

Search Problems in AI

Assignment 2

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Problem 1

The sequence of nodes expanded by A* search, given the tree, and straight line distance heuristics, is in the following order:

0. ($city, f(city), g(city), h(city)$)
1. (Lugoj, 244, 0, 244)
2. (Mehadia, 311, 70, 241)
3. (Lugoj, 384, 140, 244)
4. (Drobeta, 387, 145, 242)
5. (Craiova, 425, 265, 160)
6. (Timisoara, 440, 111, 329)
7. (Lugoj, 446, 222, 244)
8. (Mehadia, 451, 210, 241)
9. (Mehadia, 461, 220, 241)
10. (Pitesti, 503, 403, 100)
11. (Bucharest, 504, 504, 0)

Problem 2

- (a) BFS: $1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 6 \rightarrow 7 \rightarrow 8 \rightarrow 9 \rightarrow 10 \rightarrow 11$

DLS: $1 \rightarrow 2 \rightarrow 4 \rightarrow 8 \rightarrow 9 \rightarrow 5 \rightarrow 10 \rightarrow 11$

IDS:

1

$1 \rightarrow 2 \rightarrow 3$

$1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 5 \rightarrow 3 \rightarrow 6 \rightarrow 7$

$1 \rightarrow 2 \rightarrow 4 \rightarrow 8 \rightarrow 9 \rightarrow 5 \rightarrow 10 \rightarrow 11$

- (b) Bidirectional search would be effective in solving this problem. Bidirectionally finding a path between state 1 and state 11 reduces the number of nodes that needs to be explored.

Forward 1

Backward 11

Forward 2
Backward 5

The branching factor is 2 in the forward direction and 1 in the reverse direction.

Problem 3

- (a) True
- (b) True
- (c) True
- (d) False
- (e) False
- (f) True
- (g) True
- (h) True
- (i) True

Problem 4

Problem 5

a)

A heuristic is considered consistent iff:

$$h(n) \leq c(n, n+1) + h(n+1)$$

where $h()$ is the heuristic and n is the goal state

Proving by induction with the $n-1$ node in the shortest path to n (base step):

$$h(n-1) \leq c(n-1, n) + h(n)$$

since n is the goal state, $h(n) = h^*(n)$, where $h^*(n)$ is the true minimal cost to the goal state

$$h(n) \leq c(n-1, n) + h^*(n)$$

$$\text{given } c(n-1, n) + h^*(n) = h^*(n-1)$$

$$h(n-1) \leq h^*(n-1)$$

which is the definition of admissibility

Inductive Step with $n - 2$:

$$h(n - 2) \leq c(n - 2, n - 1) + h(n - 1)$$

drawing from the base case:

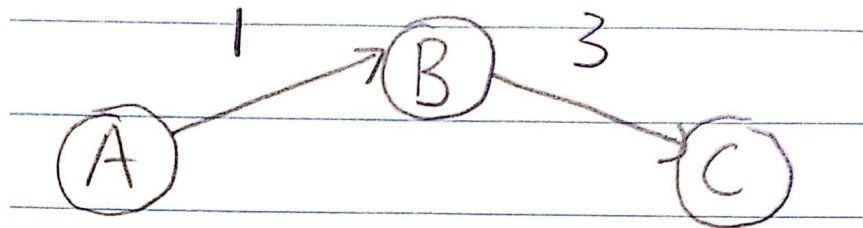
$$h(n - 2) \leq c(n - 2, n - 1) + h(n - 1) \leq c(n - 2, n - 1) + h^*(n - 1)$$

$$h(n - 2) \leq c(n - 2, n - 1) + h^*(n - 1)$$

$$h(n - 2) \leq h^*(n - 2)$$

By inductive reasoning, consistency implies admissibility

b)



