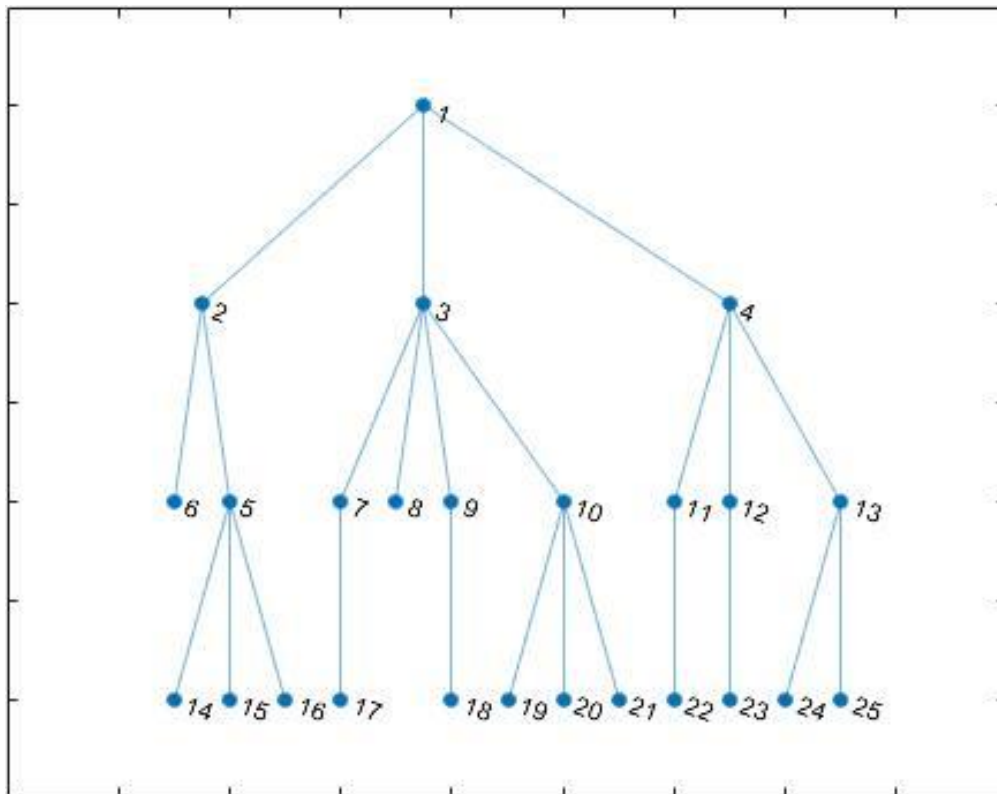`

Artificial Intelligence

# TM366: Unit 2 work sheet

Chapter 2

1. How many states will be visited until reaching the goal state using *depth-first search*? Trace the states inside the search agenda until reaching the goal state.

The Goal state is 18

- Answer:- Hint (Depth means children are in the front)
- 1
- 2,3,4
- 6,5,3,4
- 5,3,4
- 14,15,16,3,4
- 15,16,3,4
- 16,3,4
- 3,4
- 7,8,9,10,4
- 17,8,9,10,4
- 8,9,10,4
- 9,10,4
- 18,10,4
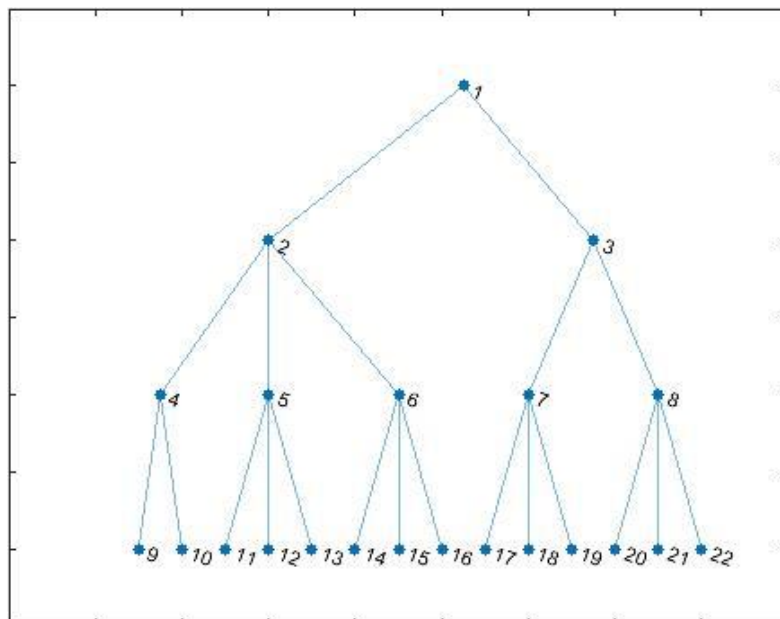- The number of visited states is 13

