Theoretical Foundations of the UML - SS 2020
— Exercise Sheet 5 —

Hand in until Monday May 25, 09:00 am via RWTHmoodle

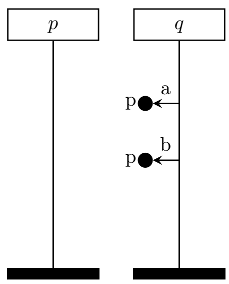
General Remarks

- 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 21 May, at 16:00. Zoom ID: 369 366 110, Password: FUML-QA

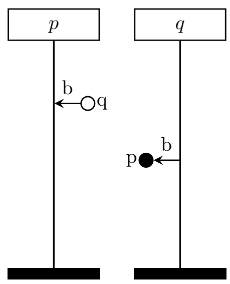
Exercise 1 (CMSG Review) (2 Points)

Consider the following CMSCs.

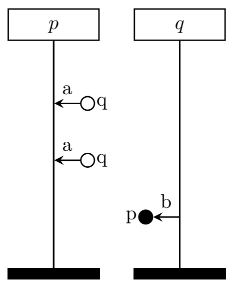
M_1



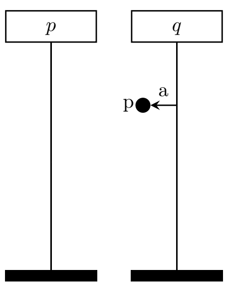
M_2



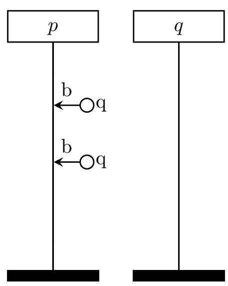
M_3



M_4



M_5

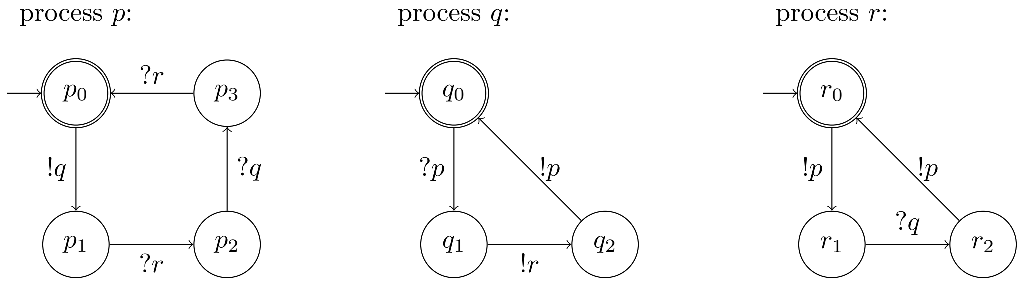


Construct a *safe* CMSG $\mathcal{G}$ containing the all of the vertices M_1, M_2, M_3, M_4, and M_5, and at least one loop (not necessarily a self-loop). Furthermore, there must be at least one accepting path traversing all vertices. You may use vertices multiple times.

Exercise 2 (Language of CFM) (2.5 Points)

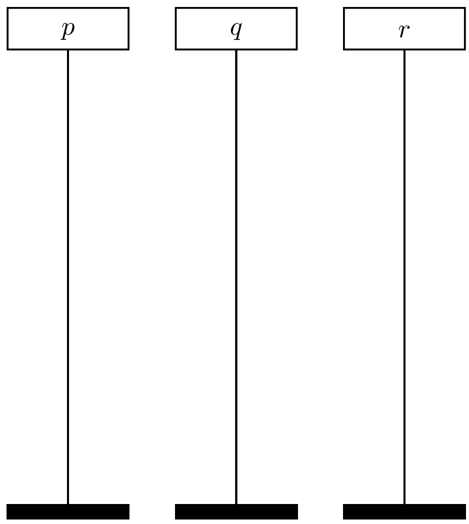
Consider the following weak CFM $\mathcal{A}$ with processes p, q, r. The shorthand $!s$ indicates a send event to process $s \in \{p, q, r\}$ with message content m. $?s$ is defined similarly.

$\mathcal{A}$:



Give a MSC M which is in the language of $\mathcal{A}$, that is $M \in \mathcal{L}(\mathcal{A})$. M should contain at least two send events.

M



Exercise 3 (CFM Boundedness) (2.5 Points)

Reconsider $\mathcal{A}$ from the previous question. Determine if $\mathcal{A}$ is universally ($\forall$-) bounded.

In case it is $\forall$-bounded, determine the smallest B such that $\mathcal{A}$ is $\forall$-B-bounded. In this case it suffices to show why $\mathcal{A}$ is not $\forall$-$(B-1)$-bounded.

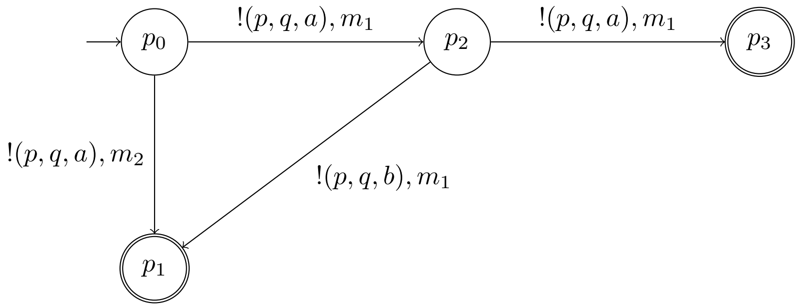
In case it is not $\forall$-bounded, give the channel which is unbounded and argue, why this channel is unbounded.

Exercise 4 (Determinism and Deadlock in CFM) (3 Points)

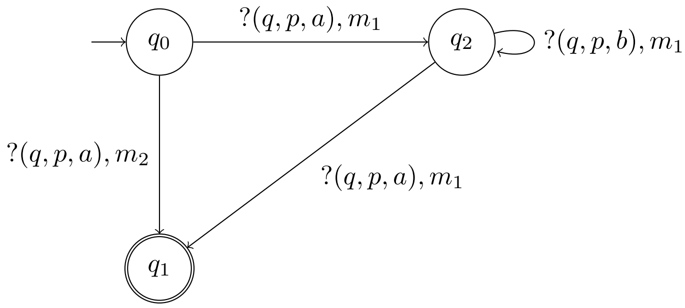
Consider the following CFM $\mathcal{A}_2$ with accepting states $F = \{(p_1, q_1), (p_3, q_1)\}$ and synchronization messages $\mathbb{D} = \{m_1, m_2\}$. A transition label $!(p, q, a), m_1$ refers to action $!(p, q, a)$ with synchronization message m_1.

$\mathcal{A}_2$:

process p:



process q:



a) Is $\mathcal{A}_2$ deterministic? If yes, justify your answer. If no, give all pairs of transitions which violate the determinism.

b) Does $\mathcal{A}_2$ contain a deadlock? If yes, give a run in $\mathcal{A}_2$ reaching the deadlock. You may omit the channel contents η and the synchronization data $m_i \in \mathbb{D}$ from the run. If no, justify your answer.