# CPSC 322 Assignment 1

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## 1 Question 1 (27points): Comparing Search Algorithms

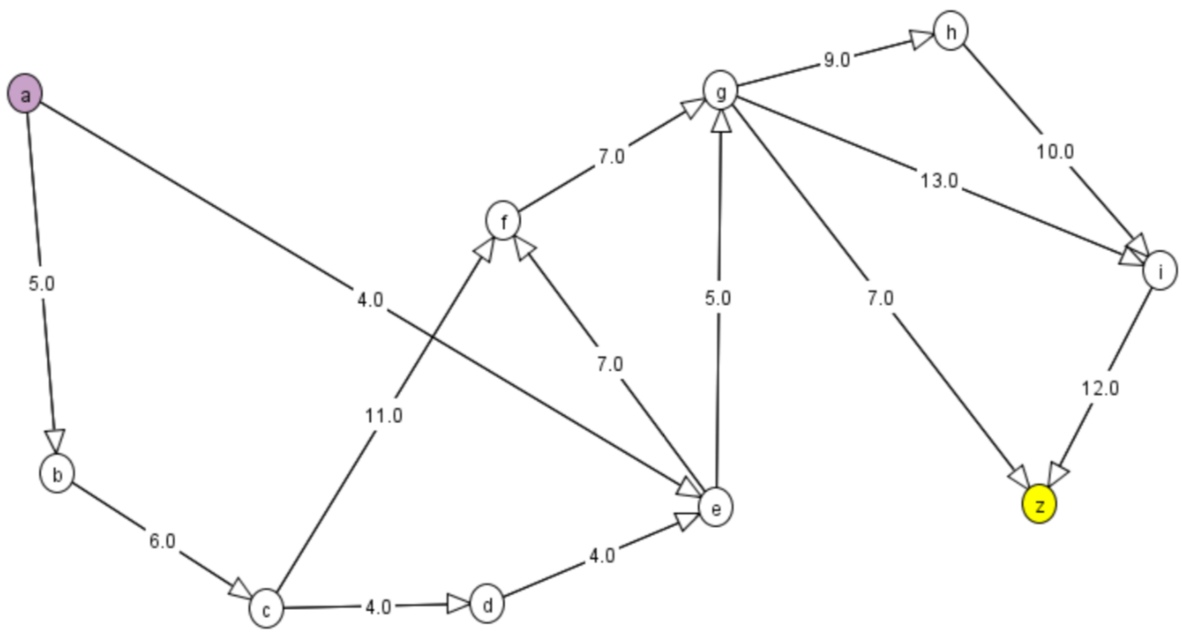


**Figure 1. Graph for question 1. The arcs are labeled with their costs.**

### 1.1 Depth-first search

### 1.2 Breadth-first search

### 1.3 A*

### 1.4 Branch-and-bound

### 1.5

(a) Did BFS and B&Bfind the optimal solutionfor this graph?

(b) Are BFSand B&B optimal in general?Explain your answer.

(c) Did B&B expandfewer nodes thanA*? Explain if your answer is true in general for these two algorithms and why.

## 2 Question 2 (36points): Uninformed Search: Peg Solitaire

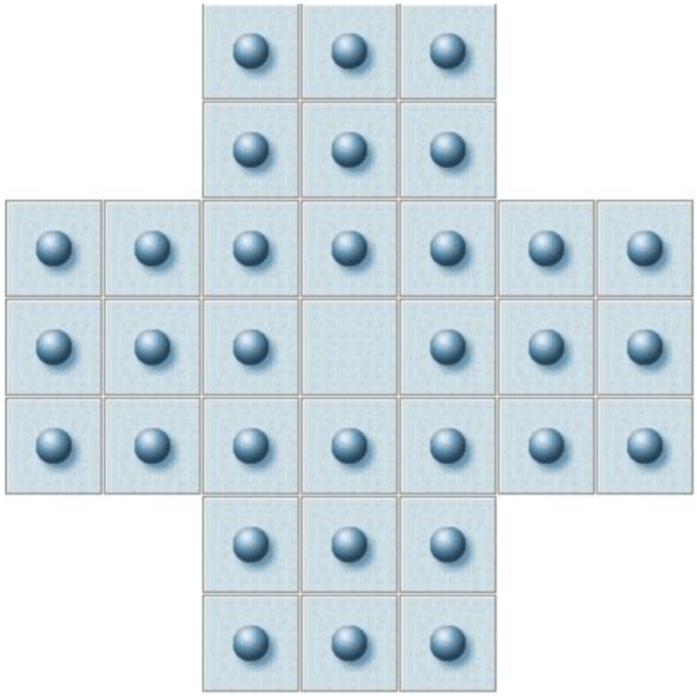

**Figure 2. A sample Peg Solitaire board at the start of the game**

*Peg Solitaire is a board game for one player involving movement of pegs on a board with holes. The standard game fills the entire board with pegs except for the central hole. The objective is to empty the entire board except for a solitary peg in the central hole, by making valid moves. A valid move is to jump a peg orthogonally over an adjacent peg into a hole two positions away and then to remove the jumped peg.*

From the Wikipedia entry: "Peg Solitaire"

| | | | | | | |
|---|---|---|---|---|---|---|
| | | $a$ | $b$ | $c$ | | |
| | | $d$ | $e$ | $f$ | | |
| $g$ | $h$ | $i$ | $j$ | $k$ | $l$ | $m$ |
| $n$ | $o$ | $p$ | $x$ | $A$ | $B$ | $C$ |
| $D$ | $E$ | $F$ | $G$ | $H$ | $I$ | $J$ |
| | | $K$ | $L$ | $M$ | | |
| | | $N$ | $O$ | $P$ | | |

**Figure 3. Peg Solitaire Board**

## 2.1 Represent peg solitaire as a search problem

(a) How would you represent a node/state?

(b) In your representation, what is the goal node?

(c) How would you representthe arcs?

(d) How many possibleboard states are there?Note: this is notthe same as the number of “valid” or “reachable” game states, which is a much more challenging problem.

## 2.2 The search tree:

(a) Write out the first three levels (counting the root as level 1) of the search tree. (Only label the arcs; labeling the nodes would be too much work).

(b) What can you say about the length of the solution(s)?

## 2.3 The search algorithm:

(a) What kind of search algorithm would you use for this problem? Justify your answer

(b) Would you use cycle-checking? Justify your answer.

(c) Would you use multiple-path-pruning? Justify your answer.

# 3 Question 3 (24 Points) Free Cell

## 3.1 Represent this as a search problem

(a) How would you represent a node/state?

(b) In your representation, what is the goal node?

(c) How would you representthe arcs?

## 3.2

Give an admissible heuristicfor this problem; explain why your heuristic is admissible. More points will be given for tighter lower bounds; for example, h=0 is a trivial (and useless) heuristic, and thus it is not acceptable.

# 4 Question 4 (15points) Modified Heuristics

## 4.1 Reduce h(n), trying in three different ways:

## 4.2 Set h(n) as the exact distance from n to a goal

To do this, you should add the costs of arcs on the optimal path from every node to the goal node, and set the sum as the heuristic function of the node.

(a) Can A* still find the optimal path?

(b) Is the efficiency of A* increased or reduced?

(c) Try to draw a more general conclusion regarding the changes in efficiency and optimality.

## 4.3 Increase h(n), also trying in three different ways

(a) When can A* still find the optimal path?

(b) When is the efficiency of A* improved or reduced?

(c) Try to draw a more general conclusion regarding the changes in efficiency and optimality.