2. Given the following search graph, how many states will be visited until reaching the goal state using *breadth-first search?* Trace the states inside the search agenda until reaching the goal state.
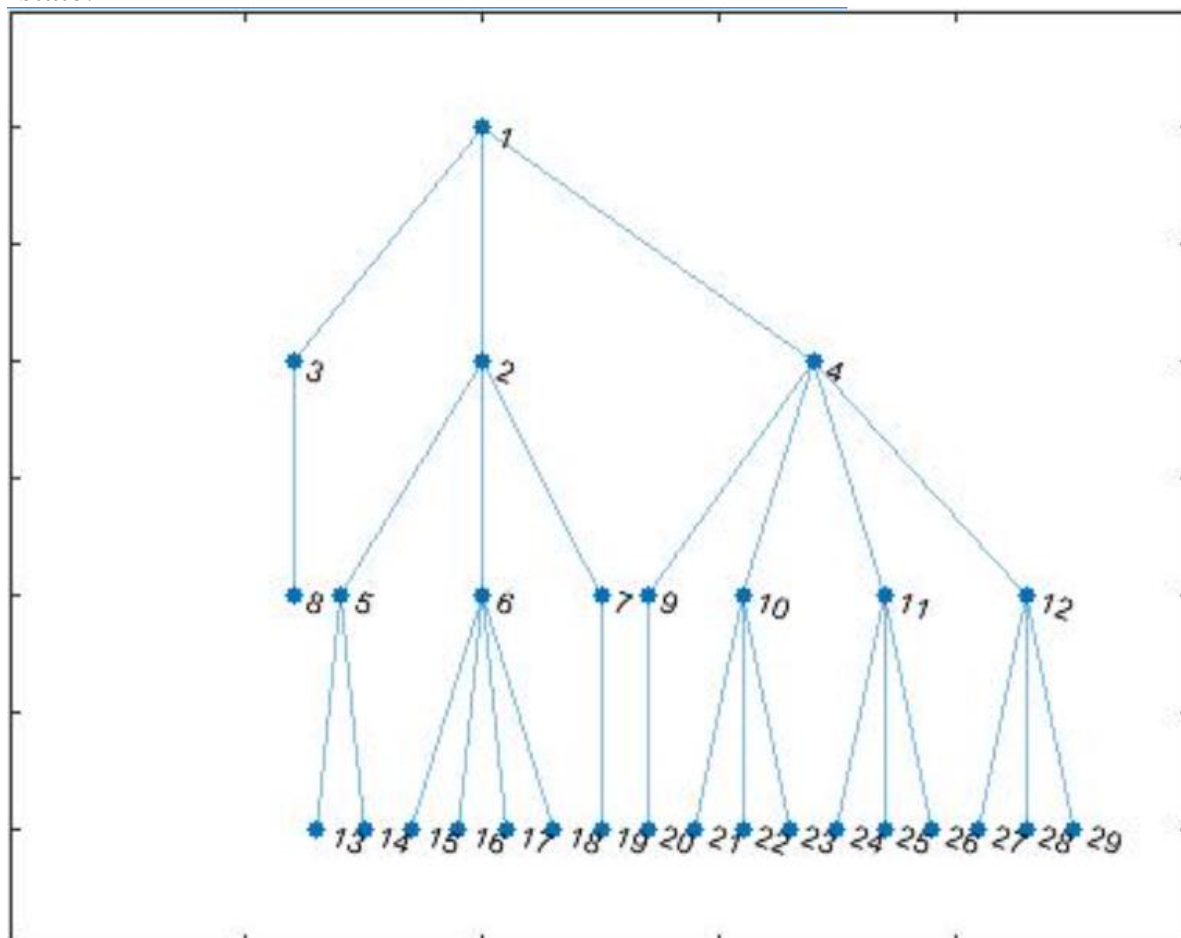
The goals state is 18

