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Foundations of UML
Winter term 2009

– Assignment 4 –

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Exercise 1 (10 points)

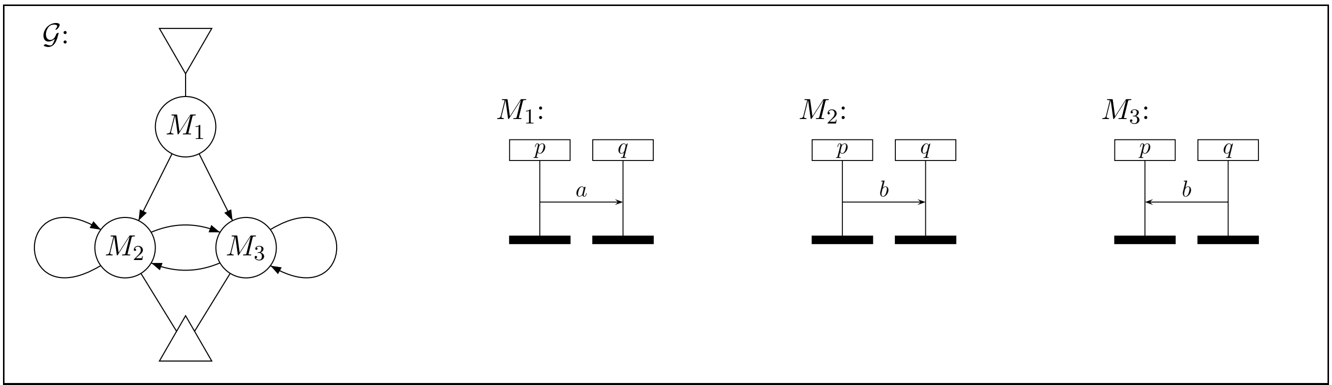
Given the following specification $\mathcal{S}$ where a producer p and a consumer c are the acting units:

- The producer p starts sending messages with content 0 (one bit) to the consumer c until he receives an acknowledgement message a from the consumer. In that case the bit is swapped to 1 and p starts sending messages with content 1 to c until the next a is received. Then again the bit is inverted and the procedure can continue as before.
- The consumer process c, however, starts by receiving at least one 0. After that he may receive more 0s until finally he sends an a to p. After this acknowledgement the remaining 0s in the buffer (p, c) have to be received. Then process c starts receiving 1s (if p sent at least one). Having received at least one message with content 1, c may send an a after any of the successing 1s. Having sent the a, the remaining 1s have to be processed before another round of receiving 0s may start.
- The system may accept directly after any a that is received by process p (as long as the empty-buffer condition is fulfilled).

Question: Find a CFM implementation for $\mathcal{S}$.

Exercise 2 (10 points)

Consider the following MSG $\mathcal{G}$.

