The Hebrew University of Jerusalem Introduction to Artificial Intelligence Problem Set 1- Search Due Date 18.04

Uninformed Search

[35 points]

Explain why each of the following statements is true, or give a counterexample:

a. Uniform-cost search is a special case of A* search.

b. For every search space with constant step cost 1, iterative deepening using GRAPH-SEARCH always finds an optimal solution.

2. Missionaries and Cannibals problem :

- Three missionaries and three cannibals must cross a river
- They have a small boat that can carry up to two people
- At any moment, if the missionaries are outnumbered by cannibals then they would be eaten.
- Note that the boat cannot cross the river by itself .

In order to devise a transportation plan we will formulate the problem as a search problem, with state space S={(c,m,b)} :

- c marking the number of cannibals on the origin bank
- m marking the number of missionaries on the origin bank
- b marking the location of the boat

With this state formulation - S0={(3,3,0)} , G={(0,0,0),(0,0,1)}
Given the following **partial** definition of transition function f :

- $(c,m,0 \mid (m \geq 2) \wedge (m-2 \geq c \vee m=2)) \rightarrow (c,m-2,1)$
- $(c,m,1 \mid (c \leq 2) \wedge (m \leq 2)) \rightarrow (c+1,m+1,0)$

a. Complete the formulation of the search problem function.
a. Find an optimal solution (optimal in the sense of boat rides) by using some (uninformed) search algorithm.
b. Is there a danger of missionaries being eaten by cannibals during the search? Explain.

informed Search:

[15 points]

1.Prove or give a counter-example:

If we have two consistent heuristics h1, h2 and such that h1(n) ≤ h2(n) for any node n, then any node expanded by A* search using h2 must also be expanded by A* search using h1.

2.Which of the following heuristics are admissible? prove (with a short but accurate argument) or give a counterexample.

Consider the n-puzzle problem seen in class:

• n × n board • n 2 − 1 tiles
• actions {up, down, left, right}

• h1 Number of misplaced tiles.

• h2 Sum of the (Manhattan) distances of every tile to its goal position.

• h3 Number of tiles out of row + Number of tiles out of column.

Optimization\Local Search:

[25 points]
Suppose you are given a graph G = (V, E) and you want to partition its vertices into two disjoint sets V1 and V2 such that:

- The size of V1 and V2 are as close as possible.
- The number of edges where one end is a node in V1 and another is a node in V2 is as small as possible.

(a) Give a function which expresses these optimization criteria .

(b) Explain how you would perform gradient ascent on this function: what are the states, and what is the set of neighbors of a given state?

(c) Do you expect gradient ascent or simulated annealing to work better on this problem? Why?

(d) Describe how you would encode this problem for a genetic algorithm, and specify the fitness Function.

(e) Define mutation and crossover operators for the genetic algorithm.
(f) Would genetic algorithms work better than iterative improvement on this problem or not? Explain your answer.

CSP:

[15 points]
You are in charge of creating the light-rail schedule in Tel-Aviv. You are given a map of all the railroads. On each line, only one train can go at any given time. You know how long it takes for a train to travel between any two stations. For any station, there is a maximum number of trains that can be accommodated at any given time. When a train is in a station, it must wait at least 1 minute. You are also given the routes that different trains must follow and the time when each train must start from its initial station. The problem is to come up with a schedule in which the total waiting time for all trains, in all intermediate stations, is minimized. Describe this as a constraint satisfaction problem. Clearly specify the variables, domains and constraints. Which of the heuristics we discussed in class would be useful here, and why?