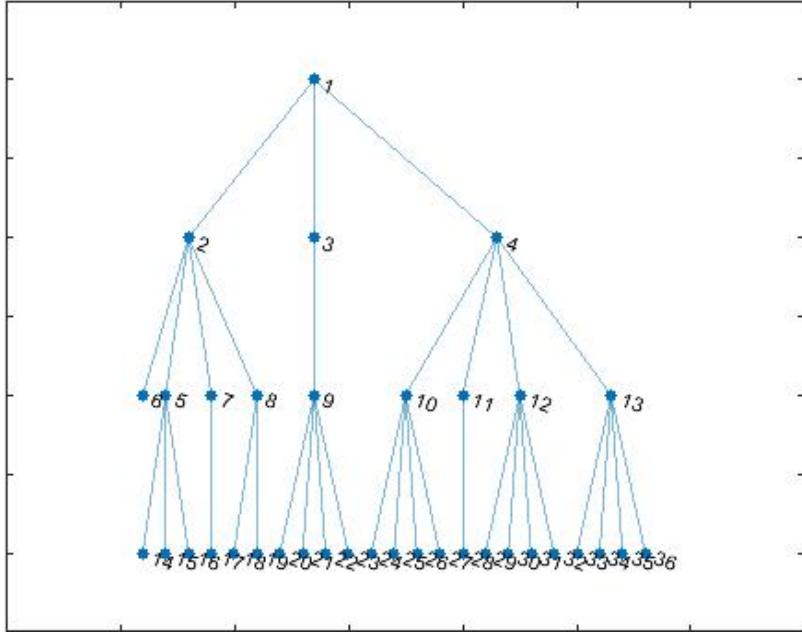


## Question 1

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 26.



**Answer:**

1,	{1},
2,3,4,	{1,2},{1,3},{1,4},
3,4,5,6,7,8,	{1,3},{1,4},{1,2,5},{1,2,6},{1,2,7},{1,2,8},
4,5,6,7,8,9,	{1,4},{1,2,5},{1,2,6},{1,2,7},{1,2,8}, ,{1,3,9},
5,6,7,8,9,10,11,12,13,	{1,2,5},{1,2,6},{1,2,7},{1,2,8},{1,3,9}, ,{1,4,10},{1,4,11},{1,4,12},{1,4,13},
6,7,8,9,10,11,12,13,14,15,16,	{1,2,6},{1,2,7},{1,2,8},{1,3,9},{1,4,10}, ,{1,4,11},{1,4,12},{1,4,13},{1,2,5,14}, ,{1,2,5,15},{1,2,5,16},
7,8,9,10,11,12,13,14,15,16,	{1,2,7},{1,2,8},{1,3,9},{1,4,10},{1,4,11}, ,{1,4,12},{1,4,13},{1,2,5,14},{1,2,5,15}, ,{1,2,5,16},
8,9,10,11,12,13,14,15,16,17,	{1,2,8},{1,3,9},{1,4,10},{1,4,11},{1,4,12}, ,{1,4,13},{1,2,5,14},{1,2,5,15},{1,2,5,16}, ,{1,2,7,17},
9,10,11,12,13,14,15,16,17,18,19,	{1,3,9},{1,4,10},{1,4,11},{1,4,12},{1,4,13}, ,{1,2,5,14},{1,2,5,15},{1,2,5,16},{1,2,7,17}, ,{1,2,8,18},{1,2,8,19},
10,11,12,13,14,15,16,17,18,19,20,21,22,23,	{1,4,10},{1,4,11},{1,4,12},{1,4,13}, ,{1,2,5,14},{1,2,5,15},{1,2,5,16},{1,2,7,17}, ,{1,2,8,18},{1,2,8,19},{1,3,9,20},{1,3,9,21}, ,{1,3,9,22},{1,3,9,23},

	{1,4,11,},{1,4,12,},{1,4,13,},{1,2,5,14,}, {1,2,5,15,},{1,2,5,16,},{1,2,7,17,},{1,2,8,18,}, {1,2,8,19,},{1,3,9,20,},{1,3,9,21,},{1,3,9,22,}, {1,3,9,23,},{1,4,10,24,},{1,4,10,25,}, {1,4,10,26,},{1,4,10,27,},
11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27, 	{1,4,12,},{1,4,13,},{1,2,5,14,},{1,2,5,15,}, {1,2,5,16,},{1,2,7,17,},{1,2,8,18,},{1,2,8,19,}, {1,3,9,20,},{1,3,9,21,},{1,3,9,22,},{1,3,9,23,}, {1,4,10,24,},{1,4,10,25,},{1,4,10,26,}, {1,4,10,27,},{1,4,11,28,},
12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28, 	{1,4,13,},{1,2,5,14,},{1,2,5,15,},{1,2,5,16,}, {1,2,7,17,},{1,2,8,18,},{1,2,8,19,},{1,3,9,20,}, {1,3,9,21,},{1,3,9,22,},{1,3,9,23,},{1,4,10,24,}, {1,4,10,25,},{1,4,10,26,},{1,4,10,27,}, {1,4,11,28,},{1,4,12,29,},{1,4,12,30,}, {1,4,12,31,},{1,4,12,32,},{1,4,13,33,},
13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32, 	{1,2,5,14,},{1,2,5,15,},{1,2,5,16,},{1,2,7,17,}, {1,2,8,18,},{1,2,8,19,},{1,3,9,20,},{1,3,9,21,}, {1,3,9,22,},{1,3,9,23,},{1,4,10,24,}, {1,4,10,25,},{1,4,10,26,},{1,4,10,27,}, {1,4,11,28,},{1,4,12,29,},{1,4,12,30,}, {1,4,12,31,},{1,4,12,32,},{1,4,13,33,}, {1,4,13,34,},{1,4,13,35,},{1,4,13,36,},
14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36, 	{1,2,5,15,},{1,2,5,16,},{1,2,7,17,},{1,2,8,18,}, {1,2,8,19,},{1,3,9,20,},{1,3,9,21,},{1,3,9,22,}, {1,3,9,23,},{1,4,10,24,},{1,4,10,25,}, {1,4,10,26,},{1,4,10,27,},{1,4,11,28,}, {1,4,12,29,},{1,4,12,30,},{1,4,12,31,}, {1,4,12,32,},{1,4,13,33,},{1,4,13,34,}, {1,4,13,35,},{1,4,13,36,},
15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36, 	{1,2,5,16,},{1,2,7,17,},{1,2,8,18,},{1,2,8,19,}, {1,3,9,20,},{1,3,9,21,},{1,3,9,22,},{1,3,9,23,}, {1,4,10,24,},{1,4,10,25,},{1,4,10,26,}, {1,4,10,27,},{1,4,11,28,},{1,4,12,29,}, {1,4,12,30,},{1,4,12,31,},{1,4,12,32,}, {1,4,13,33,},{1,4,13,34,},{1,4,13,35,}, {1,4,13,36,},
16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36, 	{1,2,7,17,},{1,2,8,18,},{1,2,8,19,},{1,3,9,20,}, {1,3,9,21,},{1,3,9,22,},{1,3,9,23,},{1,4,10,24,}, {1,4,10,25,},{1,4,10,26,},{1,4,10,27,}, {1,4,11,28,},{1,4,12,29,},{1,4,12,30,}, {1,4,12,31,},{1,4,12,32,},{1,4,13,33,}, {1,4,13,34,},{1,4,13,35,},{1,4,13,36,},
17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36, 	{1,2,8,18,},{1,2,8,19,},{1,3,9,20,},{1,3,9,21,}, {1,3,9,22,},{1,3,9,23,},{1,4,10,24,}, {1,4,10,25,},{1,4,10,26,},{1,4,10,27,}, {1,4,11,28,},{1,4,12,29,},{1,4,12,30,}, {1,4,12,31,},{1,4,12,32,},{1,4,13,33,}, {1,4,13,34,},{1,4,13,35,},{1,4,13,36,},
18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36, 	{1,2,8,19,},{1,3,9,20,},{1,3,9,21,},{1,3,9,22,}, {1,3,9,23,},{1,4,10,24,},{1,4,10,25,}, {1,4,10,26,},{1,4,10,27,},{1,4,11,28,}, {1,4,12,29,},{1,4,12,30,},{1,4,12,31,}, {1,4,12,32,},{1,4,13,33,},{1,4,13,34,}, {1,4,13,35,},{1,4,13,36,},
19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36, 	{1,2,8,19,},{1,3,9,20,},{1,3,9,21,},{1,3,9,22,}, {1,3,9,23,},{1,4,10,24,},{1,4,10,25,}, {1,4,10,26,},{1,4,10,27,},{1,4,11,28,}, {1,4,12,29,},{1,4,12,30,},{1,4,12,31,}, {1,4,12,32,},{1,4,13,33,},{1,4,13,34,}, {1,4,13,35,},{1,4,13,36,},

	{1,3,9,20,}, {1,3,9,21,}, {1,3,9,22,}, {1,3,9,23,}, {1,4,10,24,}, {1,4,10,25,}, {1,4,10,26,}, {1,4,10,27,}, {1,4,11,28,}, {1,4,12,29,}, {1,4,12,30,}, {1,4,12,31,}, {1,4,12,32,}, {1,4,13,33,}, {1,4,13,34,}, {1,4,13,35,}, {1,4,13,36,},
20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,	{1,3,9,21,}, {1,3,9,22,}, {1,3,9,23,}, {1,4,10,24,}, {1,4,10,25,}, {1,4,10,26,}, {1,4,10,27,}, {1,4,11,28,}, {1,4,12,29,}, {1,4,12,30,}, {1,4,12,31,}, {1,4,12,32,}, {1,4,13,33,}, {1,4,13,34,}, {1,4,13,35,}, {1,4,13,36,},
21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,	{1,3,9,22,}, {1,3,9,23,}, {1,4,10,24,}, {1,4,10,25,}, {1,4,10,26,}, {1,4,10,27,}, {1,4,11,28,}, {1,4,12,29,}, {1,4,12,30,}, {1,4,12,31,}, {1,4,12,32,}, {1,4,13,33,}, {1,4,13,34,}, {1,4,13,35,}, {1,4,13,36,},
22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,	{1,3,9,23,}, {1,4,10,24,}, {1,4,10,25,}, {1,4,10,26,}, {1,4,10,27,}, {1,4,11,28,}, {1,4,12,29,}, {1,4,12,30,}, {1,4,12,31,}, {1,4,12,32,}, {1,4,13,33,}, {1,4,13,34,}, {1,4,13,35,}, {1,4,13,36,},
23,24,25,26,27,28,29,30,31,32,33,34,35,36,	{1,4,10,24,}, {1,4,10,25,}, {1,4,10,26,}, {1,4,10,27,}, {1,4,11,28,}, {1,4,12,29,}, {1,4,12,30,}, {1,4,12,31,}, {1,4,12,32,}, {1,4,13,33,}, {1,4,13,34,}, {1,4,13,35,}, {1,4,13,36,},
24,25,26,27,28,29,30,31,32,33,34,35,36,	{1,4,10,25,}, {1,4,10,26,}, {1,4,10,27,}, {1,4,11,28,}, {1,4,12,29,}, {1,4,12,30,}, {1,4,12,31,}, {1,4,12,32,}, {1,4,13,33,}, {1,4,13,34,}, {1,4,13,35,}, {1,4,13,36,},
25,26,27,28,29,30,31,32,33,34,35,36,	{1,4,10,26,}, {1,4,10,27,}, {1,4,11,28,}, {1,4,12,29,}, {1,4,12,30,}, {1,4,12,31,}, {1,4,12,32,}, {1,4,13,33,}, {1,4,13,34,}, {1,4,13,35,}, {1,4,13,36,},
26,27,28,29,30,31,32,33,34,35,36,	{1,4,10,27,}, {1,4,11,28,}, {1,4,12,29,}, {1,4,12,30,}, {1,4,12,31,}, {1,4,12,32,}, {1,4,13,33,}, {1,4,13,34,}, {1,4,13,35,}, {1,4,13,36,}, {1,4,13,36,},

Path found: 1-4-10-26-

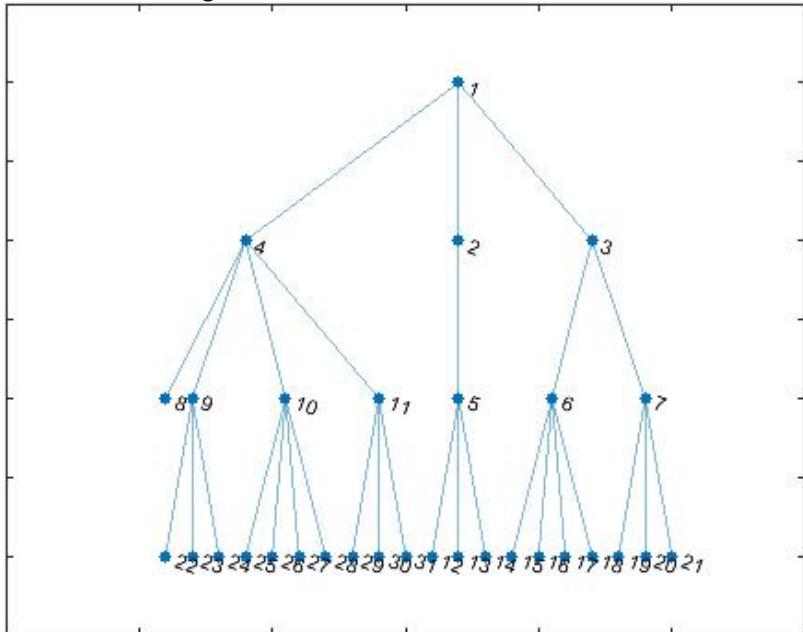
The number of visited states is 26.

## Question 2

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 26.



**Answer:**

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

Path found:1-4-10-26-

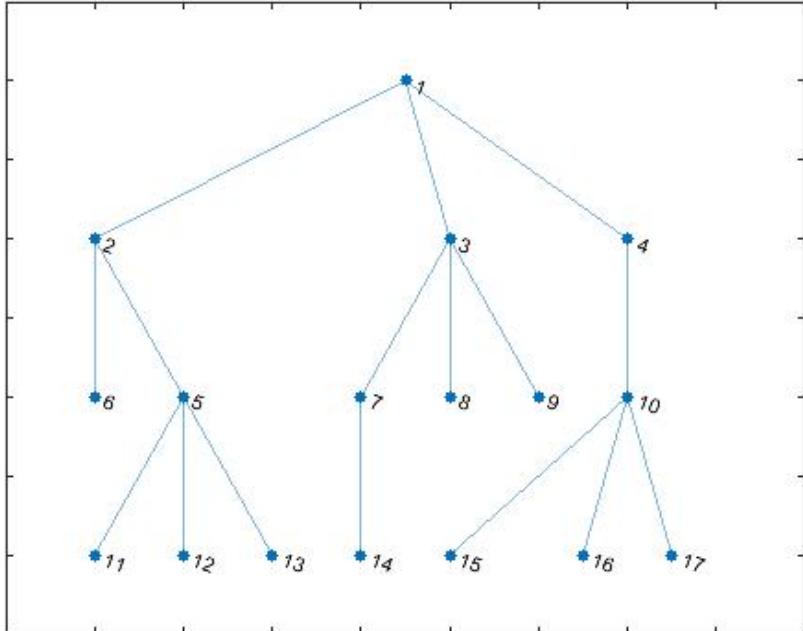
The number of visited states is 25.

## Question 3

Given the following search graph and adopting *best-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 13.



