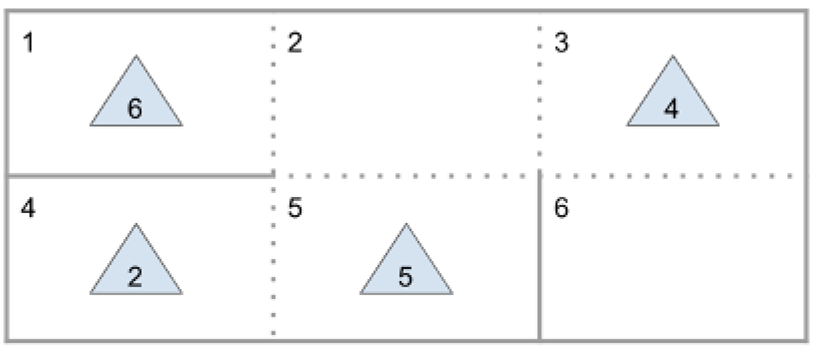
HW 2 - CSE 473 Spring 2021

Due Date: Friday, April 23th, 2021 at *11:59 pm PDT*
Total Points: 20 points

Problem 1. Heuristics for Informed Search [8 Points]

A delivery robot is moving in an n*m maze. A simple version of the maze is shown in the figure. The robot is programmed to deliver multiple parcels to their destinations. Each parcel starts at some node in the maze and has its own delivery destination. An example configuration is shown in the figure where the parcels are in their initial positions and the number on each parcel is its target destination. At every step the robot can take one of the following actions:

- Move: Move in one of these directions: {Up, Right, Down, Left}
- Pick: Pick-up a parcel in a location
- Drop: Put down a parcel at a location.



The cost of each move action is 1, and the costs of Pick and Drop are zero. The robot starts at square number 1 and can move through dotted lines - but the solid lines represent walls. The robot wants to deliver all parcels to their destinations with minimal cost.
Note that multiple parcels can be placed at the same square. You might come up with different ways of addressing these questions; For each part, there might be several possible heuristic functions. You will get credit if your heuristic follows the requested requirements -- clearly write down the assumptions and conditions in which your solution is plausible (your heuristic cannot be h(x) = 0).

a) If the robot can carry only one parcel at a time, define an admissible heuristic function for searching the space. Explain in plain English why the heuristic is admissible. Is your heuristic consistent? Why? Make sure your heuristic is not h(x) = 0. (3 points)

b) If the robot can carry multiple parcels at a time, is the function h(x) = “count of packages that are not delivered” admissible and consistent? Why or why not? (2 points)

c) If the robot can carry multiple parcels at a time, define two admissible heuristic functions. Explain in plain English why each heuristic is admissible. Are your heuristics consistent? Why? Make sure your heuristic is not h(x) = 0, and it is not a function of actual cost because it is not practical to compute the actual cost in a general case. *Hint: the heuristic function can be a function of currently carried parcels and un-carried parcels.* (3 points)

Problem 2. Rock-paper-scissors [12 points]

You are playing rock-paper-scissors with an opponent. You are trying to maximize the utility while the opponent is trying to minimize the utility. The utility of each case is given as follows:

You	Opponent	Utility
Rock	Rock	3
	Paper	-2
	Scissors	4
Paper	Rock	5
	Paper	3
	Scissors	-5
Scissors	Rock	-4
	Paper	6
	Scissors	3

2.1. Sequential Rock-Paper-Scissors: In a modified version, the players take turns to show their moves i.e., you first choose among {Rock, Paper, Scissors}, and then the opponent chooses among {Rock, Paper, Scissors}.

a) Draw the simplest search tree with the utilities provided in the table above. Label the utility of each node. [3 pts]

b) What is your best move among {Rock, Paper, Scissors} according to the above search tree? [1 pts]

c) Label each node in your search tree with alpha-beta values. Are there any nodes that you can prune in the search tree? Assume we expand the nodes in the following orders: [Rock, Paper, Scissors] [2 pts]

2.2. Normal Rock-Paper-Scissors: Now we play the normal rock-paper-scissors game in which both players move at the same time. Assume the probabilities of the opponent's moves are as follows: P(rock)=0.7, P(paper)=0.2, P(scissors)=0.1

a) Draw the simplest search tree with the provided utilities in the table. Label the utility of each node. [3 pts]

b) What is the best move among {Rock, Paper, Scissors} according to the above search tree? [1 pts]

c) If we know all leaf nodes have utilities in the range [-6, 6], can we apply alpha-beta pruning? If not, provide an explanation. If yes, provide states we can prune and explain. Assume we expand the nodes in the following orders: [Rock, Paper, Scissors] [2 pts]