Midterm Answer-Key

CS440

November 20, 2016

1

1.1 each method 5 points

BFS: A, EDCB, FEDC, GFED, HGFE, ZHGF
Path: A-E-Z

for DFS there is two possibilities:

DFS(1): A, EDCB, EDCF, EDCLI, EDCLG, EDCLJ, EDCLH, EDCLK, EDCLZ
Path: A-B-F-I-G-J-H-K-Z

DFS(2): A, EDCB, DCBZ
Path: A-E-Z

Greedy BFS: A, BCDE, CDEF, DEFG, HEFG, HFGZ
Path: A-E-Z

A*: A, BCDE, CDEF, DEFG, EFGH, ZFGH
Path: A-E-Z

1.2 5 points

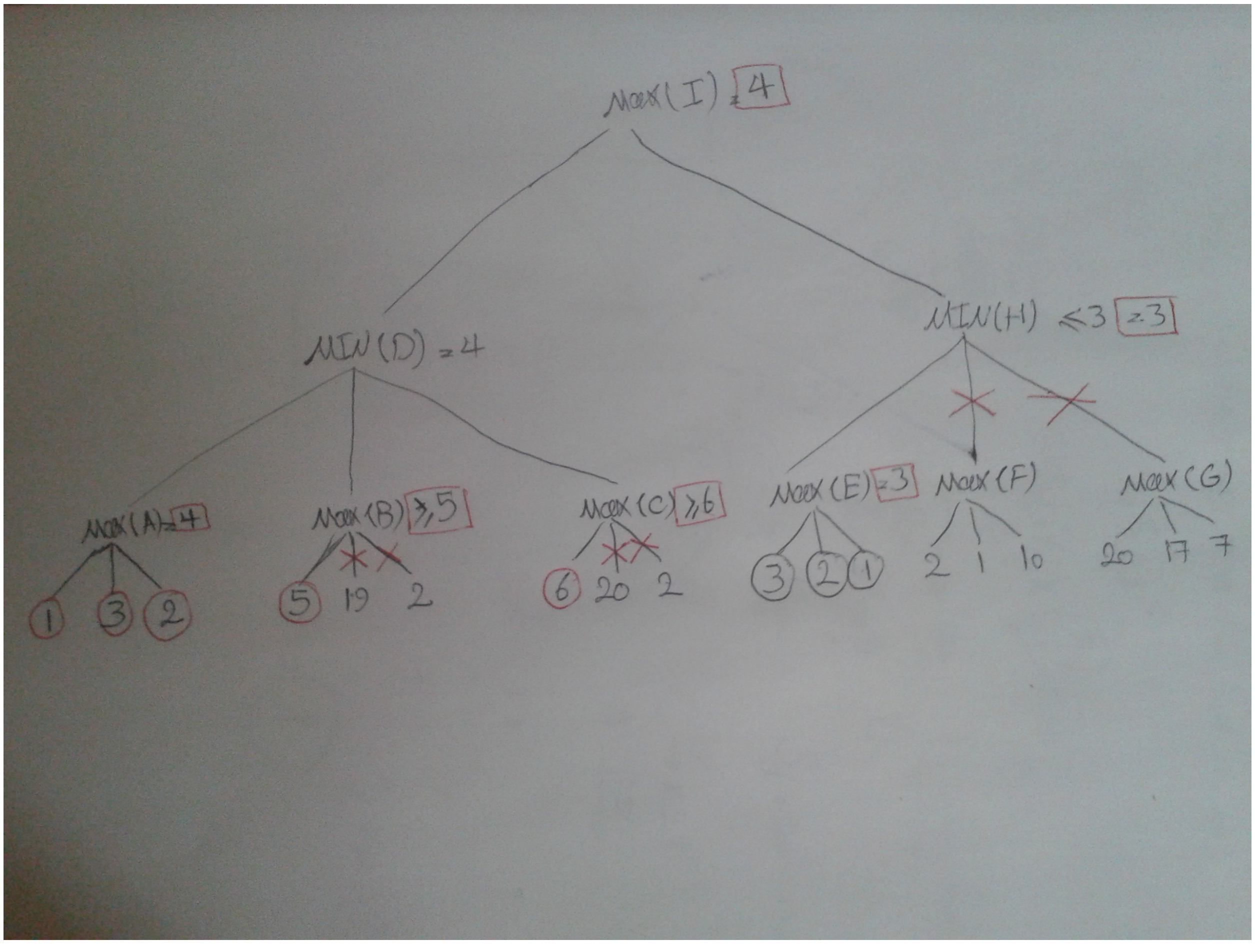
No, A*didn't find the optimal path because the heuristic function is not admissible and consistent. Other methods(BFS, DFS, GBFS) also didn't find optimal path.