Node ID	Node Heuristic value
1	6
2	19
3	1
4	9
5	8
6	15
7	16
8	4
9	10
10	9
11	13
12	14
13	15
14	6
15	14
16	13
17	3

Answer:

1,	{1,},
3,4,2,	{1,3,},{1,4,},{1,2,},
8,9,7,4,2,	{1,3,8,},{1,3,9,},{1,3,7,},{1,4,},{1,2,},

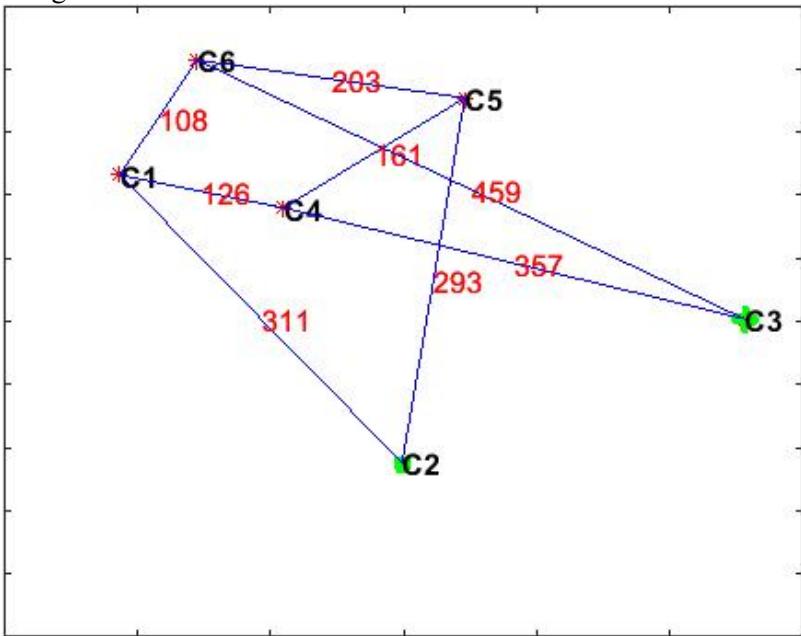
9,7,4,2,	{1,3,9},{1,3,7},{1,4},{1,2},
7,4,2,	{1,3,7},{1,4},{1,2},
14,4,2,	{1,3,7,14},{1,4},{1,2},
4,2,	{1,4},{1,2},
10,2,	{1,4,10},{1,2},
17,16,15,2,	{1,4,10,17},{1,4,10,16},{1,4,10,15},{1,2},
16,15,2,	{1,4,10,16},{1,4,10,15},{1,2},
15,2,	{1,4,10,15},{1,2},
2,	{1,2},
5,6,	{1,2,5},{1,2,6},
11,12,13,6,	{1,2,5,11},{1,2,5,12},{1,2,5,13},{1,2,6},
12,13,6,	{1,2,5,12},{1,2,5,13},{1,2,6},
13,6,	{1,2,5,13},{1,2,6},

Path found: 1-2-5-13-

The number of visited states is 16.

## Question 4

Given the following search graph, write the sequence of node numbers in the search agenda across the search life-time and using *A\* search*.



Assume the following heuristic value per node:

Node ID	Node Heuristic value
1	311
2	0
3	281
4	221
5	293
6	354

Assume distance between cities are as mentioned on the links

Apply A\* algorithm showing intermediate values for the Agenda, g(n), h(n)

Source city is :C3

Destination city:C2

Answer:

		<b>iteration 1</b>									
states	3										
g(n)	0										
h(n)	281										
g(n)+h(n)	281										
visited?	0										
		<b>iteration 2</b>									
states	3			4	6						
g(n)	0			357	459						
h(n)	281			221	354						
g(n)+h(n)	281			578	814						
visited?	1			0	0						
		<b>iteration 3</b>									
states	3			4	6	1	3	5			
g(n)	0			357	459	483	714	518			
h(n)	281			221	354	311	281	293			
g(n)+h(n)	281			578	814	794	995	811			
visited?	1			1	0	0	0	0			
		<b>iteration 4</b>									
states	3			4	6	1	3	5	2	4	6
g(n)	0			357	459	483	714	518	794	608	591
h(n)	281			221	354	311	281	293	0	221	354
g(n)+h(n)	281			578	814	794	995	811	794	829	945
visited?	1			1	0	1	0	0	0	0	0

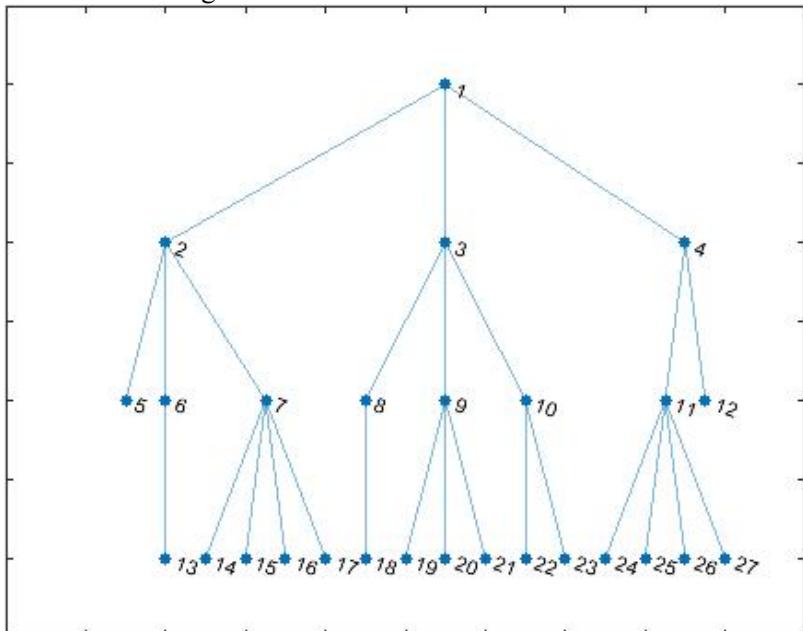
Final path:3-4-1-2-

## Question 6

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 18.



**Answer:**

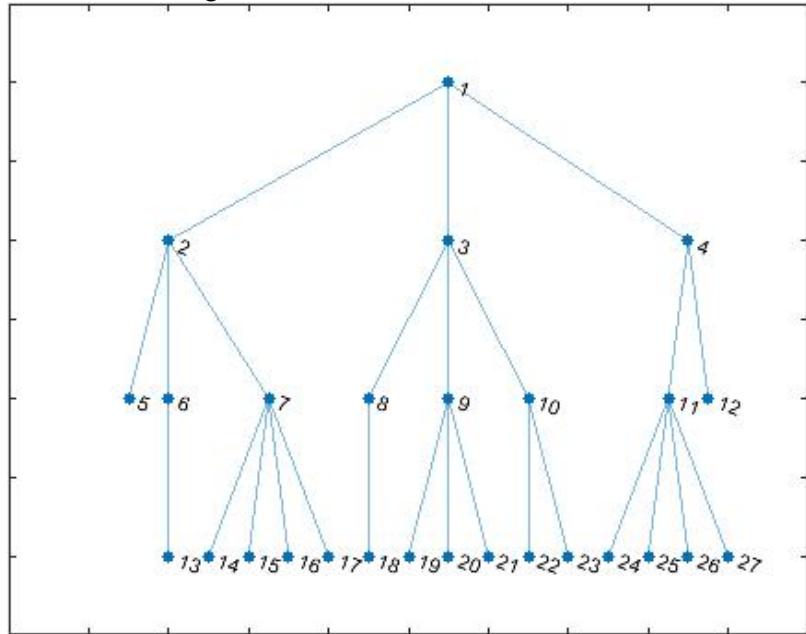
1,	{1,},
2,3,4,	{1,2,}, {1,3,}, {1,4,},
5,6,7,3,4,	{1,2,5,}, {1,2,6,}, {1,2,7,}, {1,3,}, {1,4,},
6,7,3,4,	{1,2,6,}, {1,2,7,}, {1,3,}, {1,4,},
13,7,3,4,	{1,2,6,13,}, {1,2,7,}, {1,3,}, {1,4,},
7,3,4,	{1,2,7,}, {1,3,}, {1,4,},
14,15,16,17,3,4,	{1,2,7,14,}, {1,2,7,15,}, {1,2,7,16,}, {1,2,7,17,}, {1,3,}, {1,4,},
15,16,17,3,4,	{1,2,7,15,}, {1,2,7,16,}, {1,2,7,17,}, {1,3,}, {1,4,},
16,17,3,4,	{1,2,7,16,}, {1,2,7,17,}, {1,3,}, {1,4,},
17,3,4,	{1,2,7,17,}, {1,3,}, {1,4,},
3,4,	{1,3,}, {1,4,},
8,9,10,4,	{1,3,8,}, {1,3,9,}, {1,3,10,}, {1,4,},
18,9,10,4,	{1,3,8,18,}, {1,3,9,}, {1,3,10,}, {1,4,},

Path found: 1-3-8-18-

The number of visited states is 13. Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 18.



**Answer:**

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

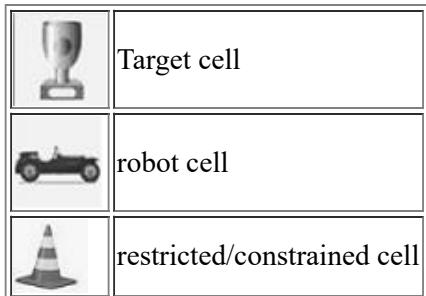
17,18,19,20,21,22,23,24,25,26,27,	{1,2,7,17,}, {1,3,8,18,}, {1,3,9,19,}, {1,3,9,20,}, {1,3,9,21,}, {1,3,10,22,}, {1,3,10,23,}, {1,4,11,24,}, {1,4,11,25,}, {1,4,11,26,}, {1,4,11,27,},
18,19,20,21,22,23,24,25,26,27,	{1,3,8,18,}, {1,3,9,19,}, {1,3,9,20,}, {1,3,9,21,}, {1,3,10,22,}, {1,3,10,23,}, {1,4,11,24,}, {1,4,11,25,}, {1,4,11,26,}, {1,4,11,27,},

Path found:1-3-8-18-

The number of visited states is 18.

## Question 7

Having the following grid and the depicted agent at location (x=5,y=5) and a target object located at (x=6,y=2)  
 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 the grid.  
 Assume Euclidian distance from the current location to the target location as the heuristic value.



---

## Answer

(row=1,col=1) <b>1</b>	(row=1,col=2) <b>6</b>	(row=1,col=3) <b>11</b>	(row=1,col=4) <b>16</b>	(row=1,col=5) <b>21</b>	(row=1,col=6) <b>26</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>7</b>	(row=2,col=3) <b>12</b> 	(row=2,col=4) <b>17</b>	(row=2,col=5) <b>22</b>	(row=2,col=6) <b>27</b> 
(row=3,col=1) <b>3</b> 	(row=3,col=2) <b>8</b> 	(row=3,col=3) <b>13</b> 	(row=3,col=4) <b>18</b>	(row=3,col=5) <b>23</b>	(row=3,col=6) <b>28</b> 
(row=4,col=1) <b>4</b>	(row=4,col=2) <b>9</b>	(row=4,col=3) <b>14</b>	(row=4,col=4) <b>19</b>	(row=4,col=5) <b>24</b>	(row=4,col=6) <b>29</b>
(row=5,col=1) <b>5</b>	(row=5,col=2) <b>10</b>	(row=5,col=3) <b>15</b>	(row=5,col=4) <b>20</b>	(row=5,col=5) <b>25</b> 	(row=5,col=6) <b>30</b>

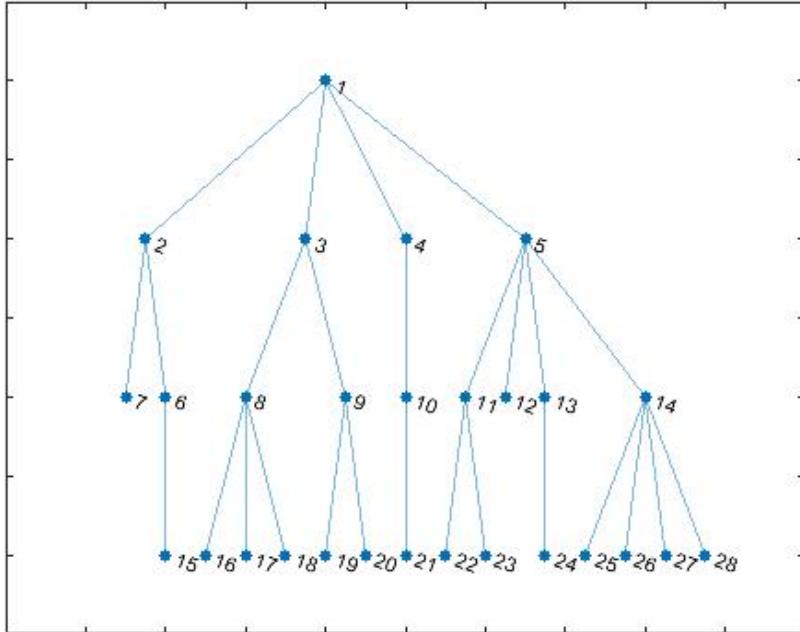
H	0.00	1.41	1.41	2.00	2.24	2.24	2.00	2.83	3.16	3.00	3.61
(row=1,col=1) 1	(row=1,col=2) 6	(row=1,col=3) 11	(row=1,col=4) 16	(row=1,col=5) 21	(row=1,col=6) 26						
(row=2,col=1) 2	(row=2,col=2) 7	(row=2,col=3) 12	(row=2,col=4) 17	(row=2,col=5) 22	(row=2,col=6) 27						
(row=3,col=1) 3	(row=3,col=2) 8	(row=3,col=3) 13	(row=3,col=4) 18	(row=3,col=5) 23	(row=3,col=6) 28						
(row=4,col=1) 4	(row=4,col=2) 9	(row=4,col=3) 14	(row=4,col=4) 19	(row=4,col=5) 24	(row=4,col=6) 29						
(row=5,col=1) 5	(row=5,col=2) 10	(row=5,col=3) 15	(row=5,col=4) 20	(row=5,col=5) 25	(row=5,col=6) 30						

## Question 8

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 27.



Answer:

1,	{1},
2,3,4,5,	{1,2},{1,3},{1,4},{1,5},

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

Path found:1-5-14-27-

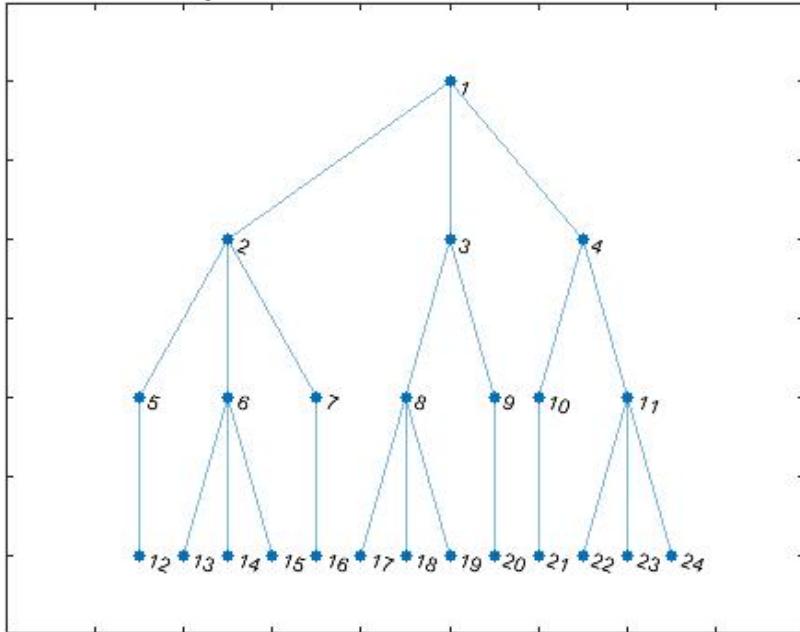
The number of visited states is 27.