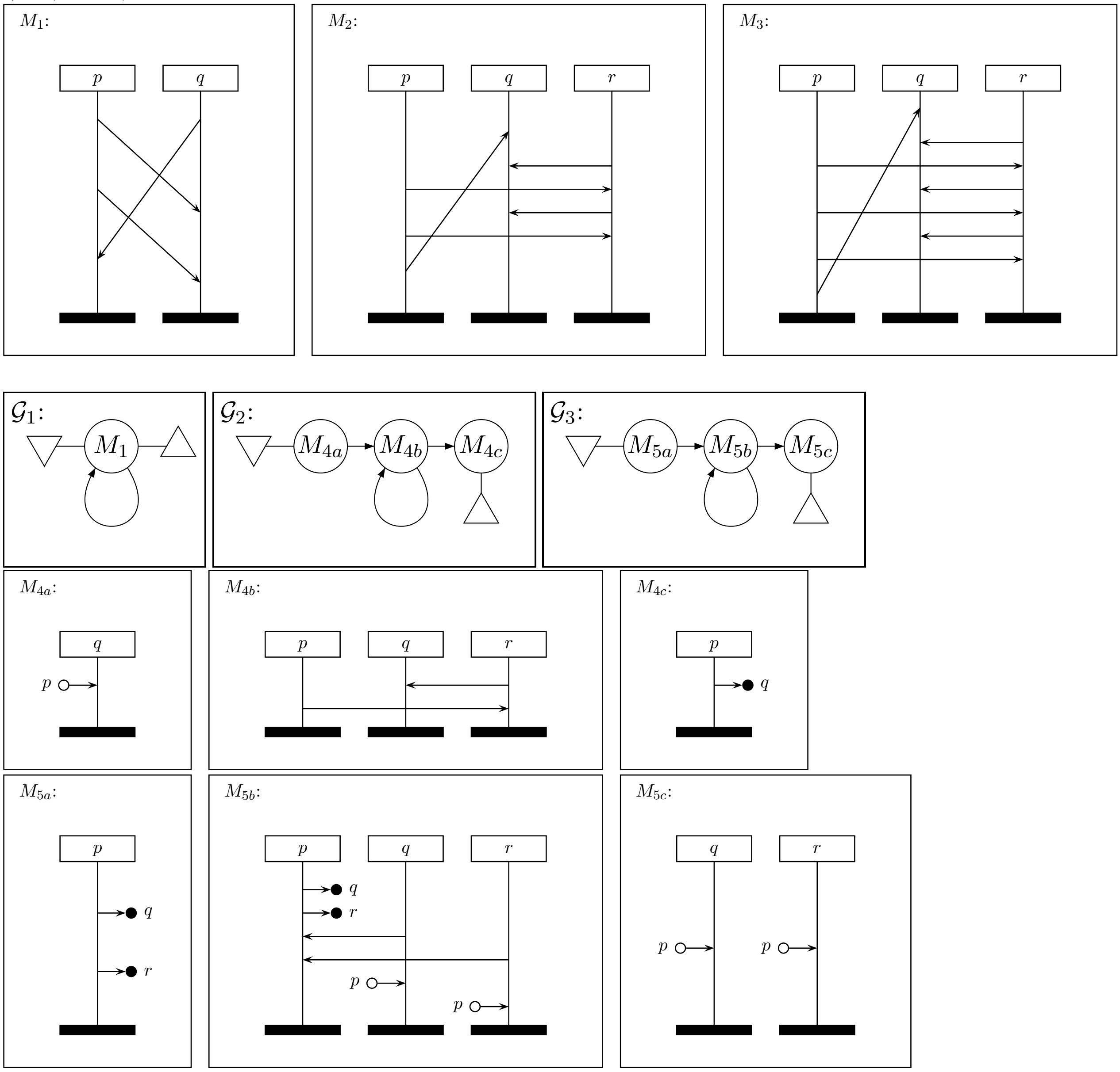


Construct a CFM $\mathcal{A}$ which exactly recognizes $\mathcal{L}(\mathcal{G})$ (i.e., where $\mathcal{L}(\mathcal{A}) = \mathcal{L}(\mathcal{G})$).

Note: Pay attention to avoid non-local-choice which would result in unwanted behavior such as deadlocks.

Exercise 3 (10 points)

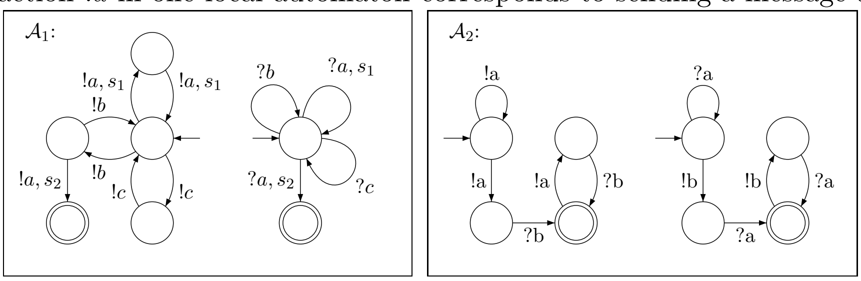
Determine for each of the following MSCs (M_1, M_2, M_3) and MSGs ($\mathcal{G}_1, \mathcal{G}_2, \mathcal{G}_3$), respectively, if they are existentially ($\exists$-) or universally ($\forall$-) bounded. In case an MSC or MSG is $\exists/\forall$-bounded, determine the smallest B such that the MSC or MSG, respectively, 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 4 (10 **points**)

Let the following two CFMs $\mathcal{A}_1$ and $\mathcal{A}_2$ be given: (The two CFMs 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.

a) Is the CFM $\mathcal{A}_i$ strongly-B-bounded? (if the answer is *yes* find the smallest such B)

b) Is the CFM $\mathcal{A}_i$ a product CFM?

c) Is the CFM $\mathcal{A}_i$ deterministic?

d) Is the CFM $\mathcal{A}_i$ deadlock-free?

Definition 1: A CFM $\mathcal{A}$ is stronlgy B-bounded if, for any $u \in Act^*$: if there is a run of $\mathcal{A}$ on u, then u is B-bounded.