Theoretical Foundations of the UML - SS 2020
— Exercise Sheet 6 —

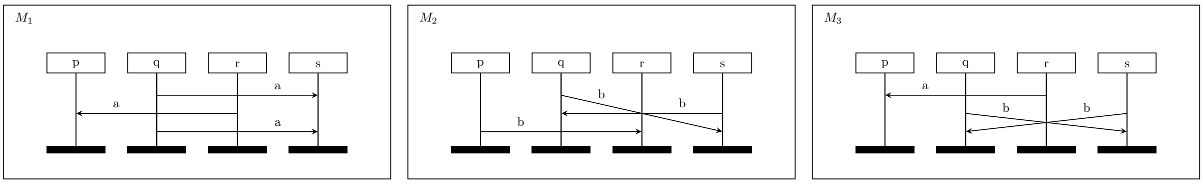
Hand in until Monday June 1, 09:00 am via RWTHmoodle

General Remarks

- There will be NO lecturing, exercise-class, or Q&A activities in the week after Pentecost ("excursion week" in Aachen), i.e., week 23 (June 1 - 5).
- 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 28 May, at 16:00. Zoom ID: 369 366 110, Password: FUML-QA.

Exercise 1 (Inference of MSCs) (2 Points)

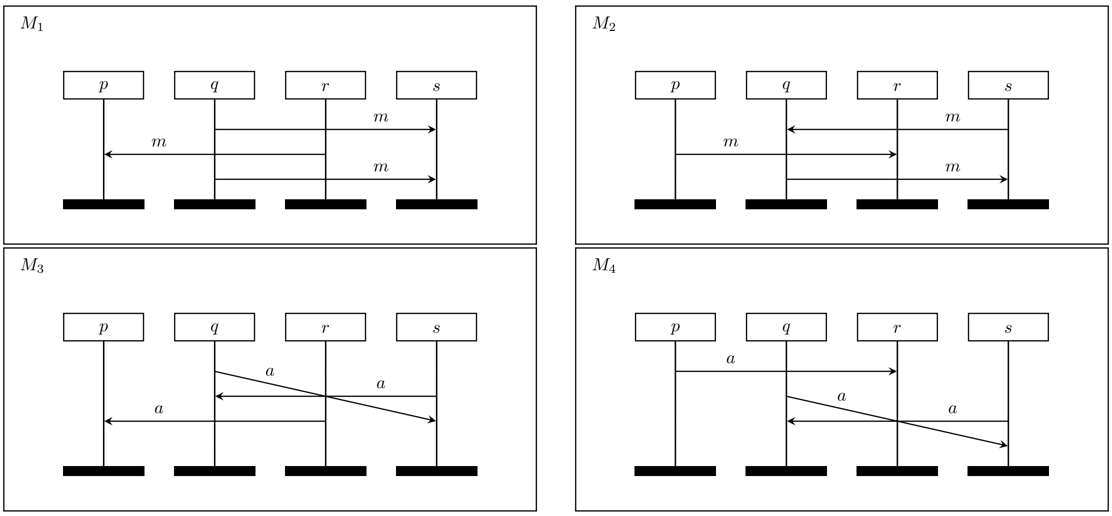
Consider the following MSCs M_1, M_2 and M_3 with the set of processes $\mathcal{P} = \{p, q, r, s\}$.



Does $\{M_1, M_2\}$ infer M_3? Justify your answer.

Exercise 2 (Realisability by Weak CFMs) (2 + 2 Points)

Consider the following MSCs M_1, M_2, M_3 and M_4.



1) Is $\{M_1, M_2\}$ realisable by a weak CFM? If yes, give a weak CFM that realises it; otherwise argue why.

2) Is $\{M_3, M_4\}$ realisable by a weak CFM? If yes, give a weak CFM that realises it; otherwise argue why.

Exercise 3 (Reduction from the JDP) (2+2 Points)

Consider an instance $J := (U, k, R, Ind)$ of the Join Dependency Problem (JDP) with

$$\begin{aligned} U &= \{a, b, c\}, \\ k &= 4, \\ R &= \{(c, a, c, b), (b, a, c, a), (b, b, c, a)\}, \\ Ind &= \{\{1, 2, 3\}, \{2, 3, 4\}, \{1, 3\}\}. \end{aligned}$$

R:

c	a	c	b
b	a	c	a
b	b	c	a

1) Draw the set of MSCs mapped from J, as in the polynomial reduction to the decision problem whether a finite set of MSCs is realisable by a weak CFM.

2) Is the obtained set of MSCs realisable by a weak CFM? Justify your answer against the reduction. In case of yes, give a weak CFM that realises it.

Exercise 4 (NP and co-NP) (2 Points)

Recall the well-known Hamiltonian Cycle Problem (HamCycle) and its complement:

Problem 6.1 (HamCycle):
Given a graph $G = (V, E)$, is there a cycle in G such that every vertex in V is visited exactly once?

Problem 6.2 ($\overline{\text{HamCycle}}$):
Given a graph $G = (V, E)$, is there NO cycle in G such that every vertex in V is visited exactly once?

Prove or disprove that $\overline{\text{HamCycle}}$ is in co-NP.

Hint: Use one of the characterisations of co-NP as shown in Lecture 10.