## Question 9

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 21.



**Answer:**

1,	{1},
2,3,4,	{1,2},{1,3},{1,4},
5,6,7,3,4,	{1,2,5},{1,2,6},{1,2,7},{1,3},{1,4},
12,6,7,3,4,	{1,2,5,12},{1,2,6},{1,2,7},{1,3},{1,4},
6,7,3,4,	{1,2,6},{1,2,7},{1,3},{1,4},
13,14,15,7,3,4,	{1,2,6,13},{1,2,6,14},{1,2,6,15},{1,2,7},{1,3},{1,4},
14,15,7,3,4,	{1,2,6,14},{1,2,6,15},{1,2,7},{1,3},{1,4},
15,7,3,4,	{1,2,6,15},{1,2,7},{1,3},{1,4},
7,3,4,	{1,2,7},{1,3},{1,4},
16,3,4,	{1,2,7,16},{1,3},{1,4},
3,4,	{1,3},{1,4},
8,9,4,	{1,3,8},{1,3,9},{1,4},
17,18,19,9,4,	{1,3,8,17},{1,3,8,18},{1,3,8,19},{1,3,9},{1,4},
18,19,9,4,	{1,3,8,18},{1,3,8,19},{1,3,9},{1,4},
19,9,4,	{1,3,8,19},{1,3,9},{1,4},
9,4,	{1,3,9},{1,4},
20,4,	{1,3,9,20},{1,4},
4,	{1,4},
10,11,	{1,4,10},{1,4,11},
21,11,	{1,4,10,21},{1,4,11},

Path found: 1-4-10-21-

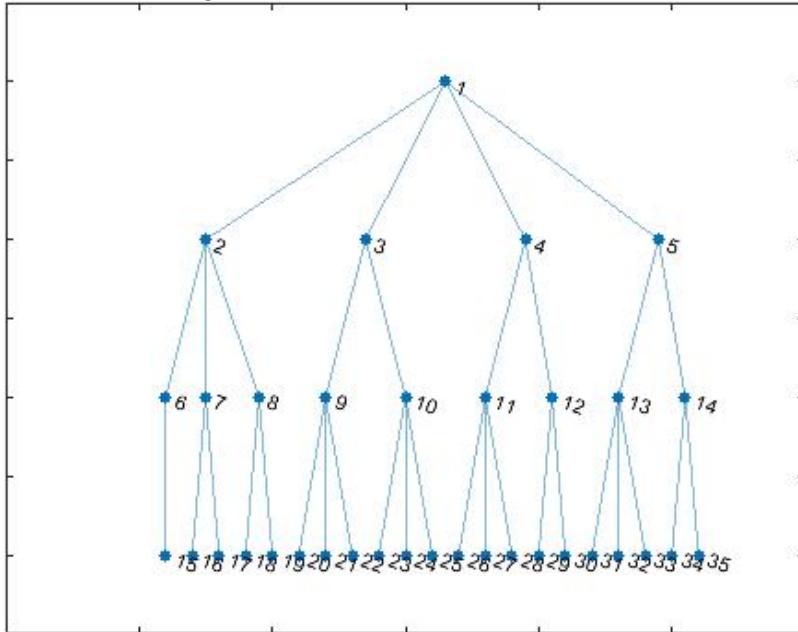
The number of visited states is 20.

## Question 10

Given the following search graph and adopting *best-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 22.



Node ID	Node Heuristic value
1	19
2	18
3	11
4	12
5	12
6	4
7	6
8	9
9	5
10	17
11	4
12	5
13	3
14	5
15	9
16	6
17	18
18	9
19	4
20	18
21	20
22	9
23	2
24	5

25	8
26	12
27	5
28	12
29	14
30	4
31	2
32	6
33	6
34	8
35	10

Answer:

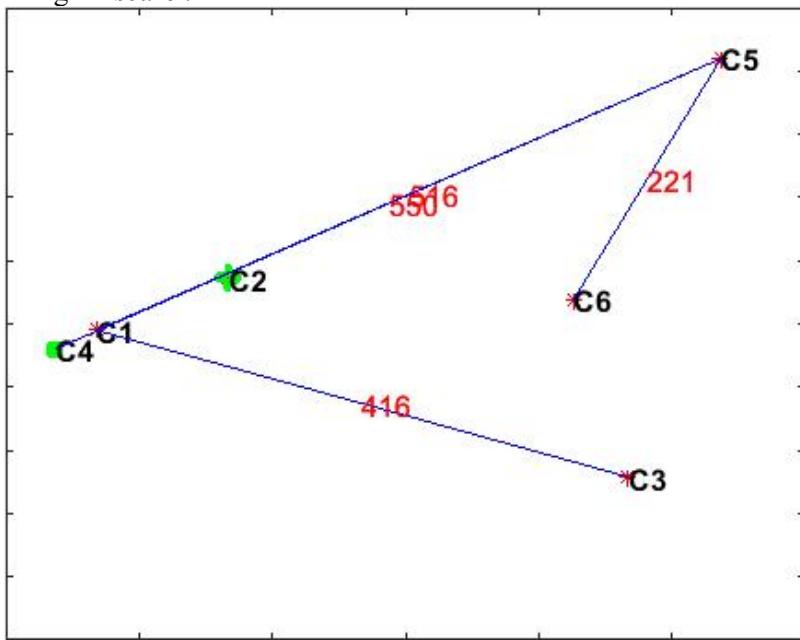
1,	{1,},
3,4,5,2,	{1,3,},{1,4,},{1,5,},{1,2,},
9,10,4,5,2,	{1,3,9,},{1,3,10,},{1,4,},{1,5,},{1,2,},
22,20,21,10,4,5,2,	{1,3,9,22,},{1,3,9,20,},{1,3,9,21,},{1,3,10,},{1,4,},{1,5,},{1,2,},

Path found: 1-3-9-22-

The number of visited states is 4.

## Question 11

Given the following search graph, write the sequence of node numbers in the search agenda across the search life-time and using *A\** search.



Assume the following heuristic value per node:

Node ID	Node Heuristic value
1	34
2	142
3	442
4	0
5	550

6	391
---	-----

Assume distance between cities are as mentioned on the links

Apply A\* algorithm showing intermediate values for the Agenda,  $g(n)$ ,  $h(n)$

Source city is :C2

Destination city:C4

Answer:

iteration 1	
states	2
$g(n)$	0
$h(n)$	142
$g(n)+h(n)$	142
visited?	0

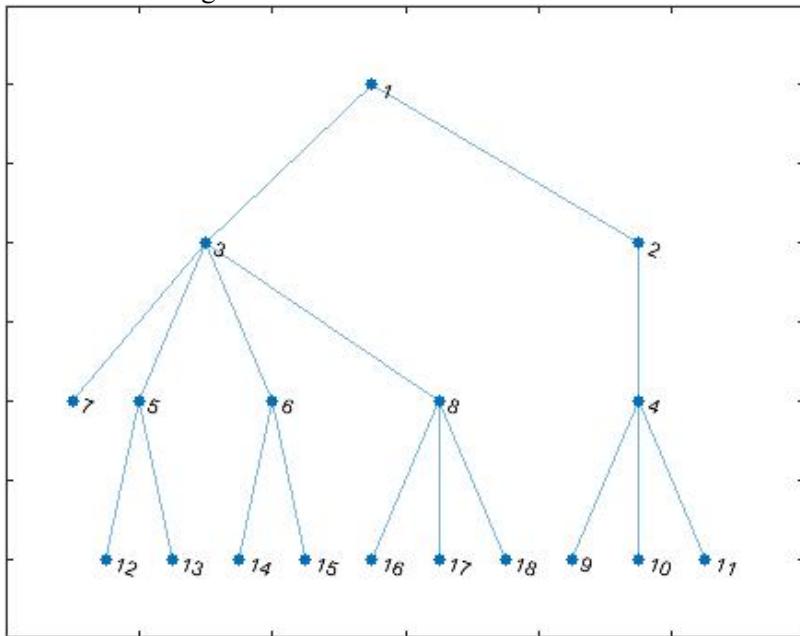
no path found

## Question 13

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 9.



Answer:

1,	{1},
2,3,	{1,2},{1,3},
3,4,	{1,3},{1,2,4},
4,5,6,7,8,	{1,2,4},{1,3,5},{1,3,6},{1,3,7},{1,3,8},
5,6,7,8,9,10,11,	{1,3,5},{1,3,6},{1,3,7},{1,3,8},{1,2,4,9},{1,2,4,10},{1,2,4,11},
6,7,8,9,10,11,12,13,	{1,3,6},{1,3,7},{1,3,8},{1,2,4,9},{1,2,4,10},{1,2,4,11},{1,3,5,12},{1,3,5,13},

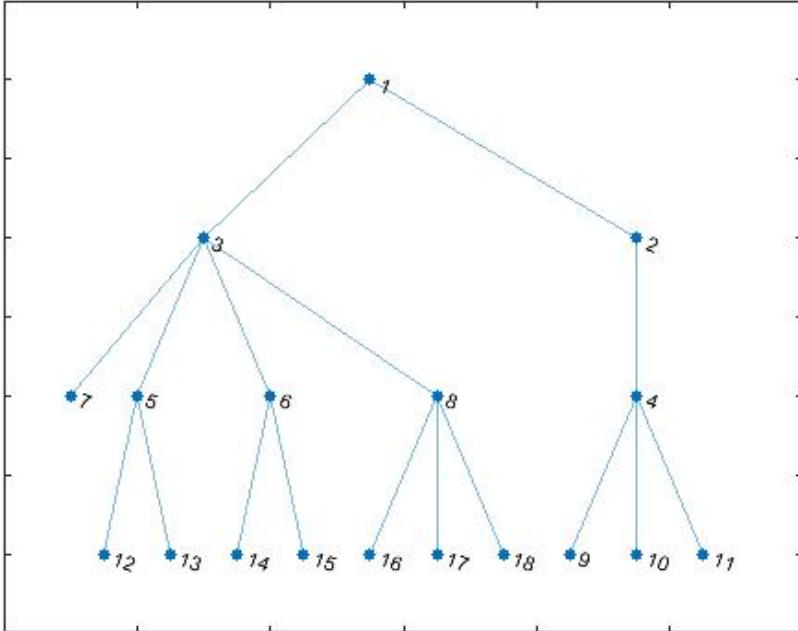
7,8,9,10,11,12,13,14,15,	{1,3,7},{1,3,8},{1,2,4,9},{1,2,4,10},{1,2,4,11},{1,3,5,12},{1,3,5,13},{1,3,6,14},{1,3,6,15},
8,9,10,11,12,13,14,15,	{1,3,8},{1,2,4,9},{1,2,4,10},{1,2,4,11},{1,3,5,12},{1,3,5,13},{1,3,6,14},{1,3,6,15},
9,10,11,12,13,14,15,16,17,18,	{1,2,4,9},{1,2,4,10},{1,2,4,11},{1,3,5,12},{1,3,5,13},{1,3,6,14},{1,3,6,15},{1,3,8,16},{1,3,8,17},{1,3,8,18}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

Path found:1-2-4-9-

The number of visited states is 9. Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 9.



Answer:

1,	{1},
2,3,	{1,2},{1,3},
4,3,	{1,2,4},{1,3},
9,10,11,3,	{1,2,4,9},{1,2,4,10},{1,2,4,11},{1,3},

Path found:1-2-4-9-

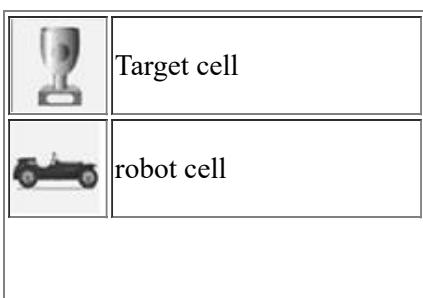
The number of visited states is 4.

## Question 14

Having the following grid and the depicted agent at location (x=5,y=5) and a target object located at (x=5,y=2)

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 the grid.

Assume Euclidian distance from the current location to the target location as the heuristic value.





restricted/constrained cell

Answer

(row=1,col=1) <b>1</b>	(row=1,col=2) <b>6</b>	(row=1,col=3) <b>11</b>	(row=1,col=4) <b>16</b> 	(row=1,col=5) <b>21</b>	(row=1,col=6) <b>26</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>7</b>	(row=2,col=3) <b>12</b>	(row=2,col=4) <b>17</b>	(row=2,col=5) <b>22</b> 	(row=2,col=6) <b>27</b>
(row=3,col=1) <b>3</b>	(row=3,col=2) <b>8</b>	(row=3,col=3) <b>13</b>	(row=3,col=4) <b>18</b>	(row=3,col=5) <b>23</b>	(row=3,col=6) <b>28</b>
(row=4,col=1) <b>4</b>	(row=4,col=2) <b>9</b>	(row=4,col=3) <b>14</b>	(row=4,col=4) <b>19</b>	(row=4,col=5) <b>24</b>	(row=4,col=6) <b>29</b>
(row=5,col=1) <b>5</b> 	(row=5,col=2) <b>10</b>	(row=5,col=3) <b>15</b>	(row=5,col=4) <b>20</b> 	(row=5,col=5) <b>25</b> 	(row=5,col=6) <b>30</b> 

states	25					
H	3.00					
states	24					
H	2.00					
states	23	29	19	25		
H	1.00	2.24	2.24	3.00		
states	22	28	18	24	29	19
H	0.00	1.41	1.41	2.00	2.24	2.24
						3.00

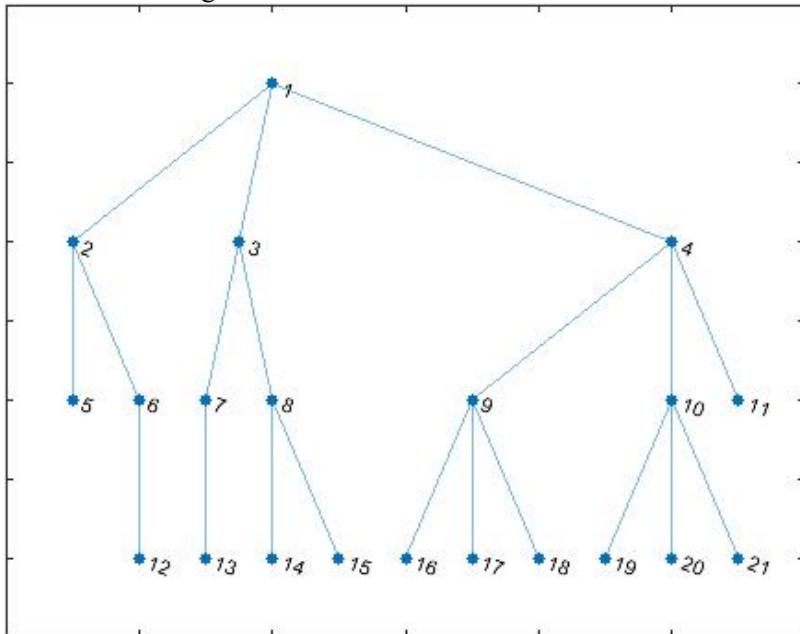
(row=1,col=1) <b>1</b>	(row=1,col=2) <b>6</b>	(row=1,col=3) <b>11</b>	(row=1,col=4) <b>16</b> 	(row=1,col=5) <b>21</b>	(row=1,col=6) <b>26</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>7</b>	(row=2,col=3) <b>12</b>	(row=2,col=4) <b>17</b>	(row=2,col=5) <b>22</b> 	(row=2,col=6) <b>27</b>
(row=3,col=1) <b>3</b>	(row=3,col=2) <b>8</b>	(row=3,col=3) <b>13</b>	(row=3,col=4) <b>18</b>	(row=3,col=5) <b>23</b> 	(row=3,col=6) <b>28</b>
(row=4,col=1) <b>4</b>	(row=4,col=2) <b>9</b>	(row=4,col=3) <b>14</b>	(row=4,col=4) <b>19</b>	(row=4,col=5) <b>24</b> 	(row=4,col=6) <b>29</b>
(row=5,col=1) <b>5</b> 	(row=5,col=2) <b>10</b>	(row=5,col=3) <b>15</b>	(row=5,col=4) <b>20</b> 	(row=5,col=5) <b>25</b> 	(row=5,col=6) <b>30</b> 

## Question 15

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 13.