1,
2,3,4,
3,4,5,6,7,
4,5,6,7,8,
5,6,7,8,9,10,11,12,
6,7,8,9,10,11,12,13,14,
7,8,9,10,11,12,13,14,15,16,17,18,
8,9,10,11,12,13,14,15,16,17,18,19,
9,10,11,12,13,14,15,16,17,18,19,
10,11,12,13,14,15,16,17,18,19,20,
11,12,13,14,15,16,17,18,19,20,21,22,23,
12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,
13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,
14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,
15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,
16,17,18,19,20,21,22,23,24,25,26,27,28,29,
17,18,19,20,21,22,23,24,25,26,27,28,29,
18,19,20,21,22,23,24,25,26,27,28,29,

Given the following search graph, how many states will be visited until reaching the goal state using *breadth-first search*? Trace the states inside the search agenda until reaching the goal state. The goals state is 8.

Answer:-

Hint (Breadth means that children are at the end)

- 1
- 2,3
- 3,4,5,6
- 4,5,6,7,8
- 5,6,7,8,9,10,
- 6,7,8,9,10,11,12,13
- 7,8,9,10,11,12,13,14,15,16
- 8,9,10,11,12,13,14,15,16,17,18,19

The number of visited states is 8

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3. Given the following search graph, how many states will be visited until reaching the goal state using *best-first search*?. Trace the states inside the search agenda until reaching the goal state.

Assume the following heuristic values:

The Goal state is 20
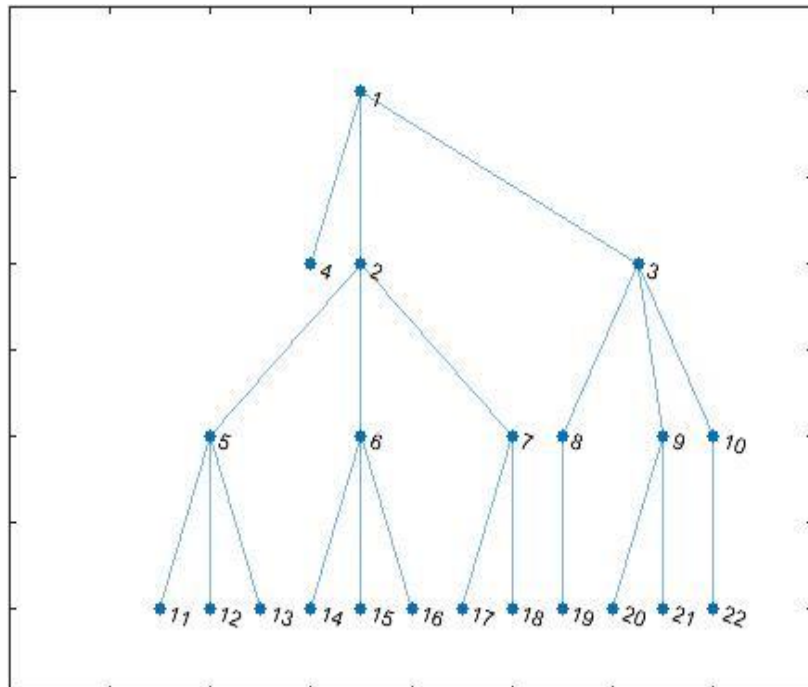
Node ID	Node Heuristic value
1	7
2	6
3	6
4	6
5	16
6	20
7	6
8	2
9	15
10	17
11	6
12	20
13	1
14	13
15	11
16	17
17	9
18	3
19	2
20	19
21	2
22	17