$$h(A) = 4$$

$$h(B) = 2$$

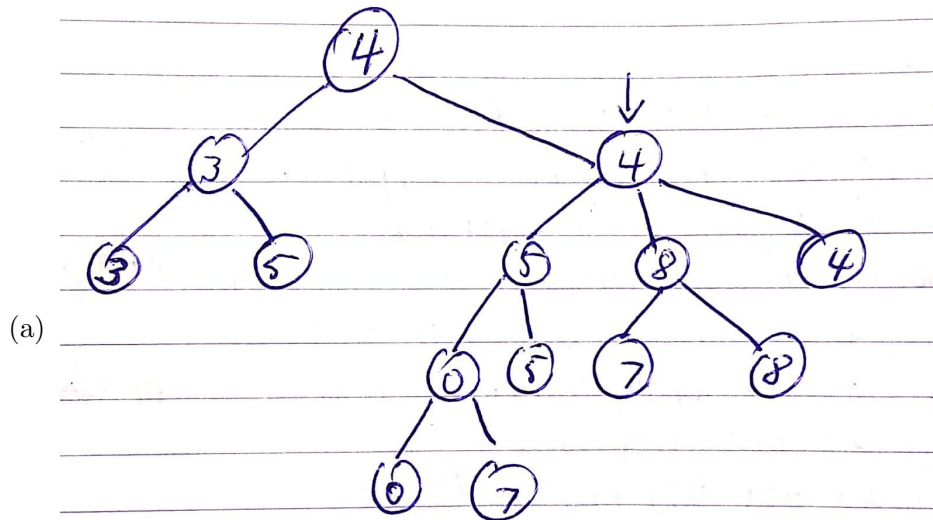
$$h(C) = 0$$

Problem 6

In solving Constraint Satisfaction Problems, we choose the most constrained variable (MCV) in order to reduce the size of the next sub-problem. In other words, choosing the MCV maximally reduces the size of the next branch among any of the other variables.

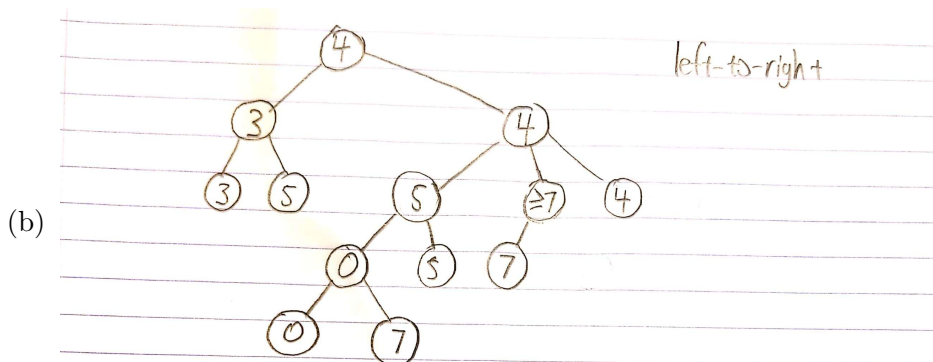
When assigning a value for this variable, we want to leave the remaining variables as unconstrained as possible in order to not accidentally eliminate any valid solutions. Thus, we want to assign the MCV the least constraining value (LCV).

Problem 7

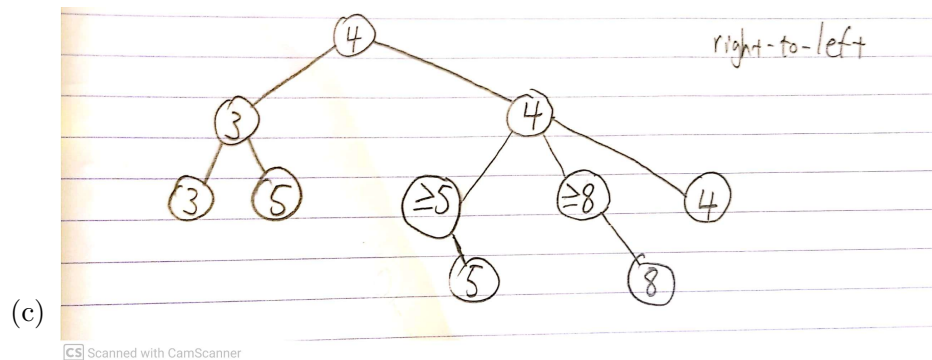


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The optimal choice for the max player would be the right node.



Scanned with CamScanner



Alpha-beta pruning is a heuristic that depends heavily on where elements are positioned, as it only operates on the best values found so far when exploring the tree. If the algorithm happens to find the 'best' node first then it can 'prune' more nodes from the tree. This is the case in right-to-left pruning, which, due to how the elements were positioned, was able to find the 'best' value more quickly and prune more nodes.

Problem 8

- (a)
- (b)
- (c)

Problem 9

- (a)
- (b)
- (c)
- (d)
- (e)
- (f)