**Answer:**

1,	{1},
2,3,4,	{1,2},{1,3},{1,4},
3,4,5,6,	{1,3},{1,4},{1,2,5},{1,2,6},
4,5,6,7,8,	{1,4},{1,2,5},{1,2,6},{1,3,7},{1,3,8},
5,6,7,8,9,10,11,	{1,2,5},{1,2,6},{1,3,7},{1,3,8},{1,4,9},{1,4,10},{1,4,11},
6,7,8,9,10,11,	{1,2,6},{1,3,7},{1,3,8},{1,4,9},{1,4,10},{1,4,11},
7,8,9,10,11,12,	{1,3,7},{1,3,8},{1,4,9},{1,4,10},{1,4,11},{1,2,6,12},
8,9,10,11,12,13,	{1,3,8},{1,4,9},{1,4,10},{1,4,11},{1,2,6,12},{1,3,7,13},
9,10,11,12,13,14,15,	{1,4,9},{1,4,10},{1,4,11},{1,2,6,12},{1,3,7,13},{1,3,8,14},{1,3,8,15},
10,11,12,13,14,15,16,17,18,	{1,4,10},{1,4,11},{1,2,6,12},{1,3,7,13},{1,3,8,14},{1,3,8,15},{1,4,9,16},{1,4,9,17},{1,4,9,18},
11,12,13,14,15,16,17,18,19,20,21,	{1,4,11},{1,2,6,12},{1,3,7,13},{1,3,8,14},{1,3,8,15},{1,4,9,16},{1,4,9,17},{1,4,9,18},{1,4,9,19},{1,4,10,19},{1,4,10,20},{1,4,10,21},
12,13,14,15,16,17,18,19,20,21,	{1,2,6,12},{1,3,7,13},{1,3,8,14},{1,3,8,15},{1,4,9,16},{1,4,9,17},{1,4,9,18},{1,4,10,19},{1,4,10,20},{1,4,10,21},
13,14,15,16,17,18,19,20,21,	{1,3,7,13},{1,3,8,14},{1,3,8,15},{1,4,9,16},{1,4,9,17},{1,4,9,18},{1,4,10,19},{1,4,10,20},{1,4,10,21},

Path found: 1-3-7-13-

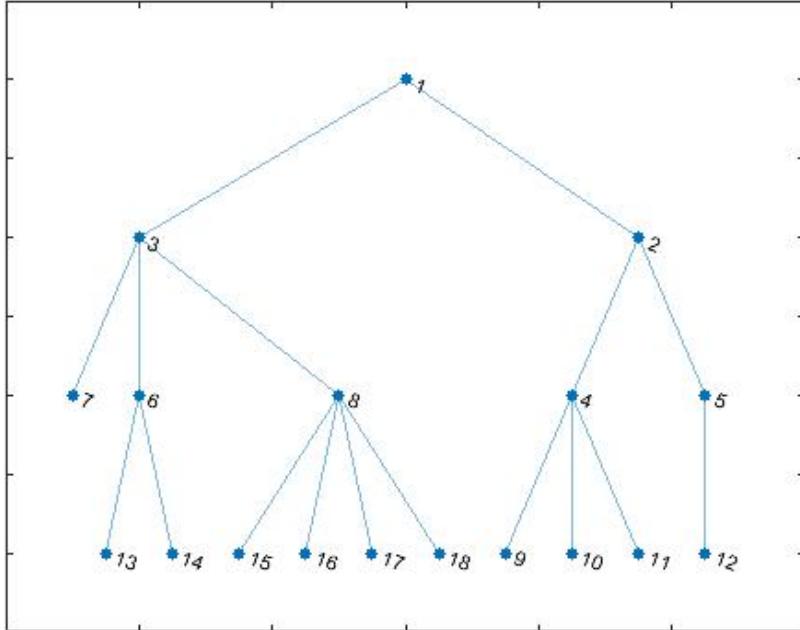
The number of visited states is 13.

## Question 16

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 10.



**Answer:**

1,	{1,},
2,3,	{1,2,}, {1,3,},
4,5,3,	{1,2,4,}, {1,2,5,}, {1,3,},
9,10,11,5,3,	{1,2,4,9,}, {1,2,4,10,}, {1,2,4,11,}, {1,2,5,}, {1,3,},
10,11,5,3,	{1,2,4,10,}, {1,2,4,11,}, {1,2,5,}, {1,3,},

Path found: 1-2-4-10-

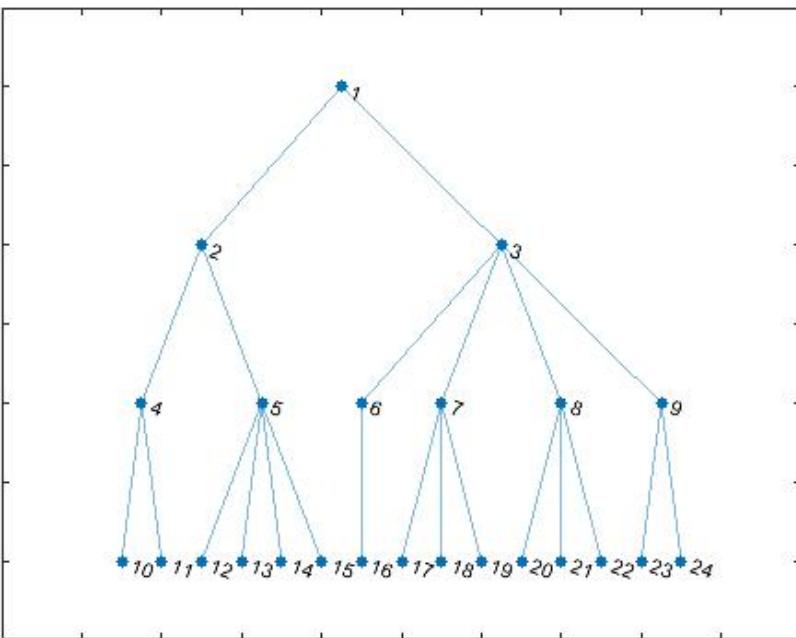
The number of visited states is 5.

## Question 17

Given the following search graph and adopting *best-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 20.



Node ID	Node Heuristic value
1	13
2	4
3	3
4	20
5	3
6	1
7	11
8	18
9	13
10	4
11	7
12	9
13	20
14	3
15	17
16	13
17	8
18	4
19	9
20	10
21	2
22	12
23	5
24	8

**Answer:**

1,	{1},
3,2,	{1,3,},{1,2,},
6,7,9,8,2,	{1,3,6,},{1,3,7,},{1,3,9,},{1,3,8,},{1,2,},

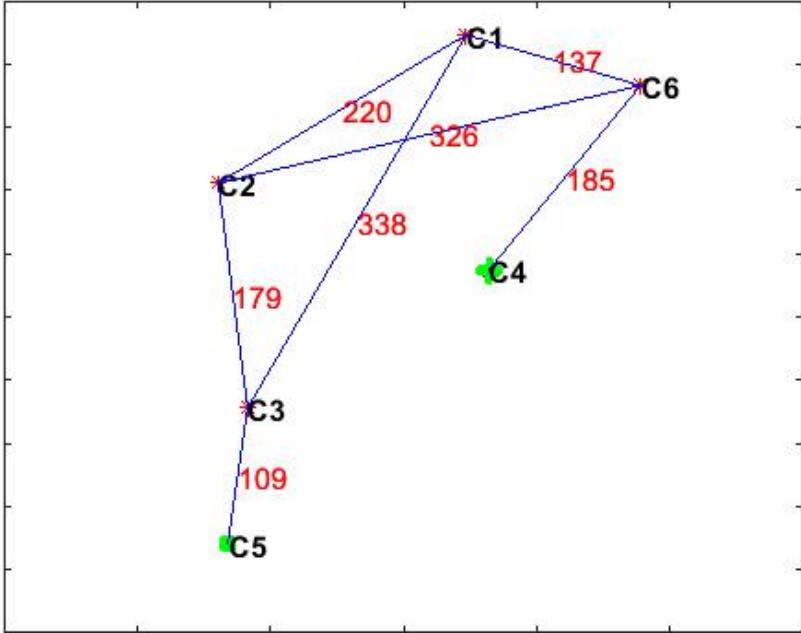
16,7,9,8,2,	{1,3,6,16},{1,3,7},{1,3,9},{1,3,8},{1,2},
7,9,8,2,	{1,3,7},{1,3,9},{1,3,8},{1,2},
18,17,19,9,8,2,	{1,3,7,18},{1,3,7,17},{1,3,7,19},{1,3,9},{1,3,8},{1,2},
17,19,9,8,2,	{1,3,7,17},{1,3,7,19},{1,3,9},{1,3,8},{1,2},
19,9,8,2,	{1,3,7,19},{1,3,9},{1,3,8},{1,2},
9,8,2,	{1,3,9},{1,3,8},{1,2},
23,24,8,2,	{1,3,9,23},{1,3,9,24},{1,3,8},{1,2},
24,8,2,	{1,3,9,24},{1,3,8},{1,2},
8,2,	{1,3,8},{1,2},
21,20,22,2,	{1,3,8,21},{1,3,8,20},{1,3,8,22},{1,2},
20,22,2,	{1,3,8,20},{1,3,8,22},{1,2},

Path found: 1-3-8-20-

The number of visited states is 14.

## Question 18

Given the following search graph, write the sequence of node numbers in the search agenda across the search life-time and using *A\* search*.



Assume the following heuristic value per node:

Node ID	Node Heuristic value
1	441
2	286
3	109
4	292
5	0
6	477

Assume distance between cities are as mentioned on the links

Apply A\* algorithm showing intermediate values for the Agenda, g(n), h(n)

Source city is :C4

Destination city:C5

Answer:

		<b>iteration 1</b>									
states		4									
g(n)		0									
h(n)		292									
g(n)+h(n)		292									
visited?		0									
		<b>iteration 2</b>									
states		4									6
g(n)		0									185
h(n)		292									477
g(n)+h(n)		292									663
visited?		1									0
		<b>iteration 3</b>									
states		4					6	1	2	4	4
g(n)		0					185	322	511	370	
h(n)		292					477	441	286	292	
g(n)+h(n)		292					663	763	798	663	
visited?		1					1	0	0	0	0
		<b>iteration 4</b>									
states		4					6	1	2	4	6
g(n)		0					185	322	511	370	556
h(n)		292					477	441	286	292	477
g(n)+h(n)		292					663	763	798	663	1033
visited?		1					1	0	0	1	0
		<b>iteration 5</b>									
states		4					6	1	2	4	6
g(n)		0					185	322	511	370	556
h(n)		292					477	441	286	292	477
g(n)+h(n)		292					663	763	798	663	1033
visited?		1					1	1	0	1	0
		<b>iteration 6</b>									
states		4					6	1	2	4	6
g(n)		0					185	322	511	370	556
h(n)		292					477	441	286	292	477
g(n)+h(n)		292					663	763	798	663	1033
visited?		1					1	1	0	1	0

Final path:4-6-1-3-5-

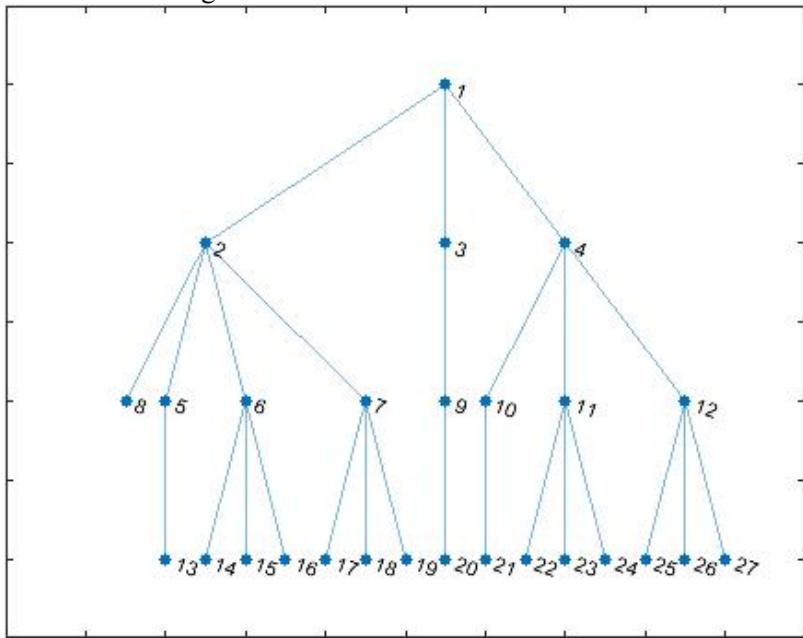
## Question 20

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.

2. How many states will be visited until reaching the goal state?  
 3. Mention the solution path if exist to the goal state.

Assume that the goals state is 17.



Answer:

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

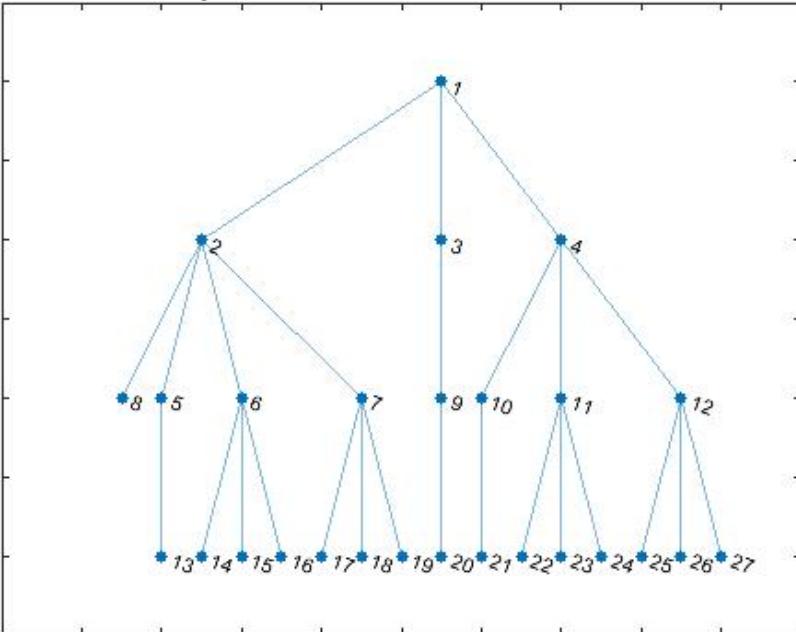
16,17,18,19,20,21,22,23,24,25,26,27,	{1,2,6,16,},{1,2,7,17,},{1,2,7,18,},{1,2,7,19,},{1,3,9,20,},{1,4,10,21,}, {1,4,11,22,},{1,4,11,23,},{1,4,11,24,},{1,4,12,25,},{1,4,12,26,}, {1,4,12,27,},
17,18,19,20,21,22,23,24,25,26,27,	{1,2,7,17,},{1,2,7,18,},{1,2,7,19,},{1,3,9,20,},{1,4,10,21,},{1,4,11,22,}, {1,4,11,23,},{1,4,11,24,},{1,4,12,25,},{1,4,12,26,},{1,4,12,27,},

Path found:1-2-7-17-

The number of visited states is 17. Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 17.



