ALBERT-LUDWIGS-
UNIVERSITÄT FREIBURG

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Discussion: TBA
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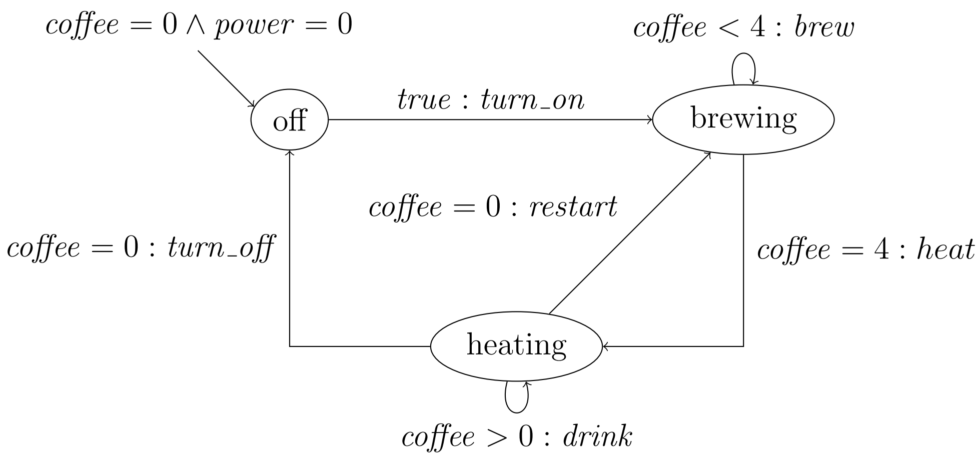
Tutorials for Cyber-Physical Systems I - Model Checking
Exercise sheet 1

Exercise 1: Coffee Machine
The following program graph describes a simple coffee machine:



The effect of the operations is given by:

$$
\begin{aligned}
\mathsf{Effect}(turn\_on, \eta) &= \eta[power := 1] \\
\mathsf{Effect}(turn\_off, \eta) &= \eta[power := 0] \\
\mathsf{Effect}(brew, \eta) &= \eta[coffee := coffee + 1] \\
\mathsf{Effect}(drink, \eta) &= \eta[coffee := coffee - 1] \\
\mathsf{Effect}(restart, \eta) &= \eta \\
\mathsf{Effect}(heat, \eta) &= \eta
\end{aligned}
$$

(a) Draw the transition system corresponding to the program graph.

(b) Check the following temporal properties. Label the transition system with the corresponding atomic propositions.

(i) If the machine is turned off ($power = 0$) it contains no coffee ($coffee = 0$).

(ii) If there are two cups of coffee ($coffee = 2$) there are either three or four cups of coffee in the next step.

(iii) There are always at most four cups of coffee ($coffee \leq 4$).

(iv) The coffee machine will be eventually turned off.

(v) If there is no coffee ($coffee = 0$), there will be coffee after at most three steps.

Exercise 2: Collatz

Convert the following C program into a program graph representation and into a transition system.

```
int i = 5;
while (i != 1) {
  if ((i % 2) == 0)
    i = i / 2;
  else
    i = 3*i + 1;
}
```

If you find out whether the program terminates for any value of i, you will become very famous.