

Quantitative Verification 5

Ex 1: TCTL Model Checking

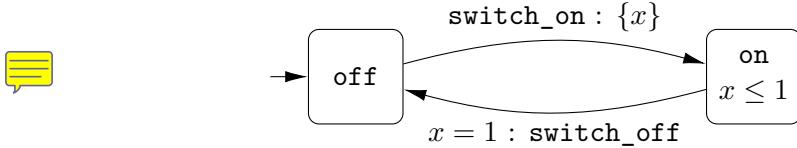
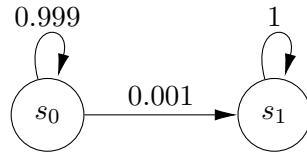


Figure 1: Timed automaton modelling a light

Consider the timed automaton shown in Fig. 1. Model check the TCTL properties “ $\exists \Diamond^{\leq 1} \text{on}$ ” and “ $\forall \Diamond^{\leq 1} \text{on}$ ”. To this end, draw the region transition system, augmented with a new clock z .

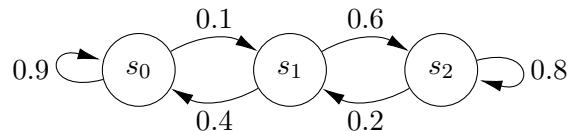
Ex 2: Reachability

Compute the probability of reaching s_1 from s_0 in the following simple Markov Chain. Additionally, compute the probability of reaching s_1 within 10 steps.



Ex 3: Matrix Representation

Write down the matrix representation of the following Markov Chain. Suppose the initial distribution is $\pi_0 = [1, 0, 0]$, i.e. the process starts in s_0 . What is the transient distribution after three time steps?



Ex 4: Proof

Prove the following statements:

- Let P be a stochastic matrix, i.e. the matrix representation of some Markov Chain. Then, $\frac{1}{2}P + \frac{1}{2}I$ is aperiodic, where I is the unit matrix.
- There exists a finite state Markov Chain with a unique stationary distribution π^* , but for any $n \in \mathbb{N}$ we have that $\pi_n = P^n \pi_0 \neq \pi^*$.
- In the lecture, we saw that if all states are irreducible, aperiodic and recurrent non-null in a Markov Chain, there is a unique limiting distribution which does not depend on π_0 . Show that each of these properties is required by finding a Markov Chain which does (i) not have a unique limiting distribution, and (ii) satisfies all but one of the properties.

HW 1: Get PRISM

Download and install the PRISM Model Checker from <http://www.prismmodelchecker.org/download.php> or <https://github.com/prismmodelchecker/prism/releases>. Familiarize yourself with the GUI and the modelling language for DTMC.