Answer:-
- 1,
- 2,3,4,
  7,3,4,5,6,
  18,3,4,17,5,6,
  3,4,17,5,6,
  8,4,17,9,5,10,6,
  19,4,17,9,5,10,6,
  4,17,9,5,10,6,
  17,9,5,10,6,
  9,5,10,6,
  21,5,10,20,6,
  5,10,20,6,
  13,11,10,20,12,6,
  11,10,20,12,6,
  10,20,12,6,
  22,20,12,6,
  20,12,6,
 The number of visited states is 17

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4. A* Search

Given the following search graph, write the sequence of node numbers in the search agenda across the search life-time and using *A* search* starting from the source city outlined and ended at the destination city.

Assume the following heuristic value per node:

Node ID	Node Heuristic value
1	56
2	157
3	188
4	101
5	258
6	164
7	76
8	236
9	118
10	0
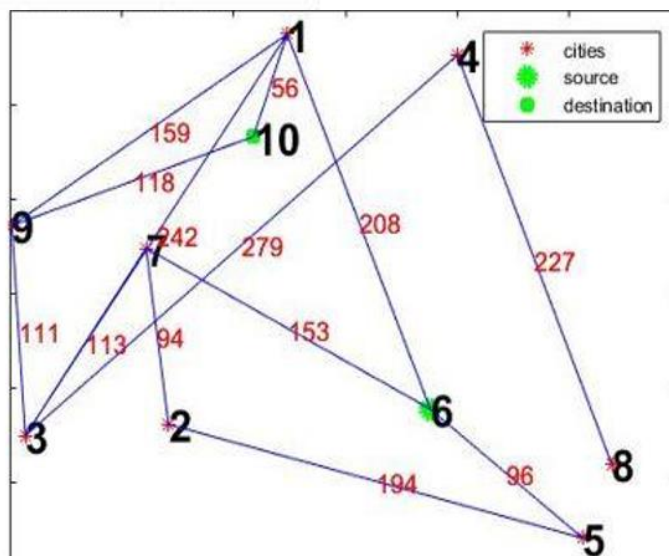
The distance between cities is outline on each line.
Show also the final resulted solution and show the intermediate H(n) and g(n) for heuristic and cost values per node.

Solution

- Source 6

  6 → 1 = 208 + 56 = 264 (208 is the cost / distance between 6 and 1 and 56 is the heuristic value of 1)

  6 → 5 = 96 +258 = 354 (96 is the cost / distance between 6 and 5 and 258 is the heuristic value of 5)

  6 → 7 153 + 76 = 229 (153 is the cost / distance between 6 and 7 and 76 is the heuristic value of 6)

  Here least is 6 → 7 so we will choose it for next move

  (6,7 → 1) = 451   153 (distance from 6 to 7) + 242 (distance from 7 to 1) + 56 (is heuristic value of 1)

  (6,7 → 2) = 404   153(distance from 6 to 7) + 94 (distance from 7 to 2) + 157 (is heuristic value of 2)

  (6,7 → 3) = 455   153(distance from 6 to 7) + 113 (distance from 7 to 3) + 188 (is heuristic value of 3)

  Backtracking to (6 →1) as next smallest value

  (6,1 → 7) = 526   208 (distance from 6 to 1) + 242 (distance from 1 to 7) + 76 (is heuristic value of 7)

  (6,1 → 9) = 485   208 (distance from 6 to 1) + 159 (distance from 1 to 9) + 118 (is heuristic value of 9)
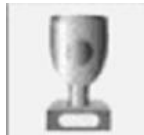
  (6,1→ 10) = 264   208 (distance from 6 to 1) + 56 (distance from 1 to 10) + 0(is heuristic value of 10)

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5. Having the following grid and the depicted agent at location (x=1,y=3) and a target object located at (x=2,y=4), Assume that the agent can just go *forward, backward, upward, downward,* **using best first search** write the content of the search agenda at each time step until reaching the target showing the selected directions on grid, Assume Euclidian distance from current location to target location as heuristic value.

