

Model Checking (SS 2023) Homework 5

Deadline: **May 03 04, 2023, 4:00 pm**

Send your solution to modelchecking@iaik.tugraz.at

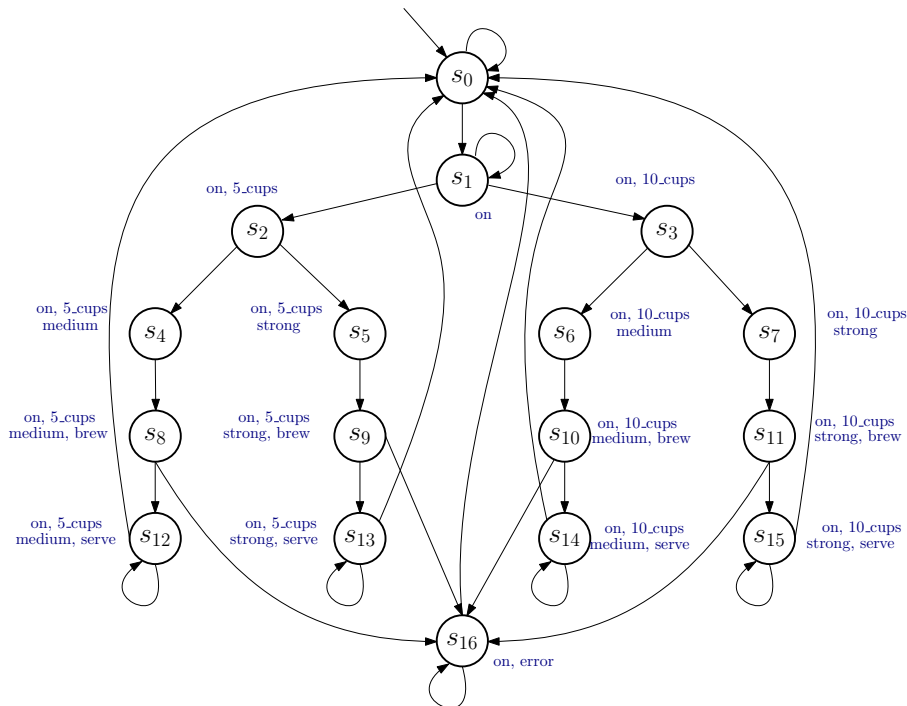
Homework can be done in groups of 1 or 2 students.

The groups need not be the same for each homework.

In the IAIK we have a coffee machine, that can serve either five or ten cups of coffee at a time in either medium or strong flavour, with the following function description:

- The brewer is normally in the off state until it is switched on.
- Once the brewer is switched on, the user can select the number of cups of coffee and the strength of coffee. The user can either select five or ten cups in either medium or strong flavour.
- Once the selections have been made, the coffee machine starts the brewing.
- During brewing, if any error is detected (say not enough coffee or no milk power), the brewer enters an error state.
- Alternatively, the brewer is able to finish brewing and can serve the coffee
- Finally, after serving or reaching an error, the coffee machine can be turned off to be eventually turned on again.

The following figure represents the Kripke structure that models the coffee machine, with atomic propositions $AP = \{\text{on}, 5_cups, 10_cups, \text{medium}, \text{strong}, \text{brew}, \text{serve}, \text{error}\}$. Each state transition in the Kripke structure represents a time step of 1 second.



Task 1. [8 points*] Translate these sentences to CTL* formulas. Indicate for each formula whether it is in CTL, LTL, both or neither. Indicate also if the Kripke structure in the figure satisfies the sentence, and give an informal explanation of why.

1. At any time, one can select ten cups of coffee and once selected, ten cups will always eventually be served unless an error occurs.
2. At any time, it is possible to eventually reach an error.
3. Always, it will happen eventually that the coffee machine remains turned off forever.
4. Before the coffee brewer remains turned off forever, there was eventually coffee.
5. Always, once the brewing is done, the machine will be turned off in the next 3 seconds.
6. It can be the case that we reach an error, but get eventually 10 cups of coffee nevertheless.
7. All reachable states can result in 10 cups of coffee.
8. It is never possible that the machine brews 5 cups of coffee in the current time step, and serves 5 more cups within the next 2 seconds.
9. The selected amount of coffee will be served within 6 seconds.

(*) Each sentence is worth 1 point, there are 9 sentences, so you are allowed one mistake.

Task 2. [2 points] Modify the Kripke structure of the machine so that it fits the following new behaviour:

1. Ensure that the machine does not stay more than 3 consecutive seconds in an error state.
2. In case the coffee selection is 5 cups, once coffee is served, the machine can be either turned off or brew again coffee with the same selection of cups and flavour.