CS5219 Assignment #2

13 March 2017

Please read this assignment specification ***fully***. You are responsible for ***everything*** it contains.

Deadline

This assignment is due at **18:00 (6:00pm) on Monday 10 April 2017**. Please plan your time accordingly, as there will be ***absolutely no late submissions*** allowed. And have fun!

Problem Statement

In this coursework you will use PRISM to construct, simulate and verify a model of two cars moving freely around a NxN grid city as shown in Figure 1.

Each car has a current position and direction. As can be seen in Figure 1, the initial position of CarA is at $\left(1, \left\lfloor \frac{2N}{3} \right\rfloor\right)$ with direction to the "right", and CarB is at (N-1,N) with direction "up". At every discrete step, each car decides where to move next with an equal probability. The possible movements are to move one cell forward (in the same direction), reverse (in the opposite direction), left, and right. Moving right, left or reverse also changes the car's current direction accordingly.

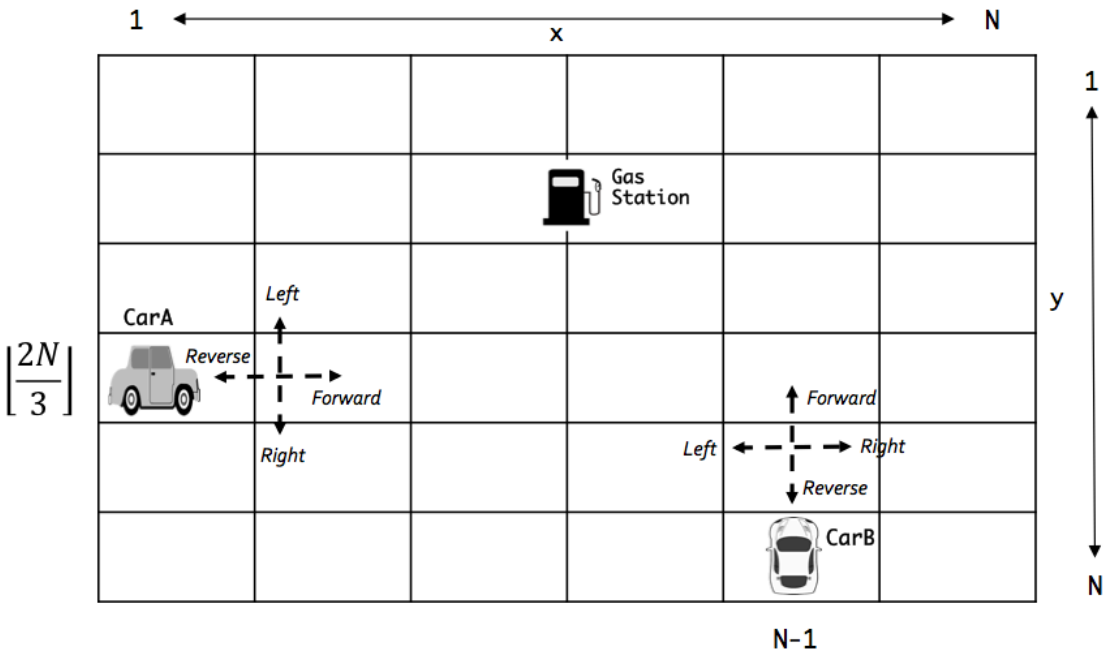

Figure 1: NxN Grid City

You will carry out this assignment on an *individual* basis, as specified in detail at the end of this assignment specification.

To complete the assignment, you will need to familiarize yourself with PRISM's language and features, and you must either download and install PRISM on your own computer, or else use the version of PRISM installed in Programming Lab 1 (COM1-B1-12).

Please let Yamilet (yserrano@u.nus.edu) know if you would like to set up a consultation about the assignment.

Requirements

For the assignment, you must complete the following steps:

1. Specify in PRISM's DTMC modeling language a model of the two cars to at least a level of detail that was described above.
2. Use PRISM to generate an example execution trace for each version of your model when N= {4, 10}.
3. Specify the following properties using PRISM's property language.
   P1: The probability that CarA or CarB eventually reaches the Gas Station within the first 30 time units. Consider that Gas Station is located in $\left(\left\lfloor\frac{2N}{3}\right\rfloor - 1, N - 3\right)$.
   P2: The probability that a car crash occurs within the first 100 time units.
4. Identify two more properties of the model and specify them using PRISM's property language. You should consider specifying properties having explicit probability bounds as well as properties that query the actual probability bound.
5. Use PRISM to verify P1, P2 and your properties against your model, compile it and run experiments that vary the model parameter N when N= {4,6,8,10}.
6. Analyze the effect on the verification of properties P1 and P2 if CarA decides to move forward or reverse each with probability ***p***, or right or left each with probability ***q***, such that $2p+2q = 1.0$ and $q>p$. Justify your answer.
7. ***Bonus:*** You might verify the following property:
   What is the expected number of bordering cells that CarA visits before reaching the Gas Station?
   Show the answer for the model parameter N = {4,6,8,10}.

Submission

Upload a ***single ZIP file*** to the folder *Assignment 2 Submissions* of the workbin *Module Documents* in IVLE. ***Put your matriculation number in the filename.*** Put the following deliverables in the ZIP file:

- your PRISM model
- your PRISM property specifications
- your set of generated execution traces
- a capture of your verification results
- plots from your verification experiments
- a 1-page report discussing your assumptions, insights, difficulties, etc., in specifying and debugging your model, specifying properties, or any other aspect of completing the coursework. Also describe any additional features you included in your model (if any).

You may complete this coursework using either the command-line version of PRISM or the GUI-based tool XPRISM.

Grading

This coursework is worth 15 marks toward your final module result, with the marks allocated as follows:

- PRISM model (60%)
- property specifications (20%)
- execution traces, experiments and verification outputs (15%)
- 1-page report (5%)

At a minimum you are expected to produce a functioning model and some verifiable properties. Higher marks will be earned for greater originality and effort, such as through a more complex and detailed model, more elaborate properties, greater range of features, a more extended use of PRISM, and so on.

Individual Effort

This coursework is to be completed as an *individual effort*. *All* work should be *completely original*, completed *solely* by the individual, and *without* derivation from or reference to *any* models or solutions that may be accessible from other sources. (If you can find it, I can find it!)

In uploading your deliverables to the workbin, you are confirming that you understand and agree to *all* of the above requirements, and that you have abided by the university's policy on plagiarism:

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