Answer:

1,	{1,},
2,3,4,	{1,2,},{1,3,},{1,4,},
5,6,7,8,3,4,	{1,2,5,},{1,2,6,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
13,6,7,8,3,4,	{1,2,5,13,},{1,2,6,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
6,7,8,3,4,	{1,2,6,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
14,15,16,7,8,3,4,	{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
15,16,7,8,3,4,	{1,2,6,15,},{1,2,6,16,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
16,7,8,3,4,	{1,2,6,16,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
7,8,3,4,	{1,2,7,},{1,2,8,},{1,3,},{1,4,},
17,18,19,8,3,4,	{1,2,7,17,},{1,2,7,18,},{1,2,7,19,},{1,2,8,},{1,3,},{1,4,},

Path found:1-2-7-17-

The number of visited states is 10.

## Question 21

Having the following grid and the depicted agent at location (x=4,y=1) and a target object located at (x=8,y=2)

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 the grid.

Assume Euclidian distance from the current location to the target location as the heuristic value.

	Target cell
	robot cell
	restricted/constrained cell

Answer

(row=1,col=1) <b>1</b> 	(row=1,col=2) <b>6</b>	(row=1,col=3) <b>11</b>	(row=1,col=4) <b>16</b> 	(row=1,col=5) <b>21</b>	(row=1,col=6) <b>26</b>	(row=1,col=7) <b>31</b> 	(row=1,col=8) <b>36</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>7</b>	(row=2,col=3) <b>12</b>	(row=2,col=4) <b>17</b> 	(row=2,col=5) <b>22</b>	(row=2,col=6) <b>27</b>	(row=2,col=7) <b>32</b>	(row=2,col=8) <b>37</b> 
(row=3,col=1) <b>3</b>	(row=3,col=2) <b>8</b>	(row=3,col=3) <b>13</b>	(row=3,col=4) <b>18</b>	(row=3,col=5) <b>23</b>	(row=3,col=6) <b>28</b>	(row=3,col=7) <b>33</b>	(row=3,col=8) <b>38</b>
(row=4,col=1) <b>4</b>	(row=4,col=2) <b>9</b>	(row=4,col=3) <b>14</b>	(row=4,col=4) <b>19</b> 	(row=4,col=5) <b>24</b>	(row=4,col=6) <b>29</b>	(row=4,col=7) <b>34</b>	(row=4,col=8) <b>39</b>
(row=5,col=1) <b>5</b>	(row=5,col=2) <b>10</b>	(row=5,col=3) <b>15</b>	(row=5,col=4) <b>20</b>	(row=5,col=5) <b>25</b>	(row=5,col=6) <b>30</b>	(row=5,col=7) <b>35</b>	(row=5,col=8) <b>40</b>

states	16						
H	4.12						
states	21	11					
H	3.16	5.10					
states	26	22	16	11			
H	2.24	3.00	4.12	5.10			
states	27	21	22	16	11		
H	2.00	3.16	3.00	4.12	5.10		
states	32	28	26	22	21	22	16
H	1.00	2.24	2.24	3.00	3.16	3.00	4.12
states	37	33	27	28	26	22	21
H	0.00	1.41	2.00	2.24	2.24	3.00	3.16

(row=1,col=1) <b>1</b> 	(row=1,col=2) <b>6</b>	(row=1,col=3) <b>11</b>	(row=1,col=4) <b>16</b> 	(row=1,col=5) <b>21</b>	(row=1,col=6) <b>26</b> 	(row=1,col=7) <b>31</b> 	(row=1,col=8) <b>36</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>7</b>	(row=2,col=3) <b>12</b>	(row=2,col=4) <b>17</b> 	(row=2,col=5) <b>22</b>	(row=2,col=6) <b>27</b> 	(row=2,col=7) <b>32</b> 	(row=2,col=8) <b>37</b> 
(row=3,col=1) <b>3</b>	(row=3,col=2) <b>8</b>	(row=3,col=3) <b>13</b>	(row=3,col=4) <b>18</b>	(row=3,col=5) <b>23</b>	(row=3,col=6) <b>28</b>	(row=3,col=7) <b>33</b>	(row=3,col=8) <b>38</b>

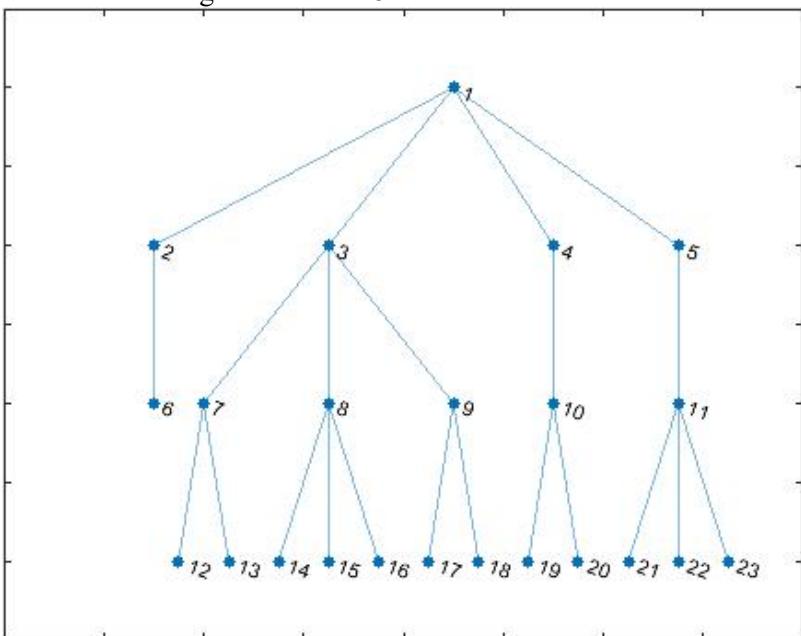
(row=4,col=1) 4	(row=4,col=2) 9	(row=4,col=3) 14	(row=4,col=4) 	(row=4,col=5) 24	(row=4,col=6) 29	(row=4,col=7) 34	(row=4,col=8) 39
(row=5,col=1) 5	(row=5,col=2) 10	(row=5,col=3) 15	(row=5,col=4) 20	(row=5,col=5) 25	(row=5,col=6) 30	(row=5,col=7) 35	(row=5,col=8) 40

## Question 22

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 18.



Answer:

1,	{1},
2,3,4,5,	{1,2},{1,3},{1,4},{1,5},
3,4,5,6,	{1,3},{1,4},{1,5},{1,2,6},
4,5,6,7,8,9,	{1,4},{1,5},{1,2,6},{1,3,7},{1,3,8},{1,3,9},
5,6,7,8,9,10,	{1,5},{1,2,6},{1,3,7},{1,3,8},{1,3,9},{1,4,10},
6,7,8,9,10,11,	{1,2,6},{1,3,7},{1,3,8},{1,3,9},{1,4,10},{1,5,11},
7,8,9,10,11,	{1,3,7},{1,3,8},{1,3,9},{1,4,10},{1,5,11},
8,9,10,11,12,13,	{1,3,8},{1,3,9},{1,4,10},{1,5,11},{1,3,7,12},{1,3,7,13},
9,10,11,12,13,14,15,16,	{1,3,9},{1,4,10},{1,5,11},{1,3,7,12},{1,3,7,13},{1,3,8,14},{1,3,8,15},
10,11,12,13,14,15,16,17,18,	{1,4,10},{1,5,11},{1,3,7,12},{1,3,7,13},{1,3,8,14},{1,3,8,15},{1,3,8,16},
11,12,13,14,15,16,17,18,19,20,	{1,5,11},{1,3,7,12},{1,3,7,13},{1,3,8,14},{1,3,8,15},{1,3,8,16},{1,3,9,17},
12,13,14,15,16,17,18,19,20,21,22,23,	{1,3,7,12},{1,3,7,13},{1,3,8,14},{1,3,8,15},{1,3,8,16},{1,3,9,17},{1,3,9,18},

13,14,15,16,17,18,19,20,21,22,23,	$\{1,3,7,13\}, \{1,3,8,14\}, \{1,3,8,15\}, \{1,3,8,16\}, \{1,3,9,17\}, \{1,3,9,18\},$ $\{1,4,10,19\}, \{1,4,10,20\}, \{1,5,11,21\}, \{1,5,11,22\}, \{1,5,11,23\},$
14,15,16,17,18,19,20,21,22,23,	$\{1,3,8,14\}, \{1,3,8,15\}, \{1,3,8,16\}, \{1,3,9,17\}, \{1,3,9,18\}, \{1,4,10,19\},$ $\{1,4,10,20\}, \{1,5,11,21\}, \{1,5,11,22\}, \{1,5,11,23\},$
15,16,17,18,19,20,21,22,23,	$\{1,3,8,15\}, \{1,3,8,16\}, \{1,3,9,17\}, \{1,3,9,18\}, \{1,4,10,19\}, \{1,4,10,20\},$ $\{1,5,11,21\}, \{1,5,11,22\}, \{1,5,11,23\},$
16,17,18,19,20,21,22,23,	$\{1,3,8,16\}, \{1,3,9,17\}, \{1,3,9,18\}, \{1,4,10,19\}, \{1,4,10,20\}, \{1,5,11,21\},$ $\{1,5,11,22\}, \{1,5,11,23\},$
17,18,19,20,21,22,23,	$\{1,3,9,17\}, \{1,3,9,18\}, \{1,4,10,19\}, \{1,4,10,20\}, \{1,5,11,21\}, \{1,5,11,22\},$ $\{1,5,11,23\},$
18,19,20,21,22,23,	$\{1,3,9,18\}, \{1,4,10,19\}, \{1,4,10,20\}, \{1,5,11,21\}, \{1,5,11,22\}, \{1,5,11,23\},$

Path found: 1-3-9-18-

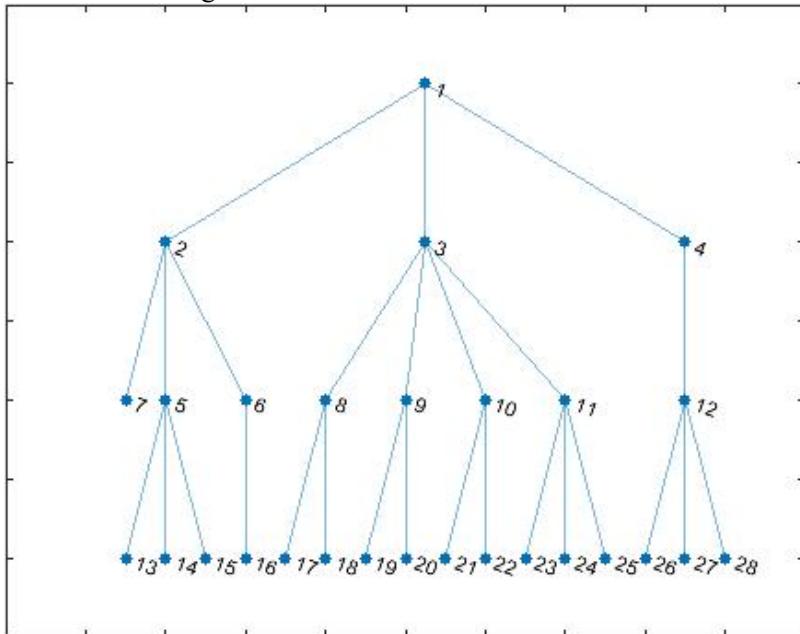
The number of visited states is 18.

## Question 23

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 18.



Answer:

1,	$\{1\},$
2,3,4,	$\{1,2\}, \{1,3\}, \{1,4\},$
5,6,7,3,4,	$\{1,2,5\}, \{1,2,6\}, \{1,2,7\}, \{1,3\}, \{1,4\},$
13,14,15,6,7,3,4,	$\{1,2,5,13\}, \{1,2,5,14\}, \{1,2,5,15\}, \{1,2,6\}, \{1,2,7\}, \{1,3\}, \{1,4\},$
14,15,6,7,3,4,	$\{1,2,5,14\}, \{1,2,5,15\}, \{1,2,6\}, \{1,2,7\}, \{1,3\}, \{1,4\},$
15,6,7,3,4,	$\{1,2,5,15\}, \{1,2,6\}, \{1,2,7\}, \{1,3\}, \{1,4\},$
6,7,3,4,	$\{1,2,6\}, \{1,2,7\}, \{1,3\}, \{1,4\},$
16,7,3,4,	$\{1,2,6,16\}, \{1,2,7\}, \{1,3\}, \{1,4\},$
7,3,4,	$\{1,2,7\}, \{1,3\}, \{1,4\},$
3,4,	$\{1,3\}, \{1,4\},$

8,9,10,11,4,	{1,3,8,}, {1,3,9,}, {1,3,10,}, {1,3,11,}, {1,4,},
17,18,9,10,11,4,	{1,3,8,17,}, {1,3,8,18,}, {1,3,9,}, {1,3,10,}, {1,3,11,}, {1,4,},
18,9,10,11,4,	{1,3,8,18,}, {1,3,9,}, {1,3,10,}, {1,3,11,}, {1,4,},

Path found: 1-3-8-18-

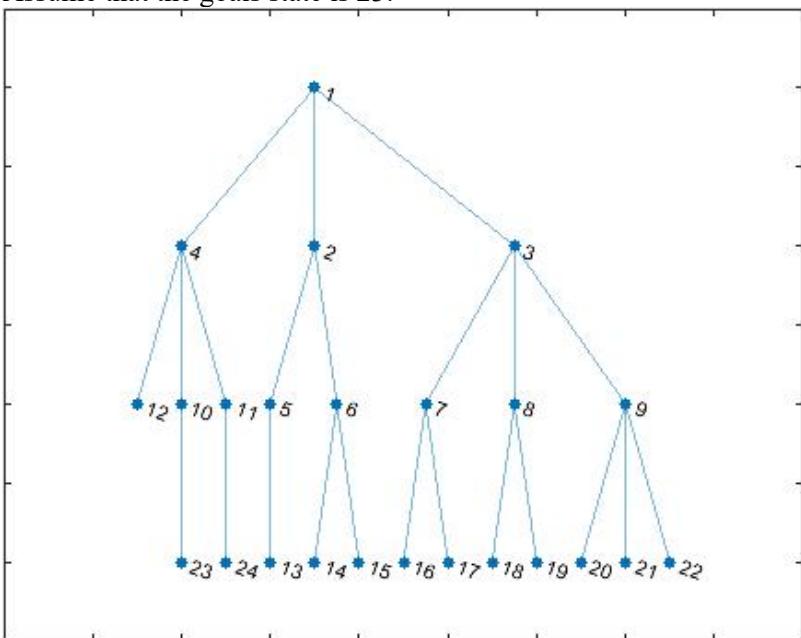
The number of visited states is 13.