1.3 5 points

Yes, All of them will find a solution. Only in the case if we have an infinity graph there is no answer for DFS.

2

2.1 20 points



2.2 5 points

It will select node D because its value is greater.

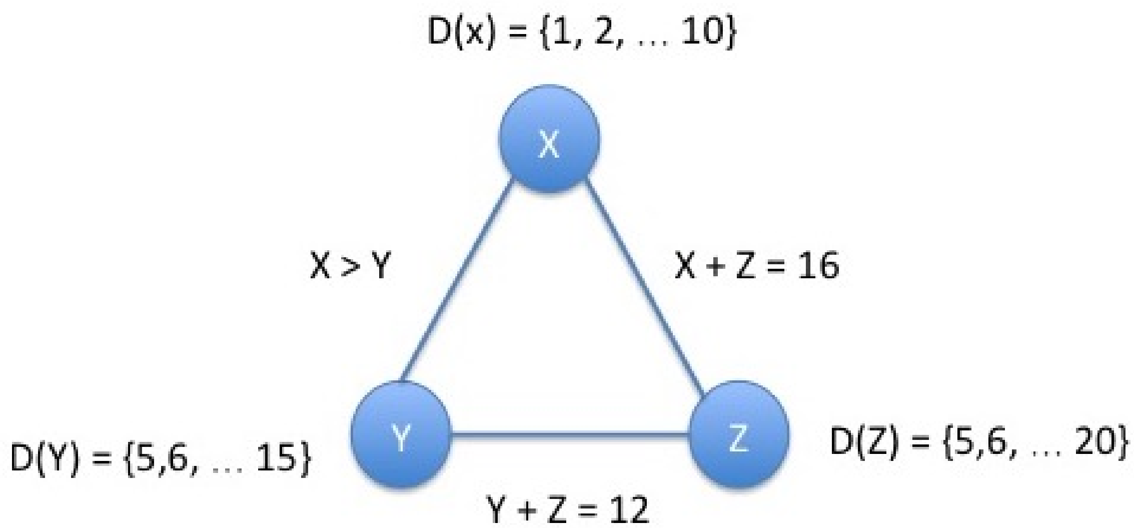
2.3 5 points

In this case the value for both D and H will be 20. So it doesn't matter to select either D or D.

3

3.1 5 points

the constraint graph can be found in figure below :



3.2 5 points

No, the constraints are not arc consistent. One example is sufficient to prove this claim. So, let us consider X=1, for which there exists no value in D(Y) such that C(X,Y) is satisfied.

3.3 20 points

applying arc consistency algorithm :

$$\begin{aligned} Applying, \quad C(X,Y) : X > Y \\ D(X) : \{6, 7, ...10\}, \quad D(Y) = \{5, ...9\} \\ \\ Applying, \quad C(Y,Z) : Y + Z = 12 \\ D(Y) : \{5, ...7\}, \quad D(Z) = \{5, ...7\} \\ \\ Applying, \quad C(X,Z) : X + Z = 16 \\ D(X) : \{9, 10\}, \quad D(Z) = \{6, 7\} \\ \\ Applying, \quad C(Y,Z) : Y + Z = 12 \\ D(X) : \{5, 6\}, \quad D(Y) = \{6, 7\} \end{aligned}$$

So the final domains are,

$$\begin{aligned} D(X) = \{9, 10\} \\ D(Y) = \{5, 6\} \\ D(Z) = \{6, 7\} \end{aligned}$$

4

4.1 5 points

f value of every node expanded by A* using an admissible heuristic is never greater than C*. Thus for any node 'n' that is expanded

$$f(n) = g(n) + h(n) \leq C^*$$

As C* is the shortest path to goal,

$$C^* \leq g^*(n) + h^*(n)$$

where $g^*(n)$ is the shortest path to node n and $h^*(n)$ is the shortest path from n to the goal state. Combining the 2 equations we have:

$$g(n) + h(n) \leq C^* \leq g^*(n) + h^*(n)$$

Using the given fact,

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

we have,

$$g(n) + h^*(n) - \epsilon \leq g^*(n) + h^*(n)$$
$$i.e. \quad g(n) \leq g^*(n) + \epsilon$$

4.2 5 points

when $h(n) = h^*(n)$, for any node 'n'
f(n) = (actual cost to get to that node) + (best cost from 'n' to goal state)
Let us consider the f value of a node on the optimal path,

$$f_o = g(n_o) + h^*(n_o) = C^*$$

let us compare this to any other node not on the optimal path,

$$f_{no} = g(n_{no}) + h^*(n_{no}) > C^*$$

because, C* is the optimal path length and actual cost of any other path is greater than C*. Thus, when A* expands a node, it expands the node with the minimum f value, which is the node on the optimal path.