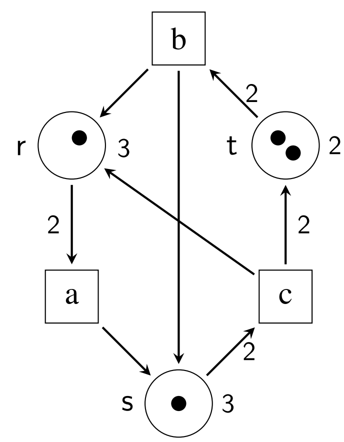
Exercise 21

Let N be the PTN shown below.



- Specify N formally as a 5-tuple $N = (P, I, T, G, C)$. How many markings for N are possible *theoretically*?
- Now let M and M' be two markings of N, with $M(r) = 0$, $M(s) = 2$, $M(t) = 0$ and $M'(r) = 1$, $M'(s) = 3$, $M'(t) = 1$, respectively. Which are the transitions that can fire in M and M', respectively? What are the possible new markings obtained from this?
- Draw the LTS corresponding to N.

Exercise 22

a) Reformulate $\forall x.\ (\phi \leftrightarrow \psi)$ using only $\exists$ and operators $\neg$ and $\wedge$. Specify all intermediate steps.

b) Explain in your own words the effects of reordering quantifiers. More precisely, explain the semantical difference between $\forall x \exists y.\ \phi$ and $\exists y \forall x.\ \phi$ in general.

Exercise 23

a) List the unit literals of the following QBF and simplify it with unit propagation.
$\exists a \forall x \forall y \forall z \exists b \exists c \exists d.((y \vee \neg z \vee c) \wedge (\neg x \vee \neg c) \wedge (a \vee z) \wedge (b \vee x \vee \neg d) \wedge (c \vee \neg x) \wedge (\neg z) \wedge (d))$

b) Explain by an example why unit propagation is not sound for a clause of size one containing only a universal literal.

c) Apply pure literal elimination on the following QBF.
$\forall x \exists a \forall y \exists b \exists c \forall z((\neg y \vee \neg c \vee a) \wedge (\neg y \vee x \vee z) \wedge (\neg x \vee z) \wedge (x \vee \neg c) \wedge (\neg y \vee b) \wedge (\neg b \vee c \vee a))$

d) Consider the QBF below. List the clauses in which universal reduction is possible.
$\forall a \forall b \forall c \exists x \exists y \exists z.((\neg x \vee \neg c \vee a) \wedge (\neg y \vee \neg x \vee a) \wedge (\neg x) \wedge (x \vee \neg b \vee c) \wedge (\neg y \vee \neg b) \wedge (\neg y \vee a))$

Exercise 24

What are the truth values of the following two QBFs?

a) $\forall a \forall b \forall c \exists x \exists y \exists z.((y \vee z \vee c \vee \neg b) \wedge (\neg z \vee \neg a) \wedge (\neg y \vee b \vee a) \wedge (a \vee b \vee c \vee y \vee \neg z) \wedge (\neg c \vee \neg b \vee \neg y) \wedge (\neg b \vee c))$

b) $\forall x \exists y \forall z.((z \leftrightarrow x) \wedge (z \leftrightarrow y))$