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Theoretical Foundations of the UML WS 17/18

— Exercise Sheet 9 —

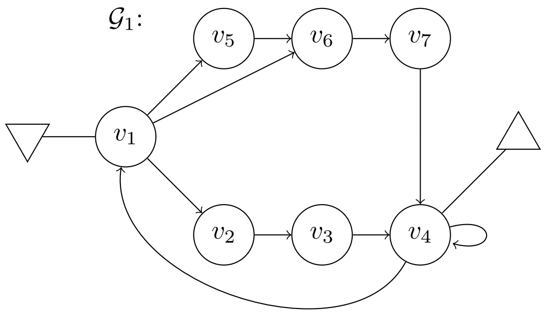
Hand in until January 16th before the exercise class.

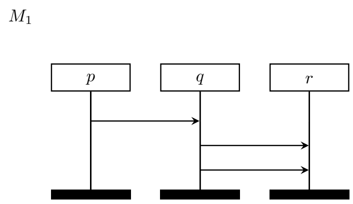
General Remarks

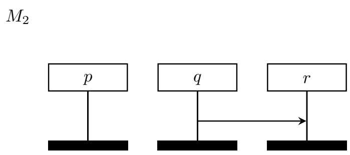
- The exercises should be solved in groups of *three* students.
- You may hand in your solutions for the exercises just before the exercise class starts at 15:30 or by dropping them into the "TFUML" box at our chair. Do *not* hand in your solutions via L2P. However the rule for bonus points *still* applies and we also firmly believe that *actively solving* the exercises is truly important so as to pass the exam.

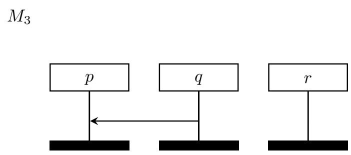
Exercise 1 **(1+1+1+6 = 9 Points)**

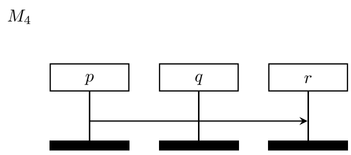
Given the following MSG $\mathcal{G}$ over $\mathcal{P} = \{p, q, r\}$, where $\lambda(v_i) = M_i$ (for $i \in \{1, \ldots, 7\}$):

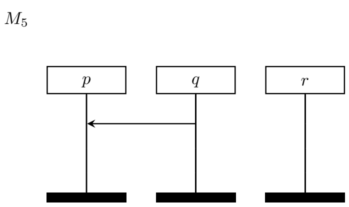


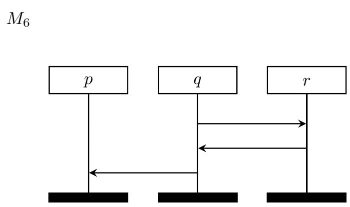


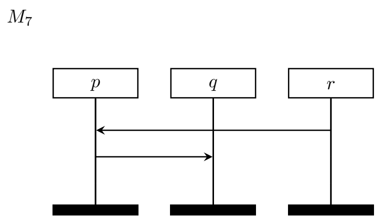












a) Transform G to an MSG G' with $\mathcal{L}(G) = \mathcal{L}(G')$ such that G' does not have any branching final vertices.

b) Argue why G' is local choice by identifying for each branching vertex v the process p that initiates the behavior along every path (i.e., find p with $\forall \pi \in \text{Paths}(v).\ \min(\pi') = \{e\} \subseteq E_p$).

c) For each vertex v of G' determine the maximal non-branching paths $nbp(v)$.

d) Construct a deadlock-free CFM A that realizes G' according to the algorithm presented in Lecture 16. For simplicity, you may depict a state (v, E) of a local automaton A_p by $(v, |E|)$.

Exercise 2 (4 Points)

We call an MSC $M = (\mathcal{P}, E, \mathcal{C}, l, m, \preceq)$ *event connected* if for all $e, e' \in E$ we have $e \sim e'$, where $\sim = (< \cup <^{-1})^*$.

Show that an MSC M is event connected iff the communication graph of M is weakly connected.

Exercise 3 (3 Points)

Write down the PDL formulas according to the informal descriptions.

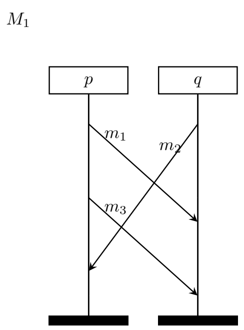
a) There does not exist a path from process 1 to process 2. In other words there is no path in the (directed) communication graph from 1 to 2.

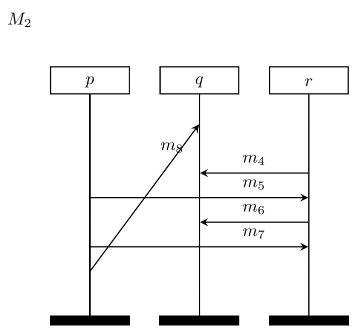
b) If process 1 receives *req* from process 2, then process 1 will eventually send an *ack* to process 2 and in between these two events, process 1 cannot send any messages to other processes.

c) If the (unique) minimal event of the MSC M occurs at process 1, then the (unique) maximal event of M occurs at process 2.

Exercise 4 (4 Points)

Consider the following MSCs. Note that the message for both MSCs is m. The index $i \in \{1, \ldots, 8\}$ is just added to give the send/receive events an unique identifier.





Show whether the formulas:

a) $\Phi_1 = \exists(\langle proc\rangle^{-1}\langle proc\rangle^{-1}\langle msg\rangle!(q,p,m) \wedge \langle msg\rangle^{-1}!(p,q,m)$ and

b) $\Phi_2 = \forall([proc]^{-1} false \wedge (\langle msg\rangle!(p,q,m) \vee \langle proc\rangle?(q,p,m)))$

hold for M_1 and the formulas

c) $\Phi_3 = \exists\langle\{!(p,q,m)\}; proc; proc; proc\rangle[proc] false$ and

d) $\Phi_4 = \exists\Big([proc]^{-1} false \to \langle\alpha\rangle[proc] false\Big)$, with

$$\alpha = \Big((\{!(q,p,m) \vee !(q,r,m)\}; proc)^*; \{?(q,p,m) \vee ?(q,r,m)\}; proc;\Big)^*$$

hold for M_2.