ASE 396 and CS 395 T (Fall 2018) - Assignment 5

Exercise 1: Consider a robot over the grid world shown in Figure 1. Express the following specifications formally in temporal logic and synthesize a reactive planner that realizes the specifications. The robot occupies only one cell at each time instance. It can move only to an adjacent cell, i.e., a cell that shares an edge with the current cell. The robot is supposed to visit the blue cell C_8 infinitely often. There is a dynamic obstacle moving over the same grid world. The obstacle can be in one of the three cells C_1, C_4 and C_7 and it can move arbitrarily but it is known to move to an adjacent cell in each transition. The controlled robot is to avoid the obstacle (i.e., not occupy the same cell) at all times. There is an uncontrolled external signal, call it PARK. The robot is to eventually go to the green cell C_0, whenever it receives a PARK signal. The PARK signal is known not to be received infinitely often.

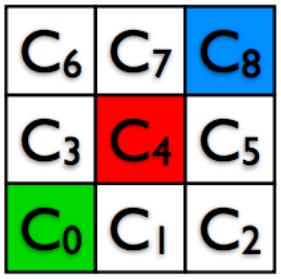

Figure 1: Grid world for Exercise 1.

How are you going to know that you wrote the specifications correctly and the controller you have synthesized does what it is supposed to do? Can you write (or use) a little "simulator" that shows the location of the robot as directed by the controller you synthesize and the location of the obstacle? In any case, you can find such a simulator (and some instructions) at `https://github.com/u-t-autonomous/gridsim`. Please feel free to use this to get a feel of the controllers you obtain in reactive synthesis.

Remember that for such a simulation you need to first fix (finite) sequences of valuations of the environment variables (PARK and the location of the obstacle in this case) that are consistent with the assumptions. That environment behavior then drives the reactive controller whose output determines how the controlled robot should move.

Exercise 2: Consider the scenario in Figure 2. Express the following specifications formally in temporal logic and synthesize an intersection logic that realizes the specifications from the shown initial location of the car. The requirements are the following. (i) The car is eventually at C_6. (ii) If there initially is a car in one of the cells C_3, C_4, and C_7 , the controlled car needs to wait until that car disappears before going through the intersection. (iii) The controlled car can go through the intersection only when C_2 and C_5 are clear. (iv) The controlled car should not collide with other cars in the intersection. (v) The controlled car can move only forward to an adjacent cell (fine to turn 90^o inside a cell).

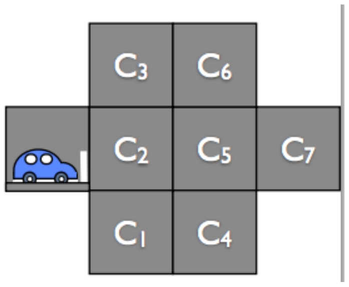

Figure 2: ”Intersection” for Exercise 2.

Note that the description above didn’t state any assumptions on the environment. What should the environment be in this problem anyway? You should decide on that. It is part of modeling. Then, you will likely need to find some environment assumptions to impose. Without assumptions, there probably is no viable controller to satisfy the requirements above. Please try to find the “weakest” possible assumptions and justify your choice. Why can the assumptions not be relaxed and still obtain a reactive planner that achieves the above requirements?

Exercise 3: Re-do the elevator exercise from the previous homework assignment. In the previous one, you were supposed to come up with a controller by yourself and the model check it against all possible environment behaviors (e.g., the way in which the requests were coming in). Now, formulate it as a reactive synthesis problems in which the requests are the uncontrolled environment and the controlled choices as before. Write the specifications in an assume-guarantee form and use a synthesis tool to construct a reactive controller. Explain every step and use simulations to give partial indication of that your controller works properly. You may need to adjust your specifications based on whether you get realizable specifications and/or the resulting behavior is what you intend it to be. Explain your reasoning of your way of modifying the specifications.