## Question 24

Given the following search graph and adopting *best-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 23.



Node ID	Node Heuristic value
1	13
2	10
3	13
4	11
5	13
6	11
7	14
8	10
9	20
10	4
11	2
12	2
13	1
14	8
15	9
16	7

17	15
18	13
19	15
20	19
21	19
22	4
23	3
24	14

Answer:

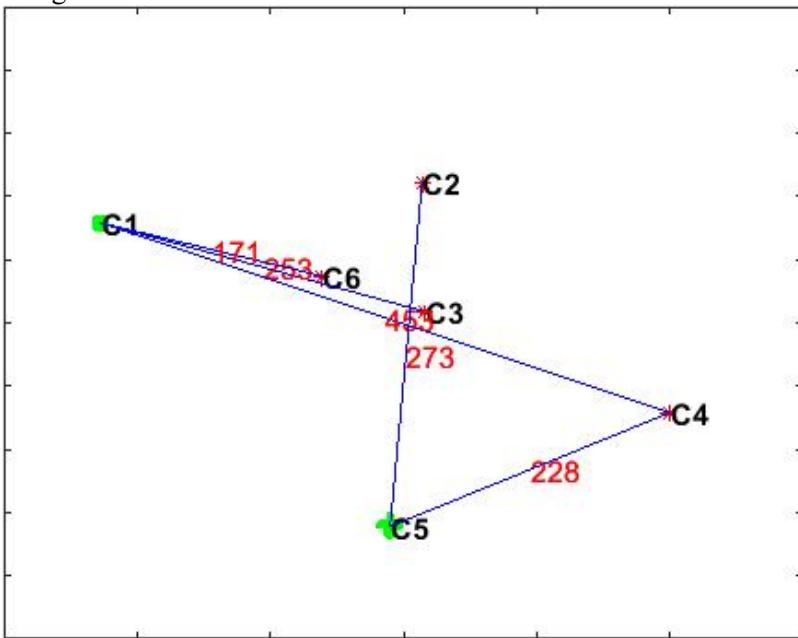
1,	{1},
2,4,3,	{1,2},{1,4},{1,3},
6,5,4,3,	{1,2,6},{1,2,5},{1,4},{1,3},
14,15,5,4,3,	{1,2,6,14},{1,2,6,15},{1,2,5},{1,4},{1,3},
15,5,4,3,	{1,2,6,15},{1,2,5},{1,4},{1,3},
5,4,3,	{1,2,5},{1,4},{1,3},
13,4,3,	{1,2,5,13},{1,4},{1,3},
4,3,	{1,4},{1,3},
11,12,10,3,	{1,4,11},{1,4,12},{1,4,10},{1,3},
24,12,10,3,	{1,4,11,24},{1,4,12},{1,4,10},{1,3},
12,10,3,	{1,4,12},{1,4,10},{1,3},
10,3,	{1,4,10},{1,3},
23,3,	{1,4,10,23},{1,3},

Path found: 1-4-10-23-

The number of visited states is 13.

## Question 25

Given the following search graph, write the sequence of node numbers in the search agenda across the search life-time and using *A\** search.



Assume the following heuristic value per node:

Node ID	Node Heuristic value
1	0
2	243
3	253
4	453
5	324
6	171

Assume distance between cities are as mentioned on the links

Apply A\* algorithm showing intermediate values for the Agenda,  $g(n)$ ,  $h(n)$

Source city is :C5

Destination city:C1

Answer:

		<b>iteration 1</b>				
states		5				
$g(n)$		0				
$h(n)$		324				
$g(n)+h(n)$		324				
visited?		0				

		<b>iteration 2</b>				
states	5		2	4		
$g(n)$	0		273	228		
$h(n)$	324		243	453		
$g(n)+h(n)$	324		516	681		
visited?	1		0	0		

		<b>iteration 3</b>				
states	5		2	4	5	
$g(n)$	0		273	228	546	
$h(n)$	324		243	453	324	
$g(n)+h(n)$	324		516	681	870	
visited?	1		1	0	0	

		<b>iteration 4</b>				
states	5		2	4	5	1
$g(n)$	0		273	228	546	681
$h(n)$	324		243	453	324	0
$g(n)+h(n)$	324		516	681	870	681
visited?	1		1	1	0	0

Final path:5-4-1-

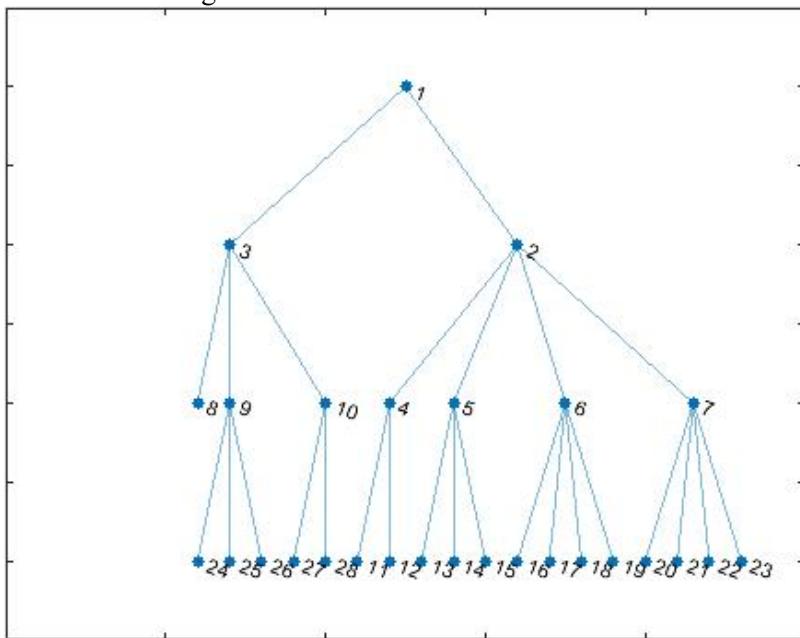
## Question 27

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.

2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 27.



**Answer:**

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

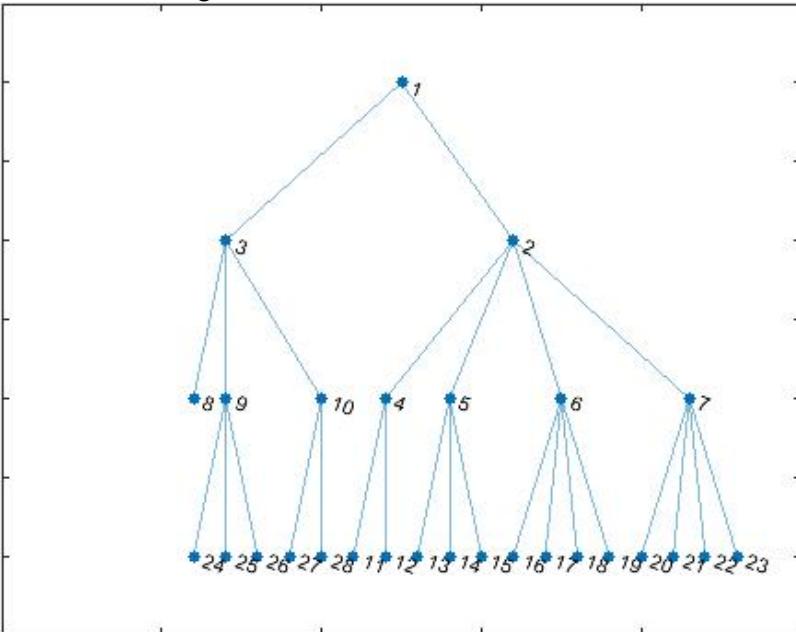
27,28,	{1,3,10,27,}, {1,3,10,28,},
--------	-----------------------------

Path found: 1-3-10-27-

The number of visited states is 27. Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 27.



Answer:

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

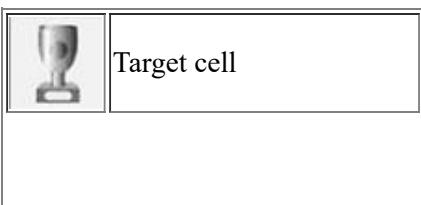
	{1,2,4,12,},{1,2,5,13,},{1,2,5,14,},{1,2,5,15,},{1,2,6,16,}, {1,2,6,17,},{1,2,6,18,},{1,2,6,19,},{1,2,7,20,},{1,2,7,21,}, {1,2,7,22,},{1,2,7,23,},{1,3,9,24,},{1,3,9,25,},{1,3,9,26,}, {1,3,10,27,},{1,3,10,28,},
13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,	{1,2,5,13,},{1,2,5,14,},{1,2,5,15,},{1,2,6,16,},{1,2,6,17,},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

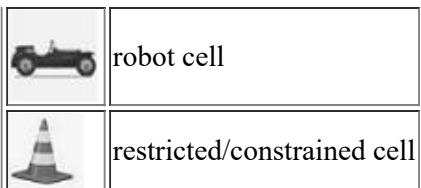
Path found:1-3-10-27-

The number of visited states is 27.

## Question 28

Having the following grid and the depicted agent at location (x=4,y=4) and a target object located at (x=7,y=3)  
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 the grid.  
Assume Euclidian distance from the current location to the target location as the heuristic value.





## Answer

(row=1,col=1) <b>1</b>	(row=1,col=2) <b>8</b>	(row=1,col=3) <b>15</b>	(row=1,col=4) <b>22</b>	(row=1,col=5) <b>29</b> 	(row=1,col=6) <b>36</b>	(row=1,col=7) <b>43</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>9</b>	(row=2,col=3) <b>16</b>	(row=2,col=4) <b>23</b>	(row=2,col=5) <b>30</b>	(row=2,col=6) <b>37</b> 	(row=2,col=7) <b>44</b>
(row=3,col=1) <b>3</b>	(row=3,col=2) <b>10</b>	(row=3,col=3) <b>17</b>	(row=3,col=4) <b>24</b>	(row=3,col=5) <b>31</b>	(row=3,col=6) <b>38</b>	(row=3,col=7) <b>45</b> 
(row=4,col=1) <b>4</b>	(row=4,col=2) <b>11</b>	(row=4,col=3) <b>18</b>	(row=4,col=4) <b>25</b> 	(row=4,col=5) <b>32</b>	(row=4,col=6) <b>39</b>	(row=4,col=7) <b>46</b>
(row=5,col=1) <b>5</b>	(row=5,col=2) <b>12</b>	(row=5,col=3) <b>19</b>	(row=5,col=4) <b>26</b>	(row=5,col=5) <b>33</b>	(row=5,col=6) <b>40</b>	(row=5,col=7) <b>47</b>
(row=6,col=1) <b>6</b>	(row=6,col=2) <b>13</b> 	(row=6,col=3) <b>20</b>	(row=6,col=4) <b>27</b>	(row=6,col=5) <b>34</b>	(row=6,col=6) <b>41</b>	(row=6,col=7) <b>48</b>
(row=7,col=1) <b>7</b>	(row=7,col=2) <b>14</b>	(row=7,col=3) <b>21</b>	(row=7,col=4) <b>28</b>	(row=7,col=5) <b>35</b>	(row=7,col=6) <b>42</b> 	(row=7,col=7) <b>49</b>

states	25											
H	3.16											
states	32	24	26	18								
H	2.24	3.00	3.61	4.12								
states	39	31	33	25	24	26	18					
H	1.41	2.00	2.83	3.16	3.00	3.61	4.12					
states	38	46	40	32	31	33	25	24	26	18		
H	1.00	1.00	2.24	2.24	2.00	2.83	3.16	3.00	3.61	4.12		
states	45	39	31	46	40	32	31	33	25	24	26	18
H	0.00	1.41	2.00	1.00	2.24	2.24	2.00	2.83	3.16	3.00	3.61	4.12

(row=1,col=1) <b>1</b>	(row=1,col=2) <b>8</b>	(row=1,col=3) <b>15</b>	(row=1,col=4) <b>22</b>	(row=1,col=5) <b>29</b> 	(row=1,col=6) <b>36</b>	(row=1,col=7) <b>43</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>9</b>	(row=2,col=3) <b>16</b>	(row=2,col=4) <b>23</b>	(row=2,col=5) <b>30</b>	(row=2,col=6) <b>37</b>	(row=2,col=7) <b>44</b>

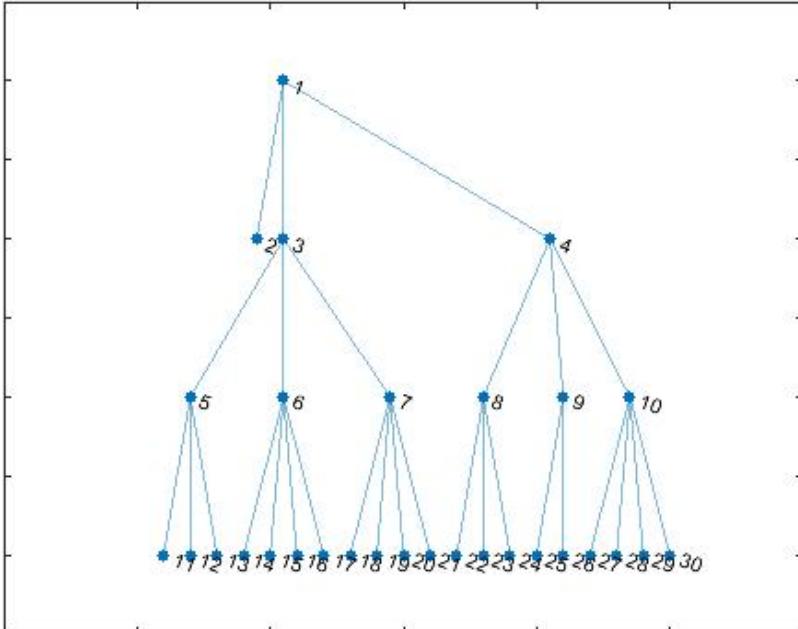
						
(row=3,col=1) 3	(row=3,col=2) 10	(row=3,col=3) 17	(row=3,col=4) 24	(row=3,col=5) 31	(row=3,col=6) 38 	(row=3,col=7) 45 
(row=4,col=1) 4	(row=4,col=2) 11	(row=4,col=3) 18	(row=4,col=4) 25 	(row=4,col=5) 32 	(row=4,col=6) 39 	(row=4,col=7) 46
(row=5,col=1) 5	(row=5,col=2) 12	(row=5,col=3) 19	(row=5,col=4) 26	(row=5,col=5) 33	(row=5,col=6) 40	(row=5,col=7) 47
(row=6,col=1) 6	(row=6,col=2) 13 	(row=6,col=3) 20	(row=6,col=4) 27	(row=6,col=5) 34	(row=6,col=6) 41	(row=6,col=7) 48
(row=7,col=1) 7	(row=7,col=2) 14	(row=7,col=3) 21	(row=7,col=4) 28	(row=7,col=5) 35	(row=7,col=6) 42 	(row=7,col=7) 49

## Question 29

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 23.