(row=1,col=1) 1	(row=1,col=2) 5	(row=1,col=3) 9	(row=1,col=4) 13	(row=1,col=5) 17
(row=2,col=1) 2	(row=2,col=2) 6	(row=2,col=3) 10	(row=2,col=4) 14	(row=2,col=5) 18
(row=3,col=1) 3	(row=3,col=2) 7	(row=3,col=3) 11	(row=3,col=4) 15	(row=3,col=5) 19
(row=4,col=1) 4	(row=4,col=2) 8	(row=4,col=3) 12	(row=4,col=4) 16	(row=4,col=5) 20

Solution

Note: - X2 and Y2 are always the goal

Following the given rule $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$

states	3		
H	1.41		
states	4	7	2
H	1.00	1.00	2.24
states	8	7	3	2
H	0.00	1.00	1.41	2.24

(row=1,col=1) 1	(row=1,col=2) 5	(row=1,col=3) 9	(row=1,col=4) 13	(row=1,col=5) 17
(row=2,col=1) 2	(row=2,col=2) 6	(row=2,col=3) 10	(row=2,col=4) 14	(row=2,col=5) 18
(row=3,col=1) 3	(row=3,col=2) 7	(row=3,col=3) 11	(row=3,col=4) 15	(row=3,col=5) 19
(row=4,col=1) 4	(row=4,col=2) 8	(row=4,col=3) 12	(row=4,col=4) 16	(row=4,col=5) 20

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6. Having the following grid and the depicted agent at location (x=4,y=3) and a target object located at (x=5,y=1)
Assume that the agent can just go forward, backward, upward, downward, using best first search write the content of the search agenda at each time step until reaching the target showing the selected directions on grid. Assume Euclidian distance from current location to target location as heuristic value.

(row=1,col=1) 1	(row=1,col=2) 5	(row=1,col=3) 9	(row=1,col=4) 13	(row=1,col=5) 17
(row=2,col=1) 2	(row=2,col=2) 6	(row=2,col=3) 10	(row=2,col=4) 14	(row=2,col=5) 18
(row=3,col=1) 3	(row=3,col=2) 7	(row=3,col=3) 11	(row=3,col=4) 15	(row=3,col=5) 19
(row=4,col=1) 4	(row=4,col=2) 8	(row=4,col=3) 12	(row=4,col=4) 16	(row=4,col=5) 20

Answer: Note:- X2 and Y2 are always the goal

Following the given rule $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$

states	15							
H	2.24							
states	14	19	11	16				
H	1.41	2.00	2.83	3.16				
states	13	18	19	15	10	11	16	
H	1.00	1.00	2.00	2.24	2.24	2.83	3.16	
states	17	18	14	19	9	15	10	11	16
H	0.00	1.00	1.41	2.00	2.00	2.24	2.24	2.83	3.16

(row=1,col=1) 1	(row=1,col=2) 5	(row=1,col=3) 9	(row=1,col=4) 13 →	(row=1,col=5) 17
(row=2,col=1) 2	(row=2,col=2) 6	(row=2,col=3) 10	(row=2,col=4) 14 ↑	(row=2,col=5) 18
(row=3,col=1) 3	(row=3,col=2) 7	(row=3,col=3) 11	(row=3,col=4) 15 ↑	(row=3,col=5) 19
(row=4,col=1) 4	(row=4,col=2) 8	(row=4,col=3) 12	(row=4,col=4) 16	(row=4,col=5) 20

7. Having the following goal state for the 8-puzzel game:

1	2	3
4	5	6
7	8	

and having the following current state s=

	5	6
3	7	8
2	4	1

a) Write the direct children states for s following the puzzle actions.
b) Mention one possible heuristic function for this game
c) Based on b, calculate the heuristic value for each child state obtained in a.

Answer:-

a. The list of children are:
   Child 1

3	5	6
	7	8
2	4	1

   Child 2

5		6
3	7	8
2	4	1

b. Assume the heuristic "the number of misplaced tiles"
c. The heuristic values are:

   for child 1 the heuristic=9
   for child 2 the heuristic=9

d. Assume the heuristic "the sum of the distances of the tiles from their goal positions"
e. The heuristic values are:

   for child 1 the heuristic=17
   for child 2 the heuristic=19

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