

# Theoretical Foundations of the UML WS 17/18

## — Exercise Sheet 6 —

Hand in until December 5th before the exercise class.

### General Remarks

- The exercises should be solved in groups of *three* students.
- You may hand in your solutions for the exercises just before the exercise class starts at 15:30 or by dropping them into the “TFUML” box at our chair. Do *not* hand in your solutions via L2P.

### Exercise 1

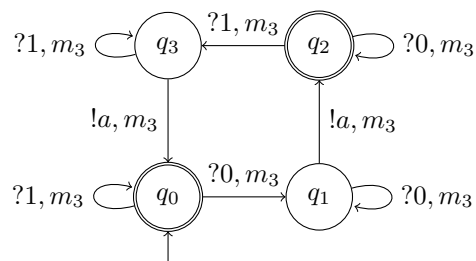
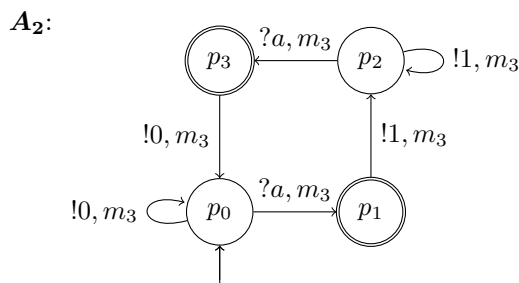
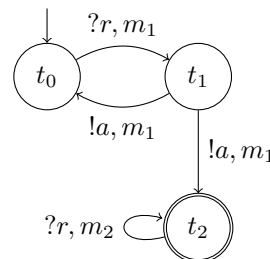
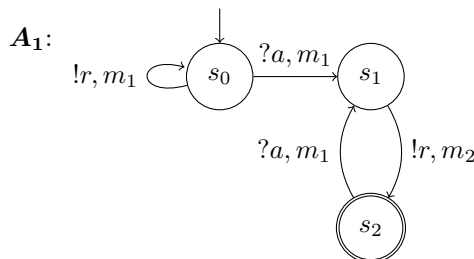
**(2 Points)**

- Prove or disprove: For all  $B \in \mathbb{N}$  holds: If CFM  $\mathcal{A}$  is universally  $B$ -bounded, then  $\mathcal{A}$  is existentially  $B$ -bounded.
- Prove or disprove: For all  $B \in \mathbb{N}$  holds: If CFM  $\mathcal{A}$  is existentially  $B$ -bounded, then  $\mathcal{A}$  is *not* universally  $(B - 1)$ -bounded.

### Exercise 2

**(4 Points)**

Consider the following CFMs  $A_1, A_2$ . Here  $!r, m_1$  indicates a send event  $!(p, q, r)$  for  $p, q \in \mathcal{P}$  and  $m_1 \in \mathbb{D}$ .



Does  $A_i, i \in \{1, 2\}$  contain a *dead-lock*? Justify your answer.

### Exercise 3

(8 Points)

a) Prove that the following decision problem is undecidable:

**PROBLEM 6.1:**

Given a CFM  $\mathcal{A}$ , is  $\mathcal{A}$  universally bounded?

b) Prove that the following decision problem is decidable:

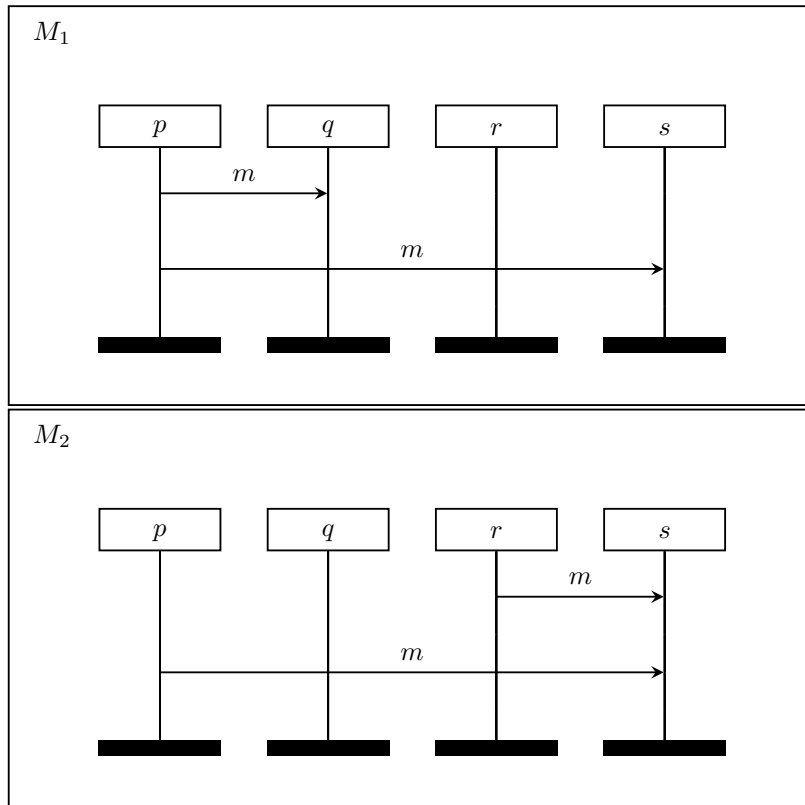
**PROBLEM 6.2:**

Given a deadlock-free CFM  $\mathcal{A}$  and a natural number  $B > 0$ , is  $\mathcal{A} \forall B$ -bounded?

### Exercise 4

(6 Points)

Given two MSCs  $M_1$  and  $M_2$  as follows:



Show that the language of  $\{M_1, M_2\}$ :

- a) is not *weak realizable*, i.e.  $|\mathbb{D}| = 1$ ;
- b) is realizable, if  $|\mathbb{D}| = 2$ . (*Hint*: it suffices to give a CFM that realizes  $\{M_1, M_2\}$  and justify why it realizes  $\{M_1, M_2\}$ .)