Answer:

1,	{1,},
2,3,4,	{1,2,},{1,3,},{1,4,},



	$\{1,4,9,26,\}, \{1,4,10,27,\}, \{1,4,10,28,\}, \{1,4,10,29,\}, \{1,4,10,30,\}$
--	---

19,20,21,22,23,24,25,26,27,28,29,30,	$\{1,3,7,19,\}, \{1,3,7,20,\}, \{1,3,7,21,\}, \{1,4,8,22,\}, \{1,4,8,23,\}, \{1,4,8,24,\}, \{1,4,9,25,\}, \{1,4,9,26,\}, \{1,4,10,27,\}, \{1,4,10,28,\}, \{1,4,10,29,\}, \{1,4,10,30,\}$
--------------------------------------	--

20,21,22,23,24,25,26,27,28,29,30,	$\{1,3,7,20,\}, \{1,3,7,21,\}, \{1,4,8,22,\}, \{1,4,8,23,\}, \{1,4,8,24,\}, \{1,4,9,25,\}, \{1,4,9,26,\}, \{1,4,10,27,\}, \{1,4,10,28,\}, \{1,4,10,29,\}, \{1,4,10,30,\}$
-----------------------------------	---

21,22,23,24,25,26,27,28,29,30,	$\{1,3,7,21,\}, \{1,4,8,22,\}, \{1,4,8,23,\}, \{1,4,8,24,\}, \{1,4,9,25,\}, \{1,4,9,26,\}, \{1,4,10,27,\}, \{1,4,10,28,\}, \{1,4,10,29,\}, \{1,4,10,30,\}$
--------------------------------	--

22,23,24,25,26,27,28,29,30,	$\{1,4,8,22,\}, \{1,4,8,23,\}, \{1,4,8,24,\}, \{1,4,9,25,\}, \{1,4,9,26,\}, \{1,4,10,27,\}, \{1,4,10,28,\}, \{1,4,10,29,\}, \{1,4,10,30,\}$
-----------------------------	---

23,24,25,26,27,28,29,30,	$\{1,4,8,23,\}, \{1,4,8,24,\}, \{1,4,9,25,\}, \{1,4,9,26,\}, \{1,4,10,27,\}, \{1,4,10,28,\}, \{1,4,10,29,\}, \{1,4,10,30,\}$
--------------------------	--

Path found: 1-4-8-23-

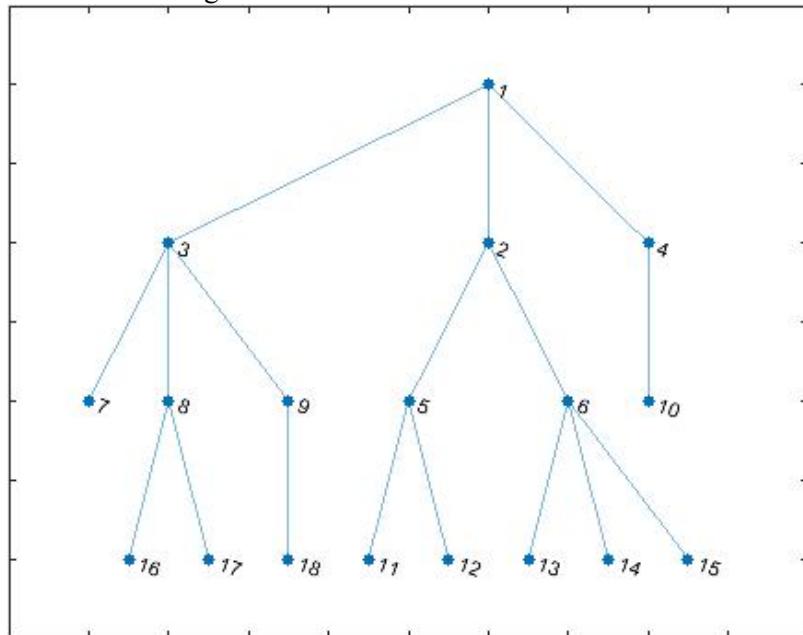
The number of visited states is 23.

## Question 30

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 13.



Answer:

1,	$\{1,\}$
2,3,4,	$\{1,2,\}, \{1,3,\}, \{1,4,\},$
5,6,3,4,	$\{1,2,5,\}, \{1,2,6,\}, \{1,3,\}, \{1,4,\},$
11,12,6,3,4,	$\{1,2,5,11,\}, \{1,2,5,12,\}, \{1,2,6,\}, \{1,3,\}, \{1,4,\},$
12,6,3,4,	$\{1,2,5,12,\}, \{1,2,6,\}, \{1,3,\}, \{1,4,\},$
6,3,4,	$\{1,2,6,\}, \{1,3,\}, \{1,4,\},$

13,14,15,3,4,	{1,2,6,13,}, {1,2,6,14,}, {1,2,6,15,}, {1,3,}, {1,4,},
---------------	--

Path found:1-2-6-13-

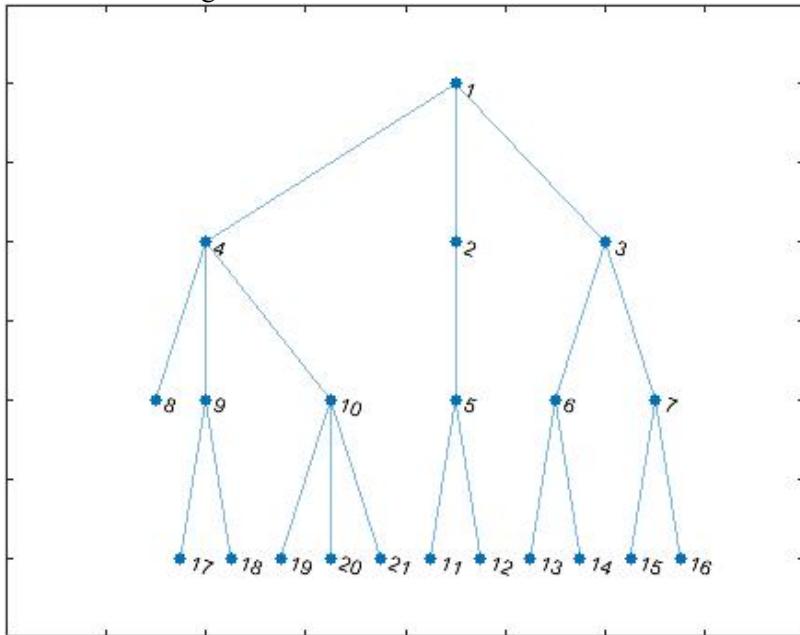
The number of visited states is 7.

## Question 31

Given the following search graph and adopting *best-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 18.



Node ID	Node Heuristic value
1	5
2	4
3	11
4	13
5	8
6	4
7	19
8	2
9	2
10	3
11	3
12	12
13	11
14	1
15	19
16	15
17	15
18	1

19	17
20	19
21	20

**Answer:**

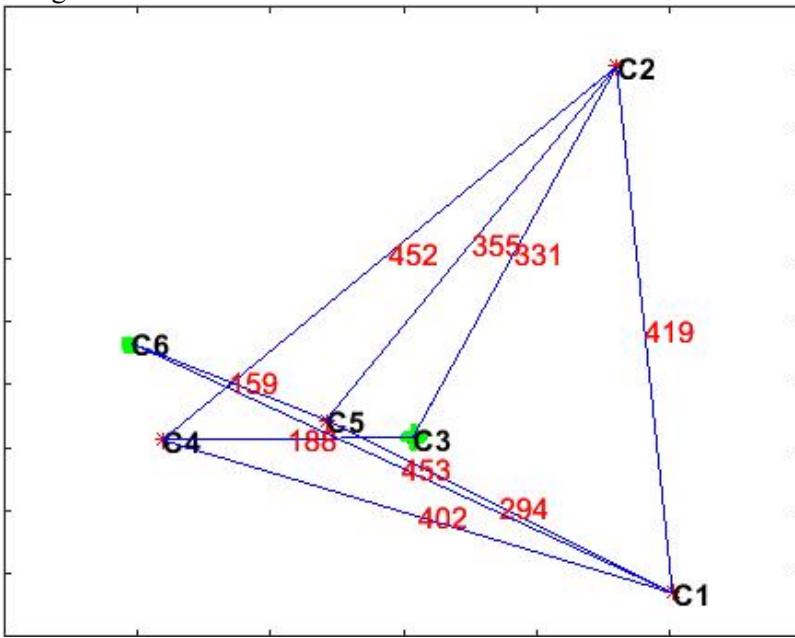
1,	{1,},
2,3,4,	{1,2,},{1,3,},{1,4,},
5,3,4,	{1,2,5,},{1,3,},{1,4,},
11,12,3,4,	{1,2,5,11,},{1,2,5,12,},{1,3,},{1,4,},
12,3,4,	{1,2,5,12,},{1,3,},{1,4,},
3,4,	{1,3,},{1,4,},
6,7,4,	{1,3,6,},{1,3,7,},{1,4,},
14,13,7,4,	{1,3,6,14,},{1,3,6,13,},{1,3,7,},{1,4,},
13,7,4,	{1,3,6,13,},{1,3,7,},{1,4,},
7,4,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

Path found: 1-4-9-18-

The number of visited states is 16.

## Question 32

Given the following search graph, write the sequence of node numbers in the search agenda across the search life-time and using *A\* search*.



Assume the following heuristic value per node:

Node ID	Node Heuristic value
1	453

2	426
3	225
4	81
5	159
6	0

Assume distance between cities are as mentioned on the links

Apply A\* algorithm showing intermediate values for the Agenda,  $g(n)$ ,  $h(n)$

Source city is :C3

Destination city:C6

Answer:

		<b>iteration 1</b>						
states		3						
$g(n)$		0						
$h(n)$		225						
$g(n)+h(n)$		225						
visited?		0						
		<b>iteration 2</b>						
states	3		2	4				
$g(n)$	0		331	188	590	640	376	
$h(n)$	225		426	81	453	426	225	
$g(n)+h(n)$	225		757	269	1042	1065	601	
visited?	1		0	0	0	0	0	
		<b>iteration 3</b>						
states	3		2	4	1	2	3	
$g(n)$	0		331	188	590	640	376	
$h(n)$	225		426	81	453	426	225	
$g(n)+h(n)$	225		757	269	1042	1065	601	
visited?	1		0	1	0	0	0	
		<b>iteration 4</b>						
states	3		2	4	1	2	3	2
$g(n)$	0		331	188	590	640	376	707
$h(n)$	225		426	81	453	426	225	426
$g(n)+h(n)$	225		757	269	1042	1065	601	1133
visited?	1		0	1	0	0	1	0
		<b>iteration 5</b>						
states	3	2	4	1	2	3	2	4
$g(n)$	0	331	188	590	640	376	707	564
$h(n)$	225	426	81	453	426	225	426	81
$g(n)+h(n)$	225	757	269	1042	1065	601	1133	645
visited?	1	0	1	0	0	1	0	0
		<b>iteration 6</b>						
states	3	2	4	1	2	3	2	3

g(n)	0	331	188	590	640	376	707	564	966	1016	752	751	663	783	686
h(n)	225	426	81	453	426	225	426	81	453	426	225	453	225	81	159
g(n)+h(n)	225	757	269	1042	1065	601	1133	645	1418	1441	977	1203	888	864	845
visited?	1	1	1	0	0	1	0	1	0	0	0	0	0	0	0

	iteration 7															
states	3	2	4	1	2	3	2	4	1	2	3	1	3	4	5	1
g(n)	0	331	188	590	640	376	707	564	966	1016	752	751	663	783	686	980
h(n)	225	426	81	453	426	225	426	81	453	426	225	453	225	81	159	453
g(n)+h(n)	225	757	269	1042	1065	601	1133	645	1418	1441	977	1203	888	864	845	1433
visited?	1	1	1	0	0	1	0	1	0	0	0	0	0	0	1	0

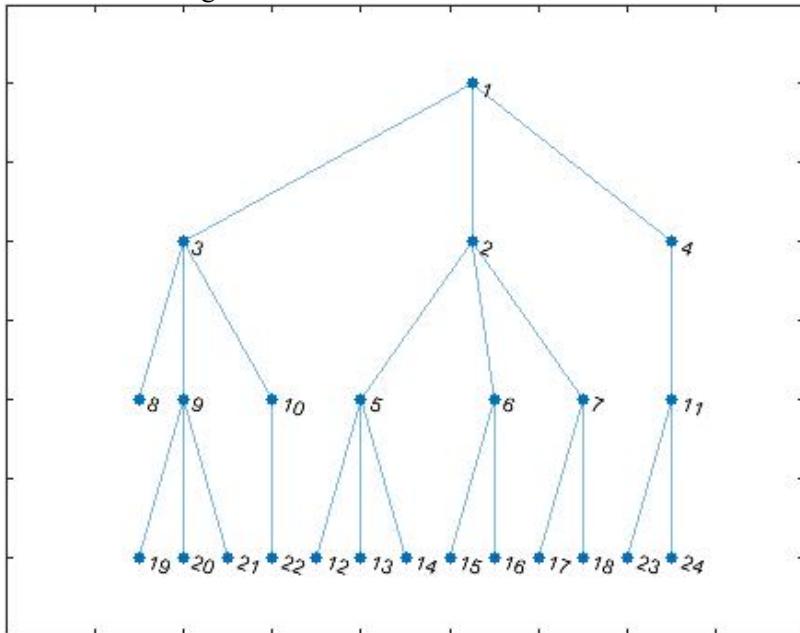
Final path: 3-2-5-6-

## Question 34

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 20.



Answer:

1,	{1},
2,3,4,	{1,2},{1,3},{1,4},
5,6,7,3,4,	{1,2,5},{1,2,6},{1,2,7},{1,3},{1,4},
12,13,14,6,7,3,4,	{1,2,5,12},{1,2,5,13},{1,2,5,14},{1,2,6},{1,2,7},{1,3},{1,4},
13,14,6,7,3,4,	{1,2,5,13},{1,2,5,14},{1,2,6},{1,2,7},{1,3},{1,4},
14,6,7,3,4,	{1,2,5,14},{1,2,6},{1,2,7},{1,3},{1,4},
6,7,3,4,	{1,2,6},{1,2,7},{1,3},{1,4},
15,16,7,3,4,	{1,2,6,15},{1,2,6,16},{1,2,7},{1,3},{1,4},

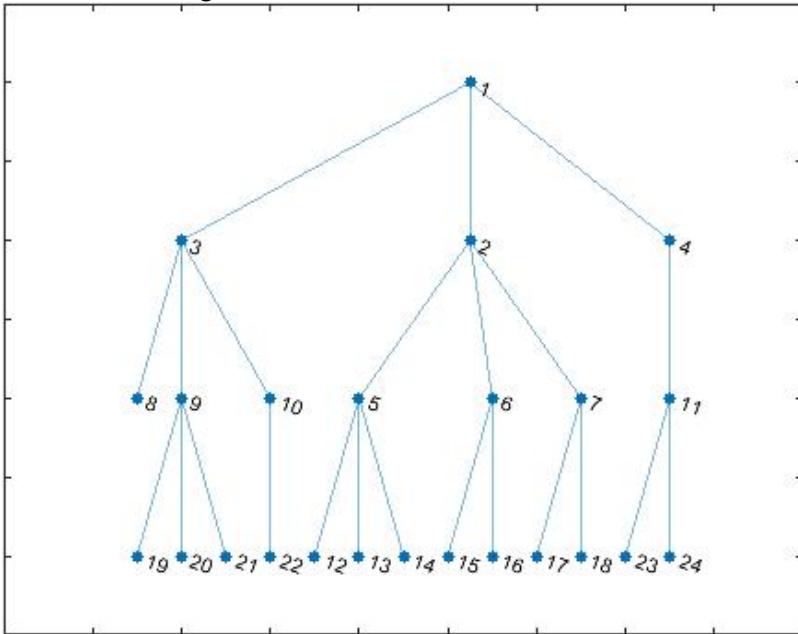
16,7,3,4,	$\{1,2,6,16,\}, \{1,2,7,\}, \{1,3,\}, \{1,4,\},$
7,3,4,	$\{1,2,7,\}, \{1,3,\}, \{1,4,\},$
17,18,3,4,	$\{1,2,7,17,\}, \{1,2,7,18,\}, \{1,3,\}, \{1,4,\},$
18,3,4,	$\{1,2,7,18,\}, \{1,3,\}, \{1,4,\},$
3,4,	$\{1,3,\}, \{1,4,\},$
8,9,10,4,	$\{1,3,8,\}, \{1,3,9,\}, \{1,3,10,\}, \{1,4,\},$
9,10,4,	$\{1,3,9,\}, \{1,3,10,\}, \{1,4,\},$
19,20,21,10,4,	$\{1,3,9,19,\}, \{1,3,9,20,\}, \{1,3,9,21,\}, \{1,3,10,\}, \{1,4,\},$
20,21,10,4,	$\{1,3,9,20,\}, \{1,3,9,21,\}, \{1,3,10,\}, \{1,4,\},$

Path found: 1-3-9-20-

The number of visited states is 17. Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 20.



