**CS1571  
Fall 2019  
9/18 Homework**

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Read Russell & Norvig, Chapter 3.6.

Then, answer the following questions. They are both to test your understanding of the reading and to review what we have covered in class so far.

1. ( 4 pts) The following are two heuristics for the N-puzzle problem (see p. 103).
   1. *h1 =* the number of misplaced tiles
   2. *h2* = the Manhattan distance

Which of the following options are true about the heuristics. Check all that apply.

\_\_\_\_\_ *h*1 and *h*2 are considered to be admissible, because they never underestimate the cost to reach the goal.

\_\_X\_\_\_ *h*1 and *h*2 are both consistent.

\_\_\_X\_\_ *h*1 and *h*2 represent optimal solutions to relaxed versions of the N-puzzle problem.

\_\_\_\_\_ *h*1 dominates *h*2.

1. (3 pts) Assume you are running a bidirectional search, where you run a BFS from the initial state, and idDFS from the goal state. What is the time and space complexity? Only one response is correct.

\_\_X\_\_\_ The time complexity is O(2bd/2), while the space complexity is   
O(bd/2 + bd).

\_\_\_\_\_ Both the time and space complexity are O(bd).

\_\_\_\_\_ Both the time and space complexity are O(bd/2).

\_\_\_\_\_ The time complexity is O(bd/2) while the space complexity is O(bd).

1. (3 pts) The following problem description is taken from this library of constraint satisfaction problems: www.csplib.org.

Consider a four way traffic junction with eight traffic lights. Four of the traffic lights are for the vehicles and can be represented by the variables V1 to V4 with domains {r,ry,g,y} (for red, red-yellow, green and yellow). The other four traffic lights are for the pedestrians and can be represented by the variables P1 to P4 with domains {r,g}. The constraints on these variables can be modelled by quaternary constraints on (Vi, Pi, Vj, Pj ) for 1 ≤ *i* ≤ 4, *j*=(1 + *i*) *mod* 4 which allow just the tuples {(r,r,g,g), (ry,r,y,r), (g,g,r,r), (y,r,ry,r)}.

Your task is to modify this description to represent a Pittsburgh intersection such as Fifth Ave. and Craig St. This junction is a four-way junction with eight traffic lights, but:

* There is no red-yellow light.
* All vehicle lights must be red for the pedestrian lights to be green, and when a vehicle light is green or yellow, the pedestrian light will be red.
* The pedestrian lights also have a “yellow” mode which warns pedestrians when the light will turn red (the flashing hand with the number countdown).

Given this new scenario, outline the following properties of the CSP:

Variables:

Vehicle: {V1, V2, V3, V4}

Pedestrian: {P1, P2, P3, P4}

Domain:

Vehicle lights: {red, green, yellow}

Pedestrian lights: {red, yellow, green}

Constraints:

For 1<=i<=4, j=(1+i) mod 3