Theoretical Foundations of the UML - SS 2020
— Exercise Sheet 8 —

Hand in until Monday June 22, 09:00 am via RWTHmoodle

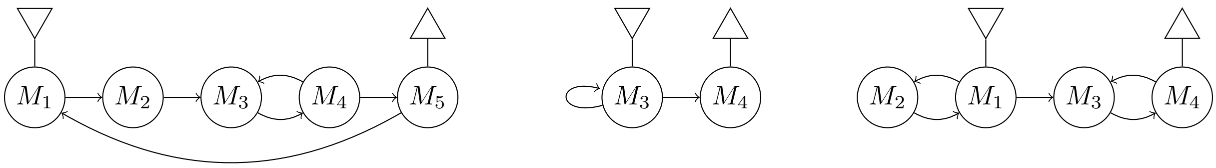
General Remarks

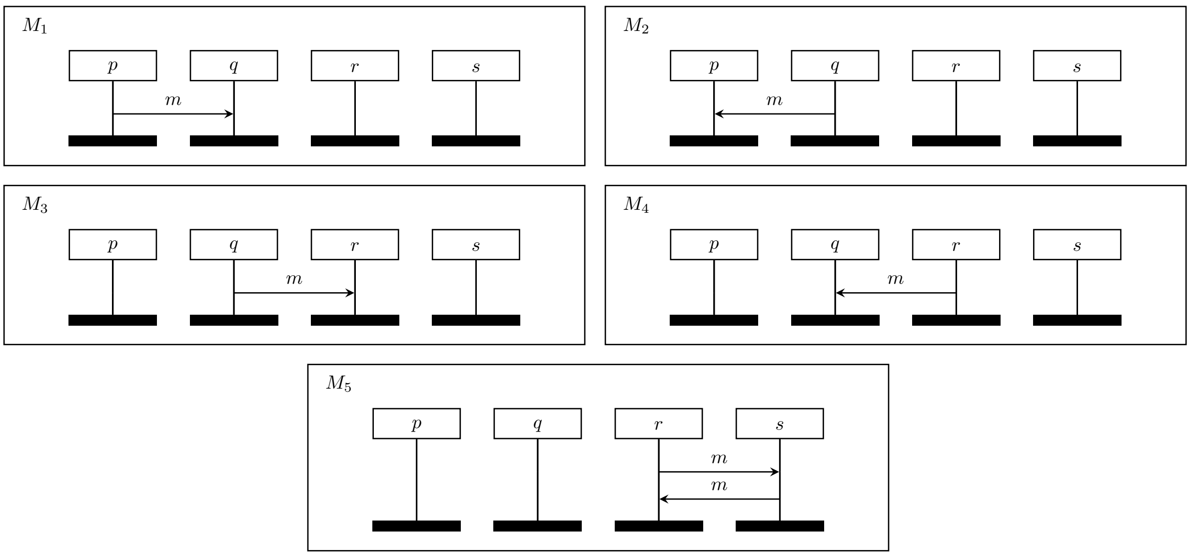
- In order to attend the exam, every registered participant of the course needs to register the exam via RWTHonline as soon as possible. The fixed dates of the exams are to be announced.
- Questions regarding the lectures and exercises, if any, are expected in the Q&A session via Zoom (instead of emails), with the next on Thursday 18 June, at 16:00. Zoom ID: 369 366 110, Password: FUML-QA.

Exercise 1 (Local-Choice MSGs) (2+2+2 Points)

Consider the following MSGs:

$\mathcal{G}_1$: $\mathcal{G}_2$: $\mathcal{G}_3$:

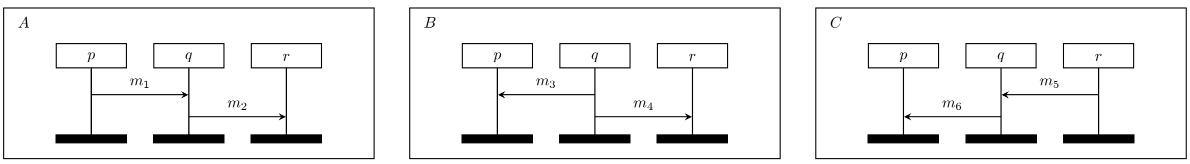


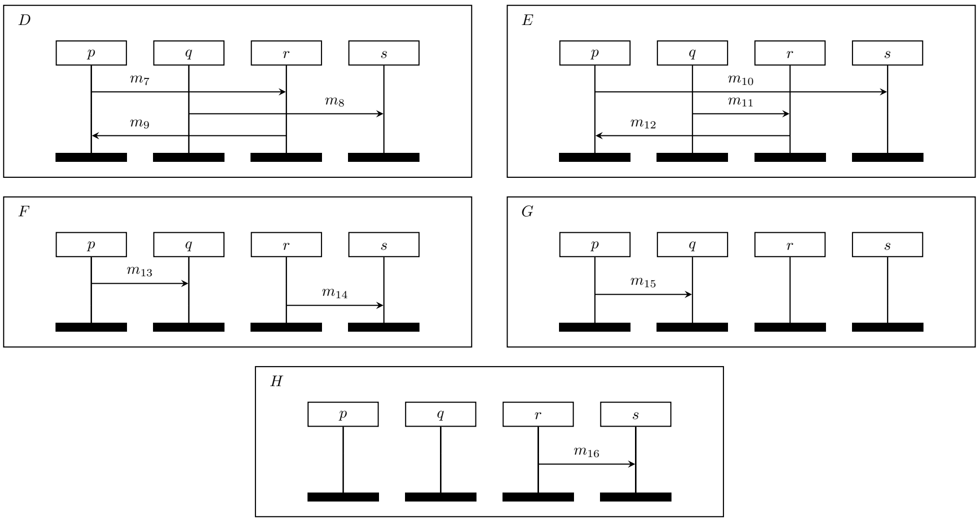


Decide for each MSG $\mathcal{G}_i$, $i \in \{1, 2, 3\}$ whether it is local choice. Justify your answers.

Exercise 2 (Regular Expressions on MSCs) (2+2+2+2 Points)

Consider the following MSCs. Note that the message for all MSCs is m. The index $i \in \{1, \dots, 16\}$ is just added to give every send/receive event a unique identifier.





Determine whether the languages of the following regular expressions α_i are realisable or not. In case of yes, check whether it can be realised by a universally or existentially bounded CFM. Justify your answers.

1) $\alpha_1 = (A \cdot B \cdot C)^*$

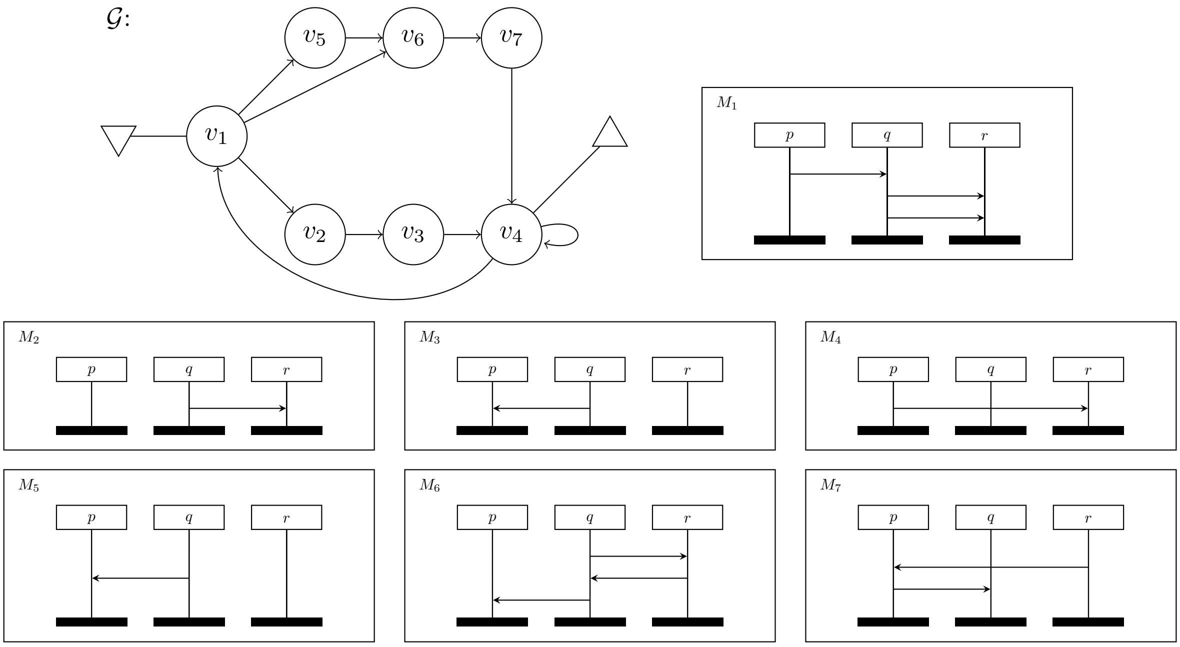
2) $\alpha_2 = D^* + E^*$

3) $\alpha_3 = (D \cdot E)^*$

4) $\alpha_4 = (F^* + G^* + H^*)^*$

Exercise 3 (Realisation of Local-Choice MSGs) (1+1+6 Points)

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



We aim to construct a deadlock-free CFM $\mathcal{A}_\mathcal{G}$ that realises $\mathcal{G}$. To this end, follow the steps below.

1) Transform $\mathcal{G}$ to an MSG $\mathcal{G}'$ with $\mathcal{L}(\mathcal{G}') = \mathcal{L}(\mathcal{G})$ such that $\mathcal{G}'$ is still local choice and does not have any branching final vertices. $\mathcal{G}'$ should not involve MSCs other than M_1 to M_7.

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

3) Construct a deadlock-free CFM $\mathcal{A}_{\mathcal{G}'}$ that realises $\mathcal{G}'$ (and thereby $\mathcal{G}$) according to the algorithm presented in Lecture 14. For simplicity, you may depict a state (v, E) of a local automaton A_s by $(v, |E|)$, and an action $!(s, s', m)$ (resp. $?(s, s', m)$) by $!s'$ (resp. $?s'$).