DAT8: Advanced topics in semantics and verification

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1. Show that if $P_1 \equiv P_2$, then $\mathrm{fn}(P_1) \equiv \mathrm{fn}(P_2)$. (It is enough to show that this holds for each of the laws defining structural congruence).

2. Give an example that shows why

$$(\nu x)!\, P \equiv !\, (\nu x)P$$

should *not* be an axiom in the definition of structural congruence. That is, find a process P and argue informally that the two sides of the above equation do not have the same behaviour.

3. The goal of this problem is to give you experience with expressing a simple system in the π-calculus. Consider a system consisting of Alice, Bob and a Server. The system should have the following behaviour.

   - Alice and Bob each share a private channel with the server. Alice does not know the channel that Bob is using, and vice versa. The server will only respond to requests from Alice and Bob.
   - Alice and Bob can send a new message to the other part (here, messages are names) as follows:
     a) Alice (or Bob, if Bob wants to send a message) will use her private channel to ask the server for a new channel. The server sends this channel to Alice and Bob.
     b) Alice (or Bob, if Bob is the one wanting to send a message) now uses the channel received to send her message to the other part.

   Describe this system in the π-calculus and find a sequence of reductions that describes the above behaviour.

4. Here is a process.

$$P \stackrel{\mathrm{def}}{=} (\nu z)((\overline{x}\langle y\rangle + z(w).\overline{w}\langle y\rangle \mid x(u).\overline{u}\langle v\rangle \mid \overline{x}\langle z\rangle)$$

   a. Find $\mathrm{fn}(P)$ and $\mathrm{bn}(P)$
   b. Find all possible τ-transitions from P.
   c. Now do the same using the reduction semantics, that is, find all possible reductions from P.

   A sanity check that is useful when checking your solutions is of course that we know that the reduction semantics and the labelled semantics agree.