Quantitative Verification Session 8

December 21, 2017

PLTL Model Checking

Exercise 1.1. Draw Rabin automata for the following LTL formulae

- Fa
- GFa
- $G\neg b \wedge GFa$

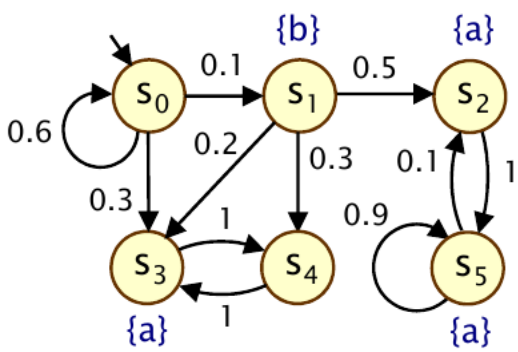

Figure 1: DTMC for PLTL Exercise

Exercise 1.2. Check whether PLTL formula $\phi = G\neg b \wedge GFa$ holds on the DTMC in Figure 1.

Markov Decision Processes

Modeling in PRISM

Exercise 2. A Tinybot is placed in a 3x2m arena at the south-west corner $(0, 0)$. Its goal is to reach a *repair station* at $(3, 1)$, but the arena is not without its challenges. At $(2, 0)$ and $(3, 2)$ are two rotor blades spinning at 20000 RPM which is certain death for Tinybot. A previous close encounter with another such hazard has left Tinybot with certain eccentricities. Firstly, it cannot move south or west. Secondly, if it tries to move north, it succeeds only 90% of the time. Finally, 10% of attempts to move east is accompanied with a major southwards deviation, which makes Tinybot end up 1m south of its intended target. You are tasked with coming up with a strategy for maximizing Tinybot's chances of reaching the repair station. Since you have recently learnt about MDPs, you decide to discretize the arena right away, design an MDP and come up with this maximizing strategy. Use PRISM Model Checker to find the best strategy for Tinybot and the probability of reaching the repair station if it follows this strategy.

See `http://www.prismmodelchecker.org/manual/RunningPRISM/Adversaries` for instructions on how to generate strategies.

Max Reachability

Exercise 3. Consider the following MDP

```
[a] s=0 -> 0.9:(s'=0) + 0.1:(s'=3)
[b] s=0 -> 1:(s'=2)
[c] s=2 -> 1:(s'=0)
[d] s=2 -> 0.1:(s'=0) + 0.1:(s'=1) + 0.8:(s'=3)
```

Compute $P_{min}[F(s=3)]$ and $P_{max}[F(s=3)]$ in two ways

1. Enumerating each strategy and computing its value analytically
2. MDP value iteration

Rewards

Exercise 4.1. The *instantaneous reward of a path* at time t associates with a path, the reward in the state of that path when exactly t time units have elapsed. In general, *Instantaneous reward* refers to the expected reward of a model at a particular instant in time. See lecture slides for more details.

Are memoryless schedulers sufficient to obtain optimal Instantaneous rewards? If yes, give a proof sketch. If no, give a counterexample.

Exercise 4.2. What about *step-bounded cumulative rewards*?

Exercise 5. Cumulative rewards to reach target. In Figure 2, compute the expected cumulative reward until reaching s_3.

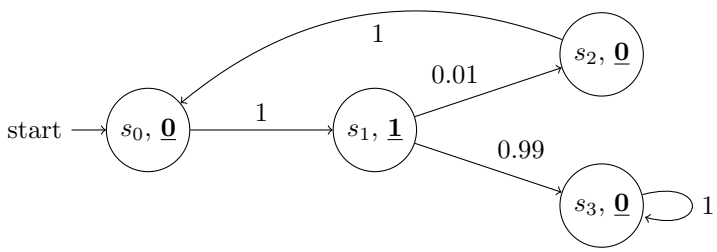

Figure 2: State rewards are bold-faced and underlined.