

# Model Checking (SS 2024) Homework 4

Deadline: **April 29, 2024, 9:00 am**  
Submit your solution through TeachCenter

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.

**Task 1. [ 60 points ]** Model the following sentences in CTL\*.

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. [ 10 points ]
2. At any time, it is possible to eventually reach an error. [ 10 points ]
3. Always, it will happen eventually that the coffee machine remains turned off forever. [ 10 points ]
4. All reachable states can result in 10 cups of coffee. [ 10 points ]
5. 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. [ 10 points ]
6. The selected amount of coffee will be served within 6 seconds. [ 10 points ]

**Task 2. [ 40 points ]** Given below is a Kripke structure that models the IAIK coffee machine. Each state transition in the Kripke structure represents a time step of 1 second. State whether the Kripke structure satisfies the following formulas. Given are the following atomic propositions  $AP = \{\text{on}, 5\_cups, 10\_cups, \text{medium}, \text{strong}, \text{brew}, \text{serve}, \text{error}\}$ .

1.  $\varphi := A((F\text{serve}) U (G\neg\text{on}))$  [ 10 points ]
2.  $\varphi := AG(\text{serve} \rightarrow ((X\neg\text{on}) \vee (XX\neg\text{on}) \vee (XXX\neg\text{on})))$  [ 10 points ]
3.  $\varphi := EF\left(F\text{error} \rightarrow EF10\text{cups} \wedge \text{serve}\right)$  [ 10 points ]
4.  $\varphi := AF(\text{serve}) \rightarrow (EFGF(\neg\text{on}))$  [ 10 points ]

