Software Modeling and Verification
Lehrstuhl für Informatik 2
RWTH Aachen University

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Foundations of the UML

Winter Term 07/08

– Assignment 5 –

Hand in until January 9th before the exercise class.

Exercise 1 (10 points)

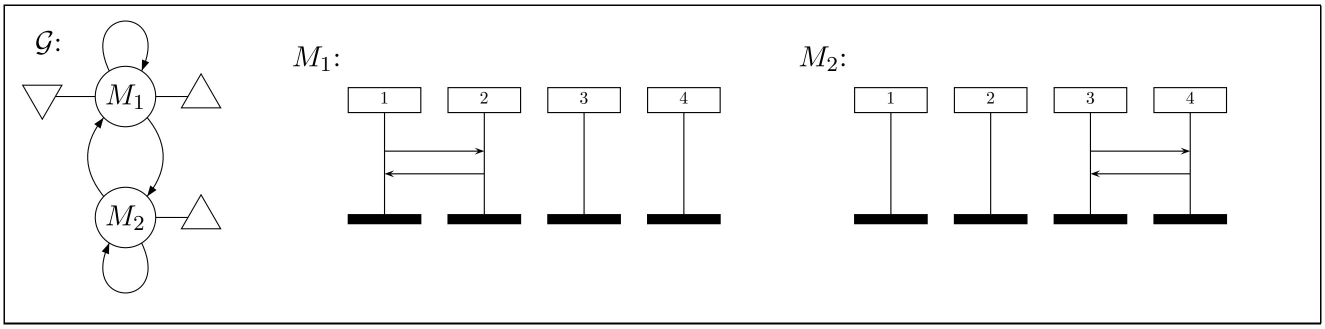
Prove the following statements for $\mathcal{P} = \{p, q, r, s\}$ and $\mathbb{C} = \{a\}$:

a) Locally accepting MPA are strictly weaker than MPA.

b) Safe MPA are strictly weaker than MPA.

Exercise 2 (5 points)

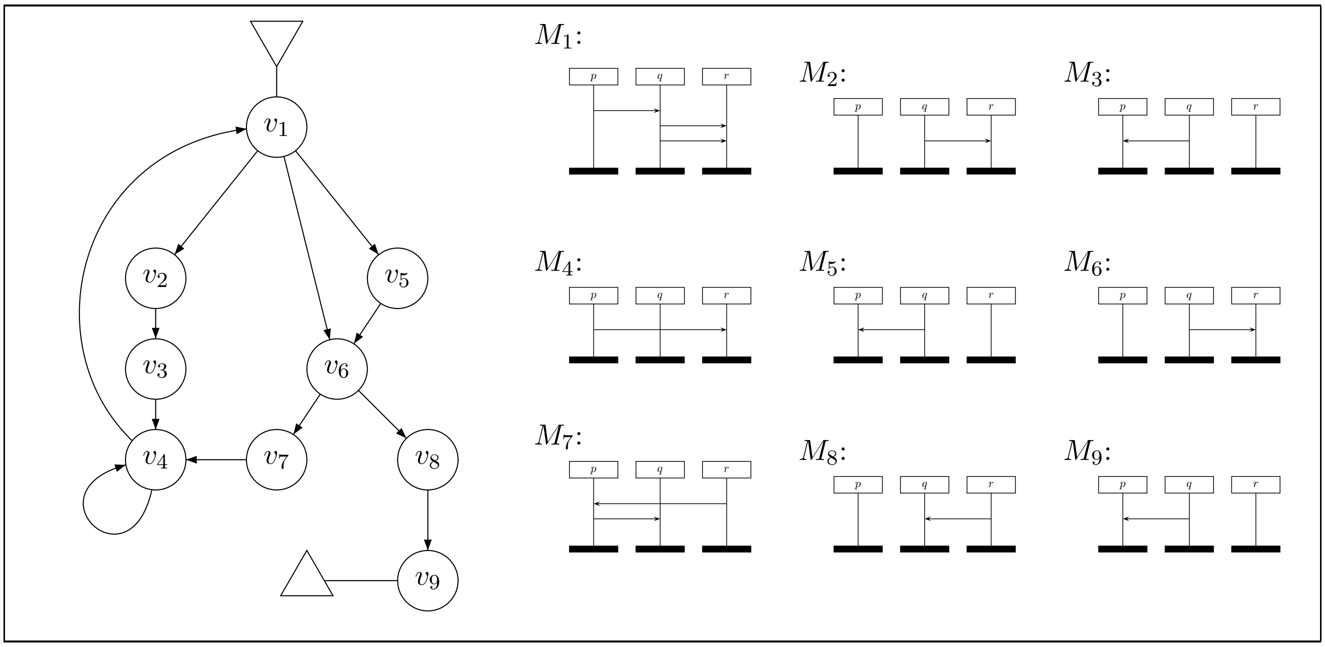
Reconsider the MSG $\mathcal{G}$ from the lecture:



