Erratum for Extended pi-Calculi

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Theorem 1 and possibly also Theorem 2 are not correct as stated. They need an additional assumption about the EF-relation. This fact was discovered after publication of the paper in connection with the mechanisation of the proofs. We here account for the counterexample and provide a solution in form of one further assumption on the EF-relation. The terminology and definitions are as in the paper.

Counterexample

Assume a unary function symbol f. For any name a, let the alias $F(a)$ be $\{^{f(a)}/_{a}\}$. Thus $F(a)$ only contains the name a, and by convention also denotes the frame $\{^{f(a)}/_{a}\}$. Define an EF-relation $\vdash$ by $F(a) \vdash f(a) = a$, and additionally $F(a) \cup F(b) \vdash a = b$. Let $\vdash$ be closed under the assumptions equivariance, equivalence, strengthening, weakening, and scope introduction. The relation then also satisfies scope elimination, idempotence, and union, i.e. it satisfies all the assumptions on an EF-relation.

Let N be any term such that $a, b \# N$, and consider the agent P defined as

$$P = (\nu a, b)(F(a) \mid F(b) \mid \overline{a}\, N.\mathbf{0} \mid b(N).\mathbf{0})$$

Here P has a τ action since $F(a) \cup F(b) \rhd \overline{a}\, N.\mathbf{0} \mid b(N).\mathbf{0} \ \xrightarrow{\tau}\ \mathbf{0}|\mathbf{0}$

Using the structural rules of Theorem 1, notably scope extension and commutativity and associativity of parallel, we have $P \sim Q$ where

$$Q = ((\nu a)(F(a) \mid \overline{a}\, N.\mathbf{0})) \mid ((\nu b)(F(b) \mid b(N).\mathbf{0}))$$

However, it is not the case that Q has a tau action. Therefore P and Q are not bisimilar, and Theorem 1 must be false.

The proof of Theorem 2 relies on Theorem 1. We believe Theorem 2 also to be false.

A solution

The counterexample relies on a highly unintuitive EF-relation, and a solution is to introduce an additional assumption about EF-relations to eliminate the undesired ones. The additional assumption is called interpolation:

Suppose $a\#M, F$ and $b\#N, G$ and $F \cup G \vdash M = N$. Then there exists K such that $a, b\#K$ and $F \cup G \vdash M = K$.

The precondition is about a frame that can be split into two parts F and G, where F is free from a and G free from b. The frame equates M and N where M is free from a and N is free from b. As an example consider the situation in the counterexample above, where $F = F(b), M = b, G = F(a), N = a$. The conclusion is that there exists a term K, free from both a and b, and equated to M. If this holds, in the counterexample above also Q would have a τ transition since its two components can interact using this K as subject.

With this additional assumption Theorems 1 and 2 hold. These results have been verified in Isabelle. There remains the question of whether a more concise assumption would suffice. We have abandoned work on this particular formalism in favour of the more general psi-calculi (proc. LICS 2009, pp39-48).