Theoretical Foundations of the UML - SS 2020
— Exercise Sheet 9 —

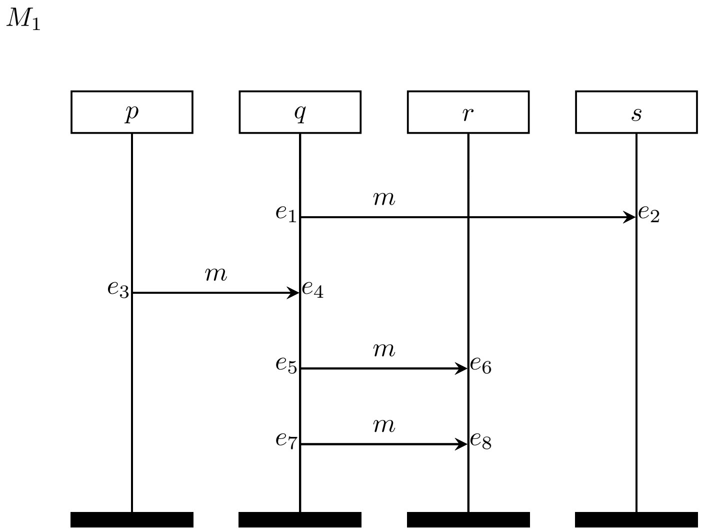
Hand in until Monday June 29, 09:00 am via RWTHmoodle

General Remarks

- Questions regarding the lectures and exercises, if any, are expected in the Q&A session via Zoom (instead of emails), with the next on Thursday 25 June, at 16:00. Zoom ID: 369 366 110, Password: FUML-QA

Exercise 1 (6 Points)

Consider the following MSC M_1.



Task: Determine for each of the following local formulas $\varphi_1, \ldots, \varphi_3$, which events $e_1, \ldots, e_8$ satisfy them. In other words, check whether $M_1, e_i \models \varphi_j$ holds.

(a) $\varphi_1 = [proc + msg]^{-1}\langle proc^*\rangle !(q, r, m)$

(b) $\varphi_2 = \langle(\{\langle proc\rangle^{-1} true\}; proc)^*\rangle !(q, r, m)$

(c) $\varphi_3 = \langle\{!(q,s,m)\};\{?(q,p,m)\}\rangle!(q,r,m)$

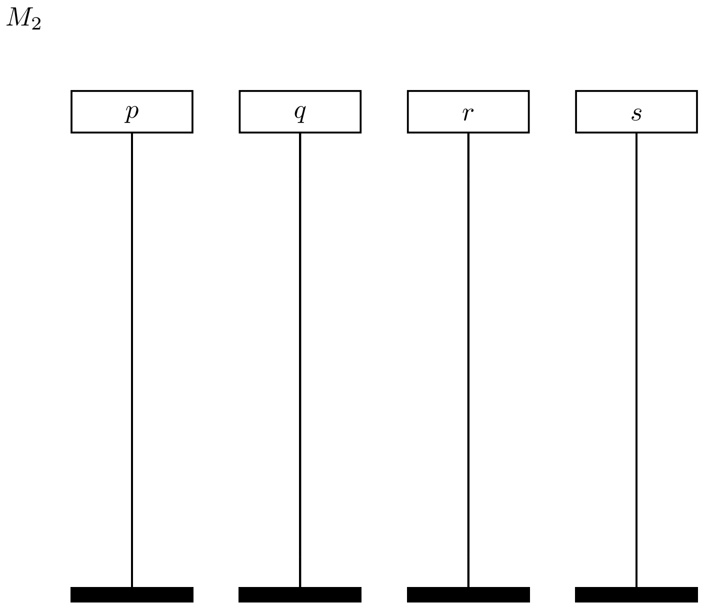
Exercise 2 (2 Points)

Consider the following two PDL formulas.

(i) $\Psi_1 = \forall\Big(\big(\langle(proc+msg)^*\rangle?(q,p,m)\big) \wedge \big(\langle(proc+msg)^*\rangle^{-1}!(r,s,m)\big)\Big)$

(ii) $\Psi_2 = \exists\Big(!(s,p,m)\vee?(q,s,m)\Big)$

Task: Give a MSC M_2 with *at least two send events* which satisfies $M_2 \models \Psi_1$ and $M_2 \not\models \Psi_2$.



Exercise 3 (6 Points)

Write down the PDL formulas that correspond to the following 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.

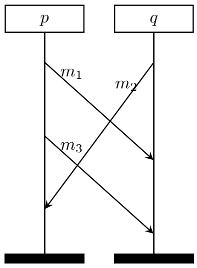
b) If process 1 receives *req* from process 2, then process 1 will eventually send an *ack* to process 2 and in between these two events, process 1 cannot send any messages to other processes.

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.

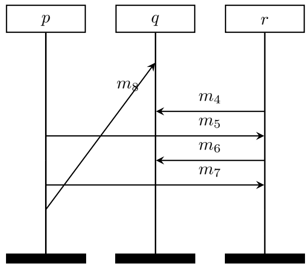
Exercise 4 (6 Points)

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.

M_1



M_2



Show whether the formulas

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

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

hold for M_1 and the formulas

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

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

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

hold for M_2.