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

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

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 (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 HamCycle is in co-NP.

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