Unit 5 - Week 3

Assignment 3

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-08-21, 23:59 IST.

Topics: Heuristic Search: Best First Search, Hill Climbing, Beam Search

NOTE: When you are required to type the answer in a textbox, keep it strict, DO NOT ENTER EXTRA SPACES OR COMMAS OR OTHER PUNCTIATIONS. The assessment is done by a program that does exact-matching, so extra stuff will produce a NO-MATCH resulting in zero marks.

This "no blanks, no extras" policy will hold THROUGHOUT this course.

In state space search we have a start state and a goal state, and the move is a state transition function which takes you from one state to another. In state space search we construct a solution or a plan. In this week we also introduce the notion of solution space search also called plan space search. Here we search in the space of all possible plans or solutions, which we refer to as candidate plans or candidate solutions. The goal is to find a candidate that is the solution. In that sense the problem does not admit a "start plan", and one could in principle start from any candidate. In fact this feature is exploited by the Iterated Hill Climbing algorithm. The moves here are perturbing a given candidate to generate new candidates, and a neighborhood function captures the effects of each such perturbation. For example, any assignment to the variables in a SAT problem is a candidate, and perturbation may involve changing the values of some variables. We look at the SAT problem below.

In the next week we will also look at the *Traveling Salesman Problem*, and look at both constructive and perturbative methods of exploring search spaces.

1) Topic from Week 2. The CLOSED list used by a search algorithm contains node-pairs as a list of two nodes (child, parent). Starting from the start node S represented by the list (S, nil), the algorithm finds the goal node G in the node-pair (G,Q). The algorithm then calls ReconstructPath before termination. If the CLOSED list is as given below:

CLOSED = {(R,M), (Q,L), (P,K), (T,O), (O,J), (N,J), (K,F), (L,H), (M,H), (J,D), (I,D), (E,B), (F,C), (H,C), (A,S), (D,B), (B,S), (C,S)}.

What is the path found by the search algorithm? Your answer should be a comma-separated list of nodes. For example, for a path S-->A-->B-->C-->G the answer is S,A,B,C,G

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: String) S,C,H,L,Q,G
String containing all of these (AND): S, C, H, L, Q, G

1 point

2) Which of the following is complete in a finite search space? **1 point**

- Best First Search
- Hill Climbing
- Beam Search with beam width = 4
- None of the above

No, the answer is incorrect.
Score: 0
Accepted Answers:
Best First Search

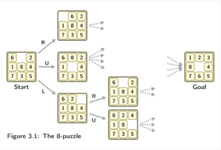


Figure 3.1: The 8-puzzle

3) Figure 3.1 shows an 8-puzzle problem with the start state and the goal state. The heuristic function h_1(N) counts the number of tiles (from 1 to 8) that are out of place, now the heuristic value of the start state is:

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Numeric) 5

1 point

4) For the above problem, the heuristic function h_2(N) returns the sum of the Manhattan distances of tiles that are out of place, now the heuristic value of the start state is:

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Numeric) 9

1 point

5) Given the start state in the above problem, which move from the set {R, L, U} could be chosen by the Hill Climbing algorithm using the heuristic function h_1 **1 point**

- R
- U
- L

No, the answer is incorrect.
Score: 0
Accepted Answers:
L

6) Given the start state in the above problem, which move from the set {R, L, U} could be chosen by the Hill Climbing algorithm using the heuristic function h_2 **1 point**

- R
- U
- L

No, the answer is incorrect.
Score: 0
Accepted Answers:
R
L

Consider a SAT problem where formula F is given by:

F = (a ∨ ¬b) ∧ (¬a ∨ b ∨ c) ∧ (¬c ∨ d) ∧ d ∧ (¬a ∨ b ∨ d) ∧ (¬a ∨ ¬d)

The *heuristic function* h(F) returns the number of satisfied clauses in the formula *F*. Observe that one has to maximize the heuristic value. A candidate assignment, or state, is of the form (abcd). If the state is 0000, then the assignment is a=0, b=0, c=0 and d=0. Let the MoveGen function be such that it changes 1 bit in a candidate. For example, from the state 0000 with one bit change we get 0001, 0010, 0100 and 1000 as the neighbours. Now let the initial state be 1010.

7) What are the values returned by h(F) for the assignments 0000, 0110 and 1011? Your answer should be a comma-separated sequence of numbers (heuristic values).

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: String) 5,3,5

1 point

8) Simulate the Hill Climbing algorithm for the above SAT problem. If the algorithm randomly chooses a move in case there is a tie, what is the probability of the algorithm solving the above SAT problem? **1.5 points**

- 25%
- 33.33%
- 50%
- 66.67%
- 100%
- none of the above

No, the answer is incorrect.
Score: 0
Accepted Answers:
100%

9) Simulate the Beam Search algorithm, with beam width 2, for the above SAT problem. Assume that if there are more than two best candidates, the algorithm randomly picks any two from them. What is the probability of the algorithm solving the above SAT problem? **1.5 points**

- 25%
- 33.33%
- 50%
- 66.67%
- 100%
- none of the above

No, the answer is incorrect.
Score: 0
Accepted Answers:
100%

10) Assume that if there are more than two best candidates, Beam Search with beam width 2 randomly picks any two from them. Which distinct pairs of 2 candidates at level 2 (after two expansion) could be best two candidates? **2 points**

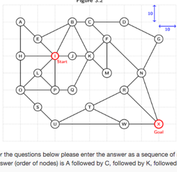
- 0000, 1001
- 0011, 1111
- 0000, 0011
- 0110, 1110

No, the answer is incorrect.
Score: 0
Accepted Answers:
0011, 1111
0000, 0011

Figure 3.2 depicts a search space in which the nodes are labeled with uppercase alphabets: A,B,C,.... Here, node I is the start node and node X is the goal node. The nodes are laid out on a grid where each square is of size 10x10 units.

Please use the Manhattan Distance as the heuristic function for the following problems.

Figure 3.2



For the questions below please enter the answer as a sequence of nodes separated by a comma. Please DO NOT enter any blanks. For example, if the answer (order of nodes) is A followed by C, followed by K, followed by D, the answer should be **Answer:** A,C,K,D

11) Given the goal node X in Figure 3.2 label each node with its heuristic value. Use the Manhattan Distance as the heuristic function. What is the value returned by the heuristic function for the nodes A, I and X respectively? Your answer must be 3 numbers separated by commas.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: String) 140,100,0
String containing all of these (AND): 140, 100, 0

1 point

12) Starting at node I, list the order in which the *Hill Climbing* algorithm explores the graph till termination, use Manhattan Distance as the heuristic function.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: String) I,H,Q
String containing all of these (AND): I, P, Q

2 points

13) Does the Hill Climbing algorithm find a path to the goal node in the previous question? **1 point**

- No
- Yes
- Cannot say

No, the answer is incorrect.
Score: 0
Accepted Answers:
No

14) List the order in which the Best First Search algorithm explores the graph till termination. Use Manhattan distance as the heuristic function.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: String) I,R,Q,K,M,F,N,X
String containing all of these (AND): I, P, Q, K, M, F, N, X

1 point

15) Does the Best First Search algorithm find a path to the goal node in the previous question? **1 point**

- No
- Yes
- Cannot say

No, the answer is incorrect.
Score: 0
Accepted Answers:
Yes

16) What is the path found (if any) by the algorithm in the previous question? If no path is found please enter NIL

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: String) I,P,Q,K,F,N,X
String containing all of these (AND): I, P, Q, K, F, N, X

2 points