Theoretical Foundations of the UML - SS 2020
— Exercise Sheet 1 —

Hand in until Monday April 27, 09:00 am via RWTHmoodle

General Remarks

- The exercises should be solved in groups of (maximally) *three* students. Find your group members in the RWTHmoodle forum.
- The solution sheet should be handed in via RWTHmoodle (UE-room) as a PDF-file.
- You need at least 40% of the exercise points over all exercise sheets to be admitted to the exam.
- The first exercise-class video will be uploaded to RWTHmoodle (UE-room) on Wednesday 29 April, at 14:30, where the solutions to this exercise sheet will be explained. A more readable PDF form of solutions will be made available afterwards.
- Further questions about the exercises and solutions can be posed in the Q&A session via Zoom, with the first on Thursday 23 April, at 16:00. Zoom ID: 369 366 110, Password: FUML-QA

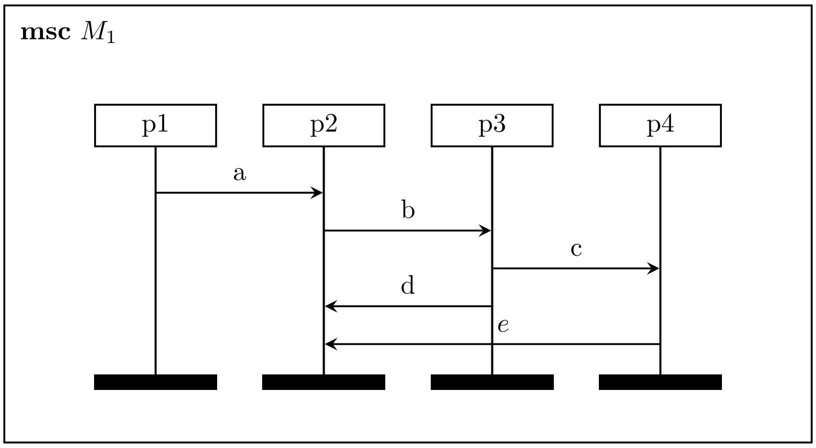
Exercise 1 (Partial Orders) (2+1 Points)

Let $\mathcal{P}(M)$ denote the powerset of a set M, i.e. $\mathcal{P}(M) = \{N \mid N \subseteq M\}$. Let A and B be two arbitrary sets with at least two elements each, and let $(A, \leq_A)$ and $(B, \leq_B)$ denote two partial orders.

1. Prove or disprove whether the following are partial orders.
   (a) $\big(\mathcal{P}(A), \subseteq\big)$
   (b) $(A \times B, \mathcal{R})$ where $(a, b)\, \mathcal{R}\, (a', b') \leftrightarrow a \neq a'$
   (c) $(A \times B, \mathcal{R})$ where $(a, b)\, \mathcal{R}\, (a', b') \leftrightarrow a = a'$
   (d) $(A \times B, \mathcal{R})$ where $(a, b)\, \mathcal{R}\, (a', b') \leftrightarrow (a \leq_A a' \wedge a \neq a') \vee (a = a' \wedge b \leq_B b')$
2. Assume that $A = \{a, b, c\}$, $\leq_A = \{(a,b), (b,c)\}^*$, $B = \{d, e\}$ and $\leq_B = \{(d,e)\}^*$ where R^* denotes the reflexive and transitive closure of the relation R. Draw the Hasse diagram for one of the cases above which is proved to be a partial order.

Exercise 2 (Message Sequence Charts) (2+1+1 Points)

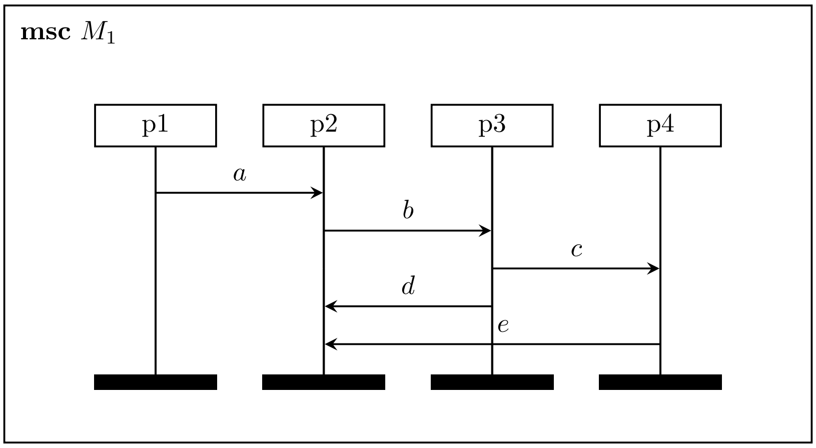
Consider the following message sequence chart.

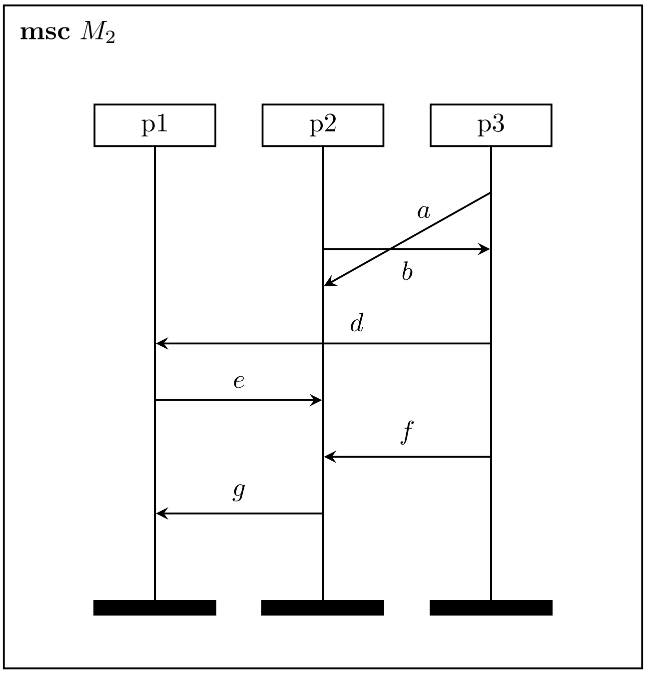


1. Provide some arbitrary names for the events, then write the formal definition of M_1 in the form of $M_1 = (\mathcal{P}, E, \mathcal{C}, l, m, \preceq)$ with
   - $\mathcal{P} = \ldots$
   - $E = \ldots$
   - $\mathcal{C} = \ldots$
   - and so on.
2. Does M_1 satisfy the FIFO property? Justify your answer.
3. Provide $Lin(M_1)$.

Exercise 3 (Races) (1.5+1.5 Points)

Consider the following message sequence charts. Do M_1 and M_2 contain any race? Justify your answer.




msc M_2
p1
p2
p3
a
b
d
e
f
g