Models of computation (MOD) 2013/14
Exam – July 17, 2014

[Ex. 1] Consider the IMP program

$$w \stackrel{\text{def}}{=} \textbf{while } \neg(x = 0) \vee \neg(y = 0) \textbf{ do } (x := x - 1; y := y - 1)$$

Define the set of stores $T = \{\sigma \mid ...\}$ for which the program w terminates and:

1. prove formally that for any store $\sigma \in T$ we have $\langle w, \sigma \rangle \to \sigma[0/x, 0/y]$. (Hint: use well-founded induction on T)
2. prove formally (by using the rule for divergence seen during the course) that $\langle w, \sigma \rangle \not\to$ for any store $\sigma \notin T$.

[Ex. 2] Consider the HOFL term:

$$t \stackrel{\text{def}}{=} \textbf{rec } f.\lambda x.\ \lambda y.\ \textbf{if } x \times y \textbf{ then } x \textbf{ else } (f x)((f x) y)$$

Derive the type, the canonical form and the denotational semantics of t.

[Ex. 3] Consider the CCS agents:

$$p \stackrel{\text{def}}{=} (\textbf{rec } x.\ a.x) | \textbf{rec } x.\ b.x \qquad q \stackrel{\text{def}}{=} \textbf{rec } x.\ a.a.x + a.b.x + b.a.x + b.b.x$$

Prove that p and q are strongly bisimilar or exhibit an HM-logic formula F that can be used to distinguish them.

[Ex. 4] Given the μ-calculus formula:

$$\phi \stackrel{\text{def}}{=} \nu x.(p \vee \Diamond x) \wedge (q \vee \Box x)$$

compute its denotational semantics and evaluate it on the LTS below: