

# Theoretical Foundations of the UML - SS 2020

## — Exercise Sheet 4 —

Hand in until Monday May 18, 09:00 am via RWTHmoodle

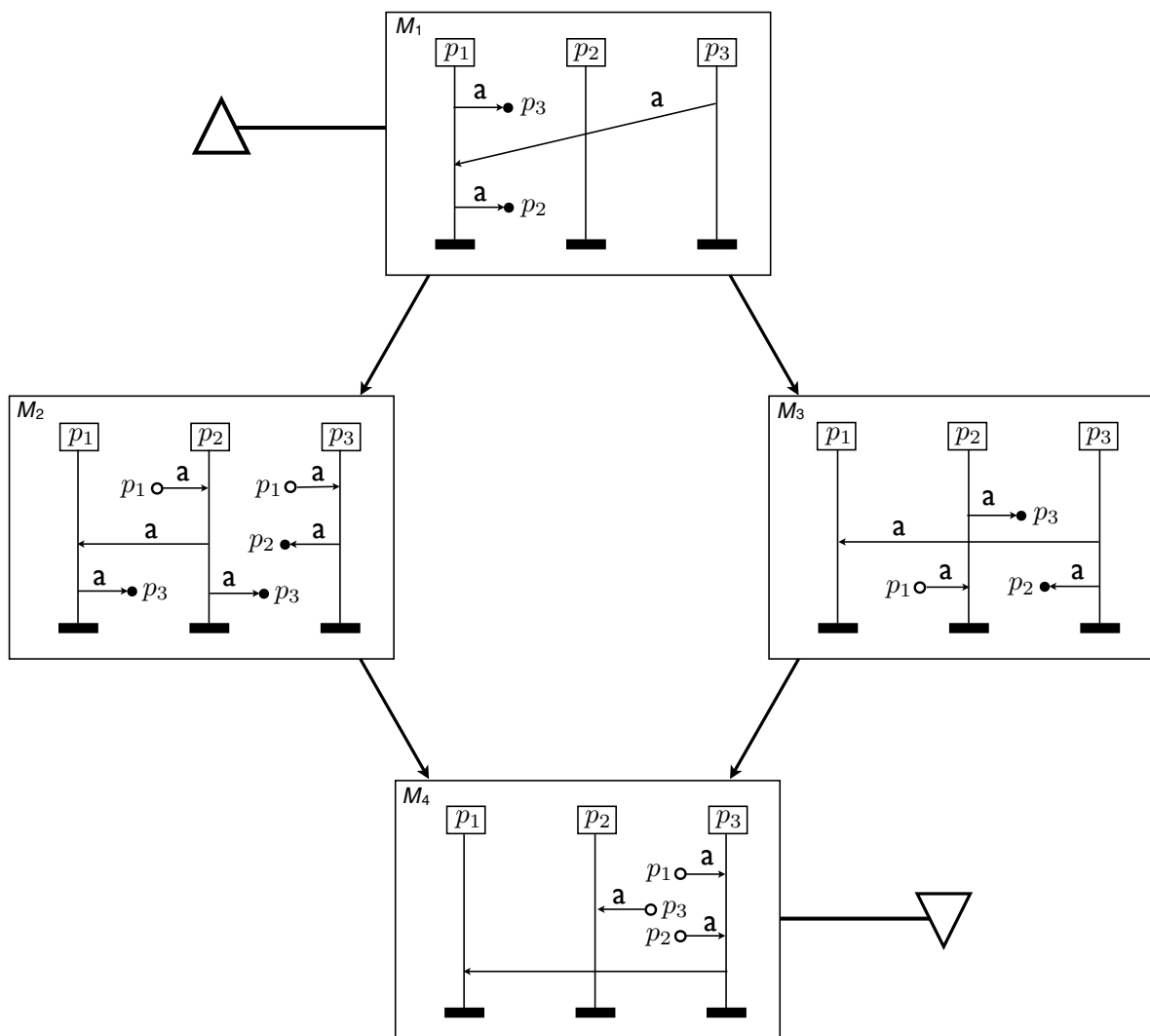
### General Remarks

- The exercises should be solved in groups of *three* students.
- *Only one student per group* is supposed to upload a solution sheet as a PDF file, where the names and matriculation numbers of all the group members have to be explicitly indicated.
- 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 14 May, at 16:00. Zoom ID: 369 366 110, Password: FUML-QA

### Exercise 1 (Language of CMSGs)

(4 Points)

Determine the MSC language of the following CMSG  $G$  by drawing the MSCs generated by  $G$ .



### Exercise 2 (Existence of Safe Paths in CMSGs) (3 + 2 Points)

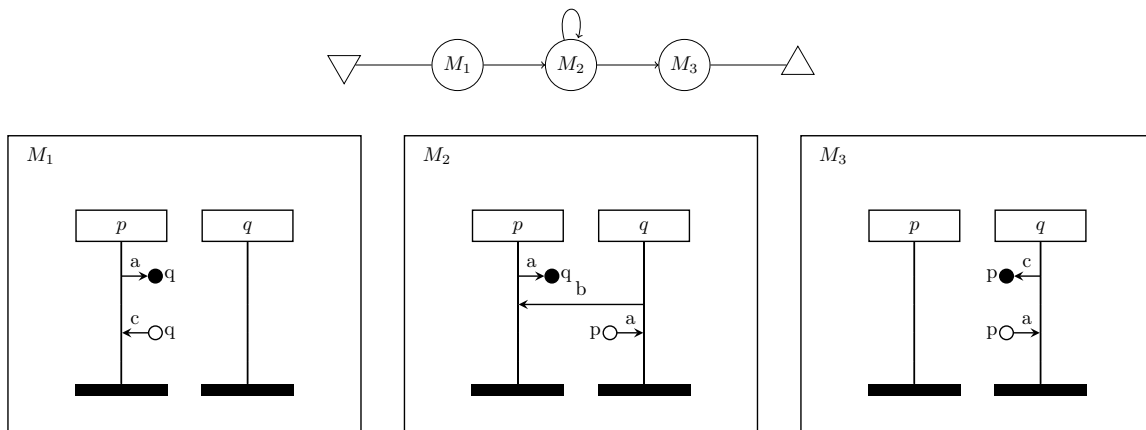
Consider the following sets  $U$  and  $W$  as an instance of Post's Correspondence Problem (PCP).

$$U = \left\{ \underbrace{a}_{u_1}, \underbrace{ab}_{u_2}, \underbrace{bba}_{u_3} \right\} \quad W = \left\{ \underbrace{baa}_{w_1}, \underbrace{aa}_{w_2}, \underbrace{bb}_{w_3} \right\}$$

- 1) Draw the CMSG instance  $G_{U,W}$  that is mapped from the above PCP instance, as in the reduction to the decision problem whether a CMSG has at least one safe, accepting path.
- 2) Does there exist a safe, accepting path  $\pi$  in  $G_{U,W}$ ? If yes, provide the MSC  $M(\pi)$ ; otherwise argue why there is no such path.

### Exercise 3 (Universality of Safe Paths in CMSGs) (3 + 3 Points)

Consider a CMSG  $G$  given as follows.



- 1) Construct the pushdown automaton  $K_{p,q}$  for the channel  $p$  to  $q$  in  $G$ .
- 2) Is  $G$  safe? Justify your answer by means of drawing the configuration graphs. If  $G$  is unsafe, give an unsafe, accepting path in  $G$ .

### Exercise 4 (Variations of the Decision Problem) (2 + 3 Points)

Prove or disprove whether the following decision problems are decidable.

**PROBLEM 4.1:**

Given a CMSG  $G$ , is there an unsafe, accepting path of  $G$ ?

**PROBLEM 4.2:**

Given a CMSG  $G$ , does  $G$  have at least two safe, accepting paths?