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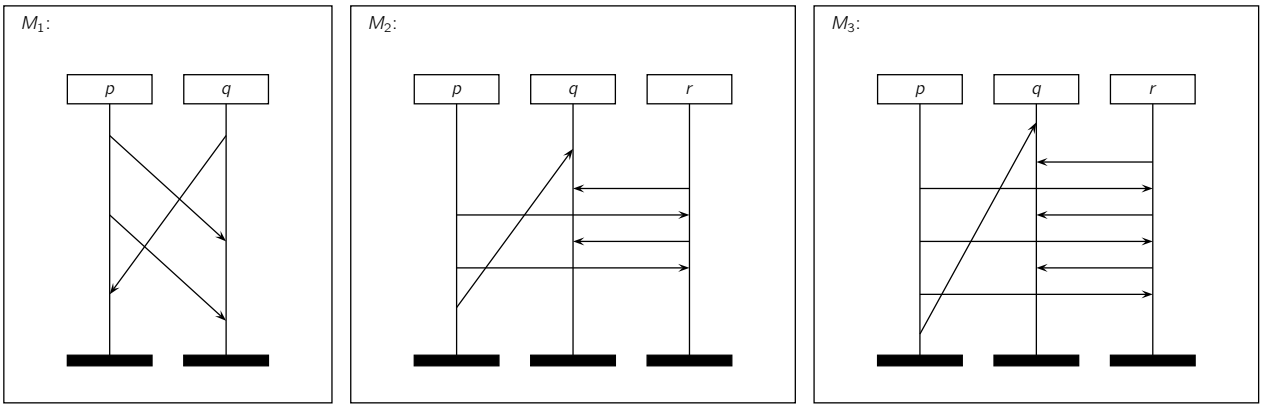
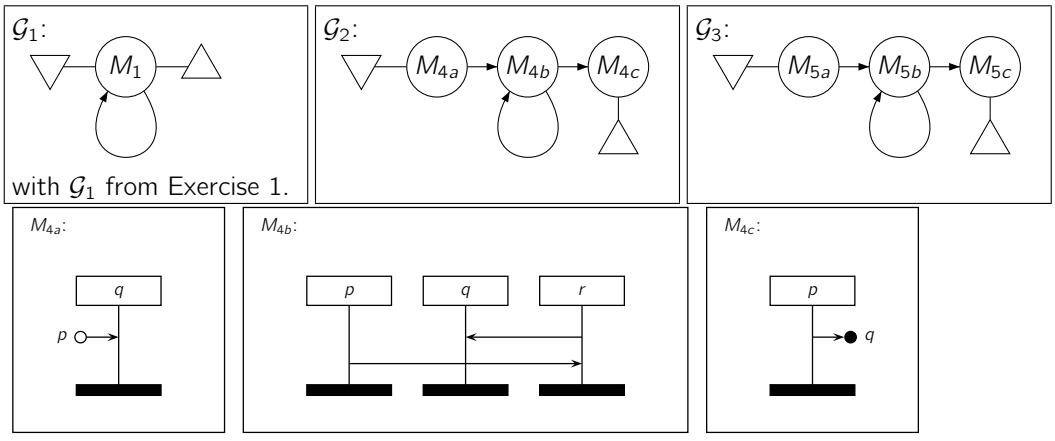
Exercise 1 (Bounded MSCs): (6 Points)

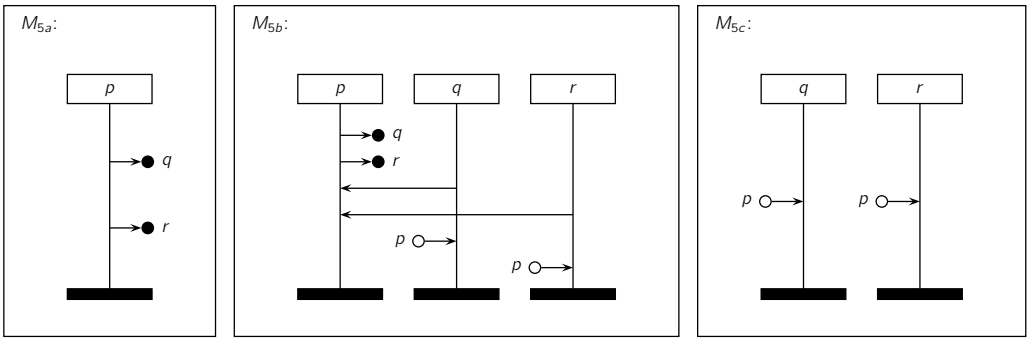
Determine for each of the following MSCs (M_1, M_2, M_3) if they are existentially ($\exists$-) or universally ($\forall$-) bounded. In case an MSC is $\exists/\forall$-bounded, determine the smallest B such that the MSC is $\exists/\forall$-B-bounded and argue why it cannot be $\exists/\forall$-$(B-1)$-bounded.



Exercise 2 (Bounded MSGs): (6 Points)

An MSG G is $\forall$B-bounded whenever all MSCs in L(G) are $\forall$B-bounded, whereas G is $\exists$B-bounded iff all its MSCs are $\exists$ B-bounded.
Determine for each of the following MSGs ($\mathcal{G}_1, \mathcal{G}_2, \mathcal{G}_3$) if they are existentially ($\exists$-) or universally ($\forall$-) bounded. In case an MSG is $\exists/\forall$-bounded, determine the smallest B such that the MSG is $\exists/\forall$-B-bounded and argue why it cannot be $\exists/\forall$-$(B-1)$-bounded.

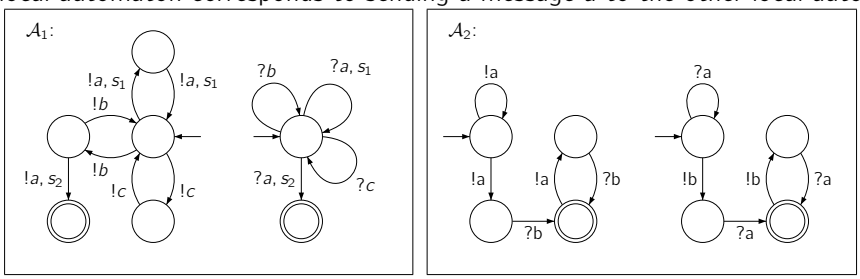




Note that, in contrast to the definition in the lecture, in $\mathcal{G}_2$ we allow a node containing a receive event to occur before the node of the corresponding send event.

Exercise 3 (Proberties of a CFM): (6 Points)

Let the following two CFM $\mathcal{A}_1$ and $\mathcal{A}_2$ be given: (The two CFM only contain 2 local automata, each. For readability purposes the sending and receiving processes were omitted. Thus, for example, executing action $!a$ in one local automaton corresponds to sending a message a to the other local automaton)



Answer the following questions for $i \in \{1, 2\}$ and give a detailed justification.

1. Is the CFM $\mathcal{A}_i$ -$\forall B$-bounded? (if the answer is *yes* find the smallest such B)
2. Is the CFM $\mathcal{A}_i$ deterministic?
3. Is the CFM $\mathcal{A}_i$ deadlock-free?

Exercise 4 (Lossy Channel Systems): (5 Points)

A lossy channel system (LCS) is a CFM in which every channel can lose messages in a nondeterministic manner. That is to say, messages stored in a channel may spontaneously get lost. A CFM is thus an LCS in which no message is ever lost. Question: define the semantics of an LCS (in terms of configurations and transitions between configurations).