Real-time and Probabilistic Systems Verification
Assignment 3

Luca Tesei

Academic Year 2016/17

Instructions

Reply to all questions justifying your answers as clearly as possible. Send the PRISM model and property files and an electronic (also handwritten and scanned, but readable) version of the answers to

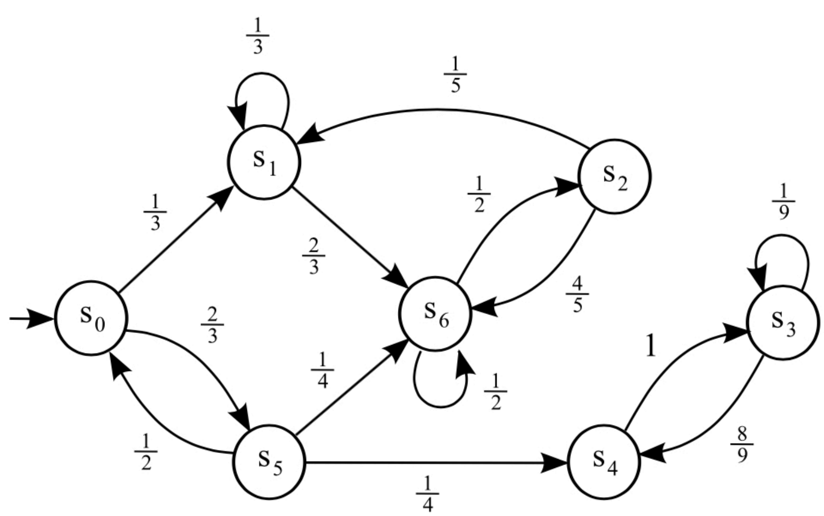
`luca <dot> tesei <at> unicam <dot> it`

by

10th March 2017 23.59

Exercise 1 - 30%

Consider the following DTMC:



1. Compute the probability measure of the union of the following cylinder sets: $\mathrm{Cyl}(s_0 s_1)$, $\mathrm{Cyl}(s_0 s_5 s_6)$, $\mathrm{Cyl}(s_0 s_5 s_4 s_3)$ and $\mathrm{Cyl}(s_0 s_1 s_6)$.
2. Compute the probability, from the initial state of the Markov chain, of reaching state s_2 within 4 steps.
3. Compute the probability, from each state of the Markov chain, of reaching state s_3 within 4 steps.

Hint: there is no need of solving systems of linear equations or of multiplying matrices to calculate the requested probabilities.

Exercise 2 - 40%

Consider the Craps Game with the following rules. The game is based on betting on the outcome of the roll of two dice. The outcome of the first roll, called the “come-out” roll, determines whether there is a need for any further rolls. On outcome 7 or 11, the game is over and the player wins. The outcomes 2, 3, or 12, however, are “craps”; the player loses. On any other outcome, the dice are rolled again, but the outcome of the come-out roll is remembered (this is called the “point”). If the next roll yields 7 or the point, the game is over. On 7, the player loses, on point the player wins. In any other case, the dice are rolled until eventually either 7 or the point is obtained.

1. Model the game as a DTMC in PRISM
2. Using PRISM facilities and PCTL, calculate the probability of winning and of losing at this game.
3. Using PRISM facilities and PCTL, study how the probability of winning and of losing within T steps varies in dependence of the increasing values of the step parameter T starting at 1, increasing of step 1 and ending at a value K (to be determined) in which a nearly ”asymptotic” value is reached.
4. Creating a proper reward structure, calculate the expected number of rolls to win and to lose the game.
5. Creating a proper reward structure and considering a variant of the game in which at each roll of the dice a cost of 1 is payed by the player, calculate the expected money payed to reach a state of winning and the expected money payed to reach a state of loosing.

Exercise 3 - 40%

Complete the model of randomized dining philosophers given in `http://www.prismmodelchecker.org/tutorial/phil.php` in order to be resource starvation-free and deadlock-free, as indicated in the same page. Write the PRISM model and check the properties with PRISM.