$\mathcal{G}$ is not communication-closed but the set of traces $Tr(\mathcal{G})$ is regular. Find a regular expression $\mathfrak{A}$ over $\{M_1, M_2\}$ such that the MSG $\mathcal{G}'$ induced by $\mathfrak{A}$ is communication-closed and recognizes the same language as $\mathcal{G}$. For your solution write down $\mathfrak{A}$, $\mathcal{G}'$ and argue why $\mathcal{G}'$ is communication-closed and $L(\mathcal{G}) = L(\mathcal{G}')$.

Exercise 3 (10 points)

Given the following local-choice MSG $\mathcal{G}$ over $\mathcal{P} = \{p, q, r\}$, where $\lambda(v_i) = M_i$ (for $i \in \{1, \ldots, 9\}$):



Construct a deadlock-free MPA $\mathcal{A}$ according to the algorithm presented in lecture 7. Determine, moreover, for every node $v \in V$ of $\mathcal{G}$ the maximal non-branching path $nbp(v)$.

Exercise 4 **(5 points)**

Design a Statechart for a simple coffee dispensing machine. The machine has two phases: in a first phase the money for the desired drink is collected. The money that can be inserted are 20 cent coins. Each beverage costs 40 cents. During the collection phase money can always be reclaimed. If 40 cents are stored in the machine, the user can choose between coffee, decaffeinated coffee and tea. After the drink was prepared the machine may output the cup and return to the collection phase.
Pay attention to the following malfunction of the machine which may always occur: a cup might get stuck and prevent the machine from behaving correctly. After such a malfunction is repaired the machine returns to the collecting phase.

Exercise 5 **(10 points)**

Design a Statechart for the life as a student described by the following properties. We assume that a student usually starts as a *student with assistant job*. Later he can be offered a PhD position and become a *PhD student*. No matter whether he becomes a PhD student or not, after graduation or finishing his PhD he will get a job. If he does not finish his student assistant career he will leave university and get no job. Both, the life of the student assistant and the life of a PhD student involve two types of activities, each.

a) student with assistant job

- *Learning* describes an iteration of *attending lecture* and *recapitulating lecture contents* after which a preparation phase starts which is completed by *writing the exam*. After the exam a new learning phase starts with *attending lecture*.
- The life of a student with assistant job also includes the *student assistant* part which starts with correcting exercises. If the student does a bad job he has to leave the chair. In case he does a good job he is promoted to a *student research assistant* position where again he either can do a bad job or do a good job and is offered a PhD position.

b) PhD student

- *Teaching* describes an iteration of *preparing* and *giving lectures*. After giving the last lecture of a course a PhD student *prepares an exam* which he will correct afterwards. In the next semester he is then again starting with the preparation of the first lecture.
- The life of a PhD student also includes *research* activities with the final goal of obtaining the PhD degree. These activities are usually divided into two successive processes: the *preparation* and the *submission* phase. In the *preparation* phase contains *reading*, *thinking* and *writing* which happen iteratively until the PhD student is satisfied. The PhD student then finishes the paper and enters the second phase. In the submission phase the paper is first being *submitted* and then either accepted for a conference or not. In case the paper was accepted the student achieves his final aim. However, if the paper was rejected the research returns to the preparation phase.

We wish you all a *Merry Christmas* and a *Happy and Prosperous New Year*!