

1998 Paper 9 Question 15

Communicating Automata and Pi Calculus

Explain briefly the role played by structural congruence in defining the reaction rules of the π -calculus. Give the structural congruence rules which involve restriction, or composition, or both. [7 marks]

A π -calculus term of the form $\text{new } \bar{z}(M_1 | \dots | M_m | !Q_1 | \dots | !Q_n)$, where $m, n \geq 0$ and each M_i is a summation, is said to be in *standard form*. Give an argument (which need not be fully formal) to show that every term of the π -calculus is structurally congruent to a standard form. [6 marks]

Consider the term

$$P = \bar{x}\langle a \rangle \mid \text{new } a (!\bar{a}\langle c \rangle \mid (a(b).b(c).\bar{c}\langle x \rangle + x(y).y(z).\bar{z}\langle a \rangle)) .$$

Convert P to standard form by the rules of structural congruence, indicating which rules are used. Hence write down all the possible reactions $P \rightarrow P'$, and the possible reactions of each resulting P' . For each result which has no further reactions, write down the simplest term to which it is strongly equivalent (\sim), giving a brief justification. [7 marks]