Intro AI Assignment 1

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1 Consider the tree with numbered nodes in figure 3.2. Nodes at the same level are processed left to right and the starting node is 0.

1.1 Write out a step-by-step application of depth-first search to this tree. Show, per step, what the frontier is using the notation in Table 1.

Step#	Frontier{DFS}	Frontier{BFS}
1	{0}	{0}
2	{1,2,3}	{1,2,3}
3	{4,5,2,3}	{2,3,4,5}
4	{10,5,2,3}	{3,4,5,6}
5	{5,2,3}	{4,5,6,7,8,9}
6	{1,12,2,3}	{5,6,7,8,9,10}
7	{20,21,12,2,3}	{6,7,8,9,10,11,12}
8	{21,12,2,3}	{7,8,9,10,11,12,13,14}
9	{12,2,3}	{8,9,10,11,12,13,14,15,16}
10	{2,3}	{9,10,11,12,13,14,15,16,17}
11	{6,3}	{10,11,12,13,14,15,16,17,18,19}
12	{13,14,3}	{11,12,13,14,15,16,17,18,19}
13	{22,14,3}	{12,13,14,15,16,17,18,19,20,21}
14	{14,3}	{13,14,15,16,17,18,19,20,21}
15	{3}	{14,15,16,17,18,19,20,21,22}
16	{7,8,9}	{15,16,17,18,19,20,21,22}
17	{15,16,8,9}	{16,17,18,19,20,21,22,23,24,25}
18	{23,24,25,16,8,9}	{17,18,19,20,21,22,23,24,25,26}
19	{24,25,16,8,9}	{18,19,20,21,22,23,24,25,26,27,28}
20	{25,16,8,9}	{19,20,21,22,23,24,25,26,27,28,29}
21	{16,8,9}	{20,21,22,23,24,25,26,27,28,29}
22	{26,8,9}	{21,22,23,24,25,26,27,28,29}
23	{8,9}	{22,23,24,25,26,27,28,29}
24	{17,9}	{23,24,25,26,27,28,29}
25	{27,28,9}	{24,25,26,27,28,29}
26	{28,9}	{25,26,27,28,29}
27	{9}	{26,27,28,29}
28	{18,19}	{27,28,29}
29	{29,19}	{28,29}
30	{19}	{29}
31	{}	{}

Table 1: Frontier of both BFS and DFS at each depth.

1.2 Write down how many search steps are needed to find node 19. Write down how many are needed to find node 24.

Answer: for DFS total search steps to find 19 is 31. For 24 is 20 steps

1.3 Redo exercise 1a and 1b using breadth-first search. Table 1: Search notation including frontier 10

Answer: for BFS, the total search steps to find 19 is 21. For 24 is 25 steps

2 See the graph in figure 3.3, indicating travel distances between some major places in the Netherlands. Assume one wants to plan their trip from Utrecht (Ut) to Ljouwert (Leeuwarden - Lj) using this graph below using the A* algorithm, with the following (admissible and consistent) heuristic: h(Ar) = 54, h(As) = 22, h(DB) = 68, h(DH) = 64, h(Gr) = 20, h(Ha) = 48, h(Le) = 32, h(Lj) = 0, h(Ma) = 104, h(Mi) = 96, h(Ut) = 52, h(Zw) = 32. Work out this example step by step, showing the frontier for each step (as in exercise 1), including the value you use for ordering the nodes in the frontier.

Step#	Frontier{A*}	Frontier cost
1	{Ut}	{52}
2	{Zw,Ar,DB,Le,Ha,DH}	{83,89,95,97,99,106}
3	{Ar,DB,Le,Ha,DH,Lj,As}	{89,95,97,99,106,139,145}
4	{DB,Le,Ha,DH,Lj,As,Ma}	{95,97,99,106,139,145,323}
5	{Le,Ha,DH,Lj,As,Mi,Ma}	{97,99,106,139,145,299,323}
6	{Ha,DH,Lj,As,Mi,Ma}	{99,106,139,145,299,323}
7	{DH,Lj,As,Mi,Ma}	{106,139,145,299,323}
8	{Lj,As,Mi,Ma}	{139,145,299,323}
9	{As,Mi,Ma}	{145,299,323}

Table 2: Frontier of A* until Lj is found.