

1. Which of the following are true and which are false? Explain your answers.

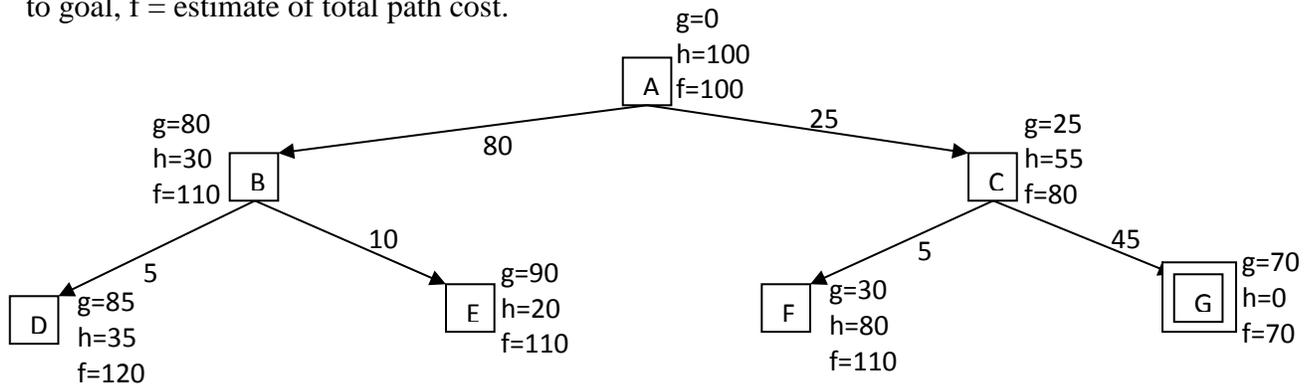
a. Depth-first search always expands at least as many nodes as A* search with an admissible heuristic.

b. $h(n)=0$ is an admissible heuristic for the 8-puzzle.

c. Breadth-first search is complete whenever the branching factor is finite, even if zero step costs are allowed.

d. Assume that a rook can move on a chessboard any number of squares in a straight line, vertically or horizontally, but cannot jump over other pieces; then Manhattan distance is an admissible heuristic for the problem of moving the rook from square A to square B in the smallest number of moves.

2. Use the following tree to indicate the order that nodes are expanded, for different types of search. Assume that A is the start node and G (double box) is the only goal node. Here, path costs are shown to the right of each path, g = cost of path so far, h = estimate of remaining cost to goal, f = estimate of total path cost.



a. Uniform-cost search.

b. Iterative deepening depth-first search.

c. Greedy best-first search.

d. A* search.

e. Is the heuristic h admissible?

f. Relabel the heuristic values h so that h is admissible but not consistent.

3. Recall that

- * True path cost so far = $g(n)$.
- * Estimated cost to goal = $h(n)$.
- * Estimated total cost = $f(n) = g(n) + h(n)$:

The following is a proof that A* tree search (queue sorted by f) is optimal if the heuristic h is admissible. The lines have been labelled A through G. Unfortunately, they have been scrambled.

Let ng be the first goal node popped off the queue. Let no be any other node on the queue. We wish to prove that no can never be extended to a path to any goal node that costs less than the path to ng that we just found.

- A : true total cost of ng
- B : $\leq f(no)$ // because queue is sorted by f
- C : $\leq g(no) + \text{true cost to goal from } no$ // because h is admissible
- D : $=f(ng)$ // by definition of f with $h(ng) = 0$ since ng is a goal
- E : $=g(no) + h(no)$ // by definition of f
- F : $=g(ng)$ // because ng represents a complete path
- G : $= \text{true total cost of } no \text{ extended to a path to any goal node}$

Fill in the blanks with the letters B, C, D, E, F, and G in the correct order to prove that the true total cost of $ng \leq$ true total cost of no . The first and last letters, A and G, have been done for you as an example.

A _____ G