UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Engineering, Built Environment and IT
Department of Computer Science

COS 314

Tutorial 2

2 March 2023

Questions

1. Given the diagram in Fig 1 where the Initial State is A and the Goal State is E. Answer the questions that follow.

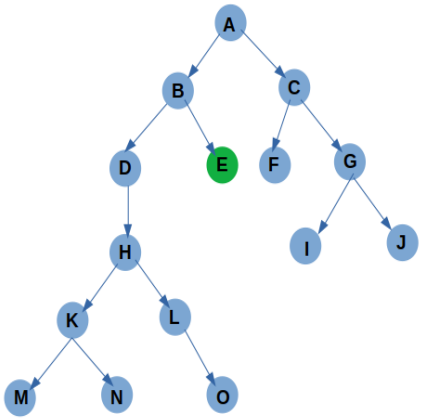


Figure 1:

   (a) List the nodes visited in performing the breadth-first Search.
   Sol: *A,B,C,D,**E***

   (b) List the nodes visited in performing the depth-first search.
   Sol: *A,B,D,H,K,M,N,L,O,**E***

   (c) List the nodes visited in performing the depth-first search with Iterative Deepening (depth bound 4). **Sol:**
      1. *iteration 1* - *A*
      2. *iteration 2* - *A, B , C*
      3. *iteration 3* - *A, B , D, **E***

      Although the Depth bound is stipulated to be four the goal state is found at depth limit 3 therefore the algorithm terminates.

2. Given the diagram in Fig. 2 where the Initial State is A and the Goal State is Q. The cost associated with each node is the numerical value in the node. Answer the questions that follow.

   (a) List the nodes visited in performing the best first search
   Sol: *A,C,G,B,D,E,**Q***

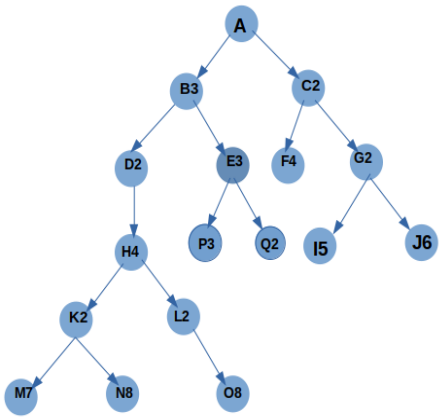


Figure 2:

(b) List the nodes visited in performing the greedy -hill climbing search with Backtracking.
Sol: *A,C,B,D*

(c) Briefly differentiate between greedy-hill climbing and the best-first search.
Sol: *In certain situation the algorithms may return the same path but it is important to note that greedy-hill climbing searches locally as opposed to globally. If the solution path lies on the same branch from the start state the algorithms will return the same solution.*

3. Consider the following problem and answer the questions that follow:
The Travelling Salesman Problem: A salesman must visit a number of cities starting and ending at the same city. The salesman cannot revisit a city. The problem involves determining a minimum cost route that the salesman must travel.

(a) Describe what a state will look like.
Sol: *We can represent the problem using a graph where each node is a city with at least one entry and exit point. Then each state corresponds to a valid solution to the problem, which is an ordered sequence of cities (defining the tour of the salesperson).*

(b) Define the legal moves for the problem.
Sol: *A legal move is one that allows transition from one state to another therefore one solution to another. So addition or subtraction of a city or pairs*

(c) Define a heuristic function for the above problem.
Sol: *A heuristic function is that calculates the distance to the goal state*

(d) Which search method should be used to find a solution to this problem? Give reasons for your answer.
Sol: *The A* algorithm may be applied in this search as it is an admissible algorithm.*

4. Consider the following problem and answer the questions that follow: The Eight Queens Problem This problem involves placing eight queens (a queen refers to a chess piece) on an 8x8 board. A queen can be placed on the board or removed from the board. The initial state is an empty board. The goal state is the 8x8 board with all eight queens placed on the board in such a way that each queen is not able to attack another queen. A queen can attack another queen if they are placed in the same row, column or along the same diagonal. A solution to the problem is the steps that must be performed to get from the initial state to the goal state.

(a) Describe what a state will look like.
Sol: *A chess-board grid representation with the 8-queens placed on the board*

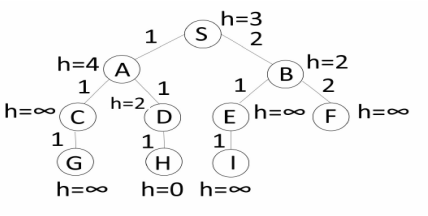
(b) Define the legal moves for the problem
Sol: *Any move that re-positions a queen on an empty square.*

(c) Define a heuristic function for the above problem.
Sol: *A function that evaluates the constraint i.e the number of pair of queens that are able to attack one another.*

(d) Which search method should be used to find a solution to this problem? Give reasons for your answer.
Sol: *Breadth first-search is an option as an optimal solution would be found although it will consume a lot of resources.*

5. Consider the state space given below and answer the questions that follow. Note that the goal state is H:

(a) List the order in which the nodes will be visited if the best-first search is used.
Sol: *S,B,A,D,**H*** *Using the heuristic values of the nodes. We expand the nodes based on the least cost.*

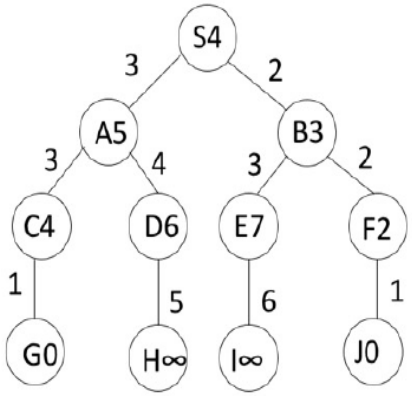


(b) List the order in which the nodes will be visited if the hill-climbing search is applied to the state space.
Sol: *S,B,E,I,F,A,D,**H***

(c) List the order in which the nodes will be visited if the A algorithm is applied to the state space.
Sol: *S,B,A,D,**H*** from using f(n) = h(n) + actual paths costs.

(d) Is h(n) admissible? Substantiate your answer.
Sol: *Not admissible as the heuristic estimates are greater than the actual costs e.g node D has a heuristic value of 2 to get to H yet the cost is 1.Therefore this (2) is an overestimate.*

6. Consider the state space given below and answer the questions that follow. Note that the goal states are G and J:



(a) List the order in which the nodes will be visited if the best-first search is used.
Sol: *S,B,F,J* using Heuristic values of the nodes.

(b) List the order in which the nodes will be visited if the hill-climbing search is applied to the state space.
Sol: *S,B,F,J* using Heuristic values of the nodes.

(c) List the order in which the nodes will be visited if the A algorithm is applied to the state space.
Sol: *S,B,F,J* using f(n) = h(n) + actual paths costs, values of the nodes.

(d) Is h(n) admissible? Substantiate your answer.
Sol: *Not admissible as the heuristic estimates are greater than the actual costs e.g node F has a heuristic value of 2 to get to J yet the cost is 1. Therefore this (2) is an overestimate.*

7. The 8-puzzle problem is a well studied problem in artificial intelligence. Develop a program to compare the performance of the breadth first and best-first in solving the following instances of the 8-puzzle problem of differing difficulty. The comparison is on the number of steps and computational effort required to solve the problem. (Please note the programs must be implemented in Java.

Table 1: 8-Puzzle Problem Instances.

Instance	Start State	Goal State	Known Optimum
1	123804765	134862705	5
2	123804765	281043765	9
3	123804765	281463075	12
4	123804765	231804765	16
5	867254301	123456780	31