Answer:

1,	$\{1\},$
2,3,4,	$\{1,2,\}, \{1,3,\}, \{1,4,\},$
3,4,5,6,7,	$\{1,3,\}, \{1,4,\}, \{1,2,5,\}, \{1,2,6,\}, \{1,2,7,\},$
4,5,6,7,8,9,10,	$\{1,4,\}, \{1,2,5,\}, \{1,2,6,\}, \{1,2,7,\}, \{1,3,8,\}, \{1,3,9,\}, \{1,3,10,\},$
5,6,7,8,9,10,11,	$\{1,2,5,\}, \{1,2,6,\}, \{1,2,7,\}, \{1,3,8,\}, \{1,3,9,\}, \{1,3,10,\}, \{1,4,11,\},$
6,7,8,9,10,11,12,13,14,	$\{1,2,6,\}, \{1,2,7,\}, \{1,3,8,\}, \{1,3,9,\}, \{1,3,10,\}, \{1,4,11,\}, \{1,2,5,12,\}, \{1,2,5,13,\}, \{1,2,5,14,\},$
7,8,9,10,11,12,13,14,15,16,	$\{1,2,7,\}, \{1,3,8,\}, \{1,3,9,\}, \{1,3,10,\}, \{1,4,11,\}, \{1,2,5,12,\}, \{1,2,5,13,\}, \{1,2,5,14,\}, \{1,2,5,15,\}, \{1,2,6,15,\}, \{1,2,6,16,\},$
8,9,10,11,12,13,14,15,16,17,18,	$\{1,3,8,\}, \{1,3,9,\}, \{1,3,10,\}, \{1,4,11,\}, \{1,2,5,12,\}, \{1,2,5,13,\}, \{1,2,5,14,\}, \{1,2,6,15,\}, \{1,2,6,16,\}, \{1,2,6,17,\}, \{1,2,7,17,\}, \{1,2,7,18,\},$
9,10,11,12,13,14,15,16,17,18,	$\{1,3,9,\}, \{1,3,10,\}, \{1,4,11,\}, \{1,2,5,12,\}, \{1,2,5,13,\}, \{1,2,5,14,\}, \{1,2,6,15,\}, \{1,2,6,16,\}, \{1,2,6,17,\}, \{1,2,7,17,\}, \{1,2,7,18,\},$
10,11,12,13,14,15,16,17,18,19,20,21,	$\{1,3,10,\}, \{1,4,11,\}, \{1,2,5,12,\}, \{1,2,5,13,\}, \{1,2,5,14,\}, \{1,2,6,15,\}, \{1,2,6,16,\}, \{1,2,6,17,\}, \{1,2,7,18,\}, \{1,3,9,19,\}, \{1,3,9,20,\}, \{1,3,9,21,\},$

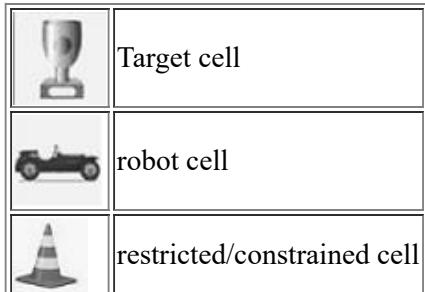
11,12,13,14,15,16,17,18,19,20,21,22,	$\{1,4,11\}, \{1,2,5,12\}, \{1,2,5,13\}, \{1,2,5,14\}, \{1,2,6,15\}, \{1,2,6,16\},$ $\{1,2,7,17\}, \{1,2,7,18\}, \{1,3,9,19\}, \{1,3,9,20\}, \{1,3,9,21\}, \{1,3,10,22\},$
12,13,14,15,16,17,18,19,20,21,22,23,24,	$\{1,2,5,12\}, \{1,2,5,13\}, \{1,2,5,14\}, \{1,2,6,15\}, \{1,2,6,16\}, \{1,2,7,17\},$ $\{1,2,7,18\}, \{1,3,9,19\}, \{1,3,9,20\}, \{1,3,9,21\}, \{1,3,10,22\}, \{1,4,11,23\},$ $\{1,4,11,24\},$
13,14,15,16,17,18,19,20,21,22,23,24,	$\{1,2,5,13\}, \{1,2,5,14\}, \{1,2,6,15\}, \{1,2,6,16\}, \{1,2,7,17\}, \{1,2,7,18\},$ $\{1,3,9,19\}, \{1,3,9,20\}, \{1,3,9,21\}, \{1,3,10,22\}, \{1,4,11,23\}, \{1,4,11,24\},$
14,15,16,17,18,19,20,21,22,23,24,	$\{1,2,5,14\}, \{1,2,6,15\}, \{1,2,6,16\}, \{1,2,7,17\}, \{1,2,7,18\}, \{1,3,9,19\},$ $\{1,3,9,20\}, \{1,3,9,21\}, \{1,3,10,22\}, \{1,4,11,23\}, \{1,4,11,24\},$
15,16,17,18,19,20,21,22,23,24,	$\{1,2,6,15\}, \{1,2,6,16\}, \{1,2,7,17\}, \{1,2,7,18\}, \{1,3,9,19\}, \{1,3,9,20\},$ $\{1,3,9,21\}, \{1,3,10,22\}, \{1,4,11,23\}, \{1,4,11,24\},$
16,17,18,19,20,21,22,23,24,	$\{1,2,6,16\}, \{1,2,7,17\}, \{1,2,7,18\}, \{1,3,9,19\}, \{1,3,9,20\}, \{1,3,9,21\},$ $\{1,3,10,22\}, \{1,4,11,23\}, \{1,4,11,24\},$
17,18,19,20,21,22,23,24,	$\{1,2,7,17\}, \{1,2,7,18\}, \{1,3,9,19\}, \{1,3,9,20\}, \{1,3,9,21\}, \{1,3,10,22\},$ $\{1,4,11,23\}, \{1,4,11,24\},$
18,19,20,21,22,23,24,	$\{1,2,7,18\}, \{1,3,9,19\}, \{1,3,9,20\}, \{1,3,9,21\}, \{1,3,10,22\}, \{1,4,11,23\},$ $\{1,4,11,24\},$
19,20,21,22,23,24,	$\{1,3,9,19\}, \{1,3,9,20\}, \{1,3,9,21\}, \{1,3,10,22\}, \{1,4,11,23\}, \{1,4,11,24\},$
20,21,22,23,24,	$\{1,3,9,20\}, \{1,3,9,21\}, \{1,3,10,22\}, \{1,4,11,23\}, \{1,4,11,24\},$

Path found: 1-3-9-20-

The number of visited states is 20.

## Question 35

Having the following grid and the depicted agent at location (x=6,y=3) and a target object located at (x=5,y=5)  
 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 the grid.  
 Assume Euclidian distance from the current location to the target location as the heuristic value.



Answer

(row=1,col=1) 1	(row=1,col=2) 7	(row=1,col=3) 13	(row=1,col=4) 19	(row=1,col=5) 25	(row=1,col=6) 31
(row=2,col=1) 2 	(row=2,col=2) 8	(row=2,col=3) 14	(row=2,col=4) 20	(row=2,col=5) 26	(row=2,col=6) 32
(row=3,col=1) 3 	(row=3,col=2) 9	(row=3,col=3) 15	(row=3,col=4) 21	(row=3,col=5) 27 	(row=3,col=6) 33 
(row=4,col=1) 4	(row=4,col=2) 10	(row=4,col=3) 16	(row=4,col=4) 22	(row=4,col=5) 28	(row=4,col=6) 34



(row=5,col=1) <b>5</b>	(row=5,col=2) <b>11</b>	(row=5,col=3) <b>17</b>	(row=5,col=4) <b>23</b>	(row=5,col=5) <b>29</b> 	(row=5,col=6) <b>35</b>
(row=6,col=1) <b>6</b>	(row=6,col=2) <b>12</b>	(row=6,col=3) <b>18</b>	(row=6,col=4) <b>24</b>	(row=6,col=5) <b>30</b>	(row=6,col=6) <b>36</b>

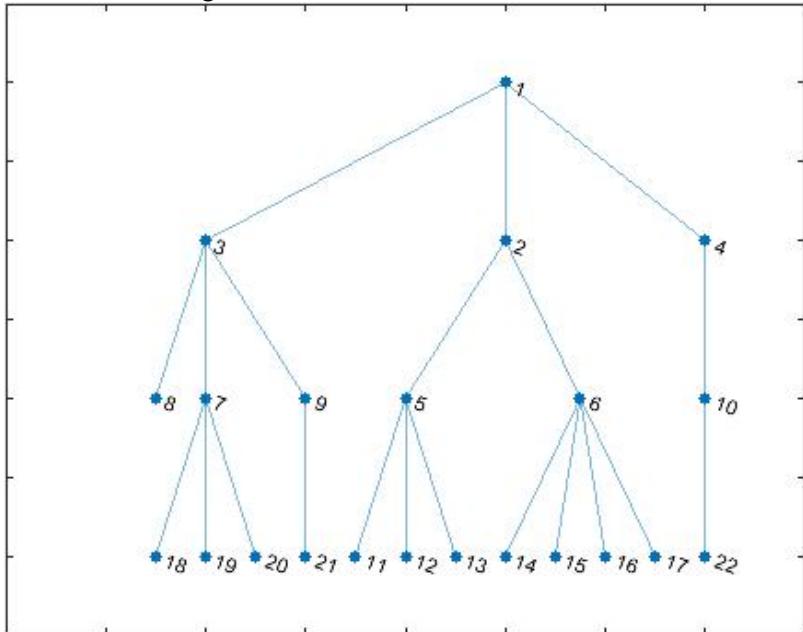
states	33	26	31	26	31	26	31	26	31	26	31	26	31	26	31	26	31	26	31
H	2.24	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12
states	32	26	31	26	31	26	31	26	31	26	31	26	31	26	31	26	31	26	31
H	3.16	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12
states	33	26	31	26	31	26	31	26	31	26	31	26	31	26	31	26	31	26	31
H	2.24	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12
states	32	26	31	26	31	26	31	26	31	26	31	26	31	26	31	26	31	26	31
H	3.16	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12	3.00	4.12
(row=1,col=1) 1																			
	7																		
(row=2,col=1) 2																			
																			
(row=3,col=1) 3																			
																			
(row=4,col=1) 4																			
																			
(row=5,col=1) 5																			
	11																		
(row=6,col=1) 6																			
	12																		
(row=1,col=2)																			
	13																		
(row=2,col=2)																			
	8																		
(row=3,col=2)																			
	9																		
(row=4,col=2)																			
	10																		
(row=5,col=2)																			
	11																		
(row=1,col=3)																			
	13																		
(row=2,col=3)																			
	14																		
(row=3,col=3)																			
	15																		
(row=4,col=3)																			
	16																		
(row=5,col=3)																			
	17																		
(row=1,col=4)																			
	19																		
(row=2,col=4)																			
	20																		
(row=3,col=4)																			
	21																		
(row=4,col=4)																			
	22																		
(row=5,col=4)																			
	23																		
(row=1,col=5)																			
	25																		
(row=2,col=5)																			
	26																		
(row=3,col=5)																			
	27																		
(row=4,col=5)																			
	28																		
(row=5,col=5)																			
	29																		
(row=1,col=6)																			
	31																		
(row=2,col=6)																			
	32																		
(row=3,col=6)																			
	33																		
(row=4,col=6)																			
	34																		
(row=5,col=6)																			
	35																		
(row=6,col=6)																			
	36																		

## Question 36

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 18.



**Answer:**

1,	{1},
2,3,4,	{1,2,},{1,3,},{1,4,},
3,4,5,6,	{1,3,},{1,4,},{1,2,5,},{1,2,6,},
4,5,6,7,8,9,	{1,4,},{1,2,5,},{1,2,6,},{1,3,7,},{1,3,8,},{1,3,9,},
5,6,7,8,9,10,	{1,2,5,},{1,2,6,},{1,3,7,},{1,3,8,},{1,3,9,},{1,4,10,},
6,7,8,9,10,11,12,13,	{1,2,6,},{1,3,7,},{1,3,8,},{1,3,9,},{1,4,10,},{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},
7,8,9,10,11,12,13,14,15,16,17,	{1,3,7,},{1,3,8,},{1,3,9,},{1,4,10,},{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},{1,2,6,14,}, {1,2,6,15,},{1,2,6,16,},{1,2,6,17,},
8,9,10,11,12,13,14,15,16,17,18,19,20,	{1,3,8,},{1,3,9,},{1,4,10,},{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},{1,2,6,14,}, {1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,3,7,18,},{1,3,7,19,},{1,3,7,20,},
9,10,11,12,13,14,15,16,17,18,19,20,	{1,3,9,},{1,4,10,},{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},{1,2,6,14,},{1,2,6,15,}, {1,2,6,16,},{1,2,6,17,},{1,3,7,18,},{1,3,7,19,},{1,3,7,20,},
10,11,12,13,14,15,16,17,18,19,20,21,	{1,4,10,},{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,}, {1,2,6,17,},{1,3,7,18,},{1,3,7,19,},{1,3,7,20,},{1,3,9,21,},
11,12,13,14,15,16,17,18,19,20,21,22,	{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,6,17,}, {1,3,7,18,},{1,3,7,19,},{1,3,7,20,},{1,3,9,21,},{1,4,10,22,},
12,13,14,15,16,17,18,19,20,21,22,	{1,2,5,12,},{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,3,7,18,}, {1,3,7,19,},{1,3,7,20,},{1,3,9,21,},{1,4,10,22,},
13,14,15,16,17,18,19,20,21,22,	{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,3,7,18,},{1,3,7,19,}, {1,3,7,20,},{1,3,9,21,},{1,4,10,22,},
14,15,16,17,18,19,20,21,22,	{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,3,7,18,},{1,3,7,19,},{1,3,7,20,}, {1,3,9,21,},{1,4,10,22,},
15,16,17,18,19,20,21,22,	{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,3,7,18,},{1,3,7,19,},{1,3,7,20,},{1,3,9,21,}, {1,4,10,22,},
16,17,18,19,20,21,22,	{1,2,6,16,},{1,2,6,17,},{1,3,7,18,},{1,3,7,19,},{1,3,7,20,},{1,3,9,21,}, {1,4,10,22,},
17,18,19,20,21,22,	{1,2,6,17,},{1,3,7,18,},{1,3,7,19,},{1,3,7,20,},{1,3,9,21,},{1,4,10,22,},
18,19,20,21,22,	{1,3,7,18,},{1,3,7,19,},{1,3,7,20,},{1,3,9,21,},{1,4,10,22,},

Path found: 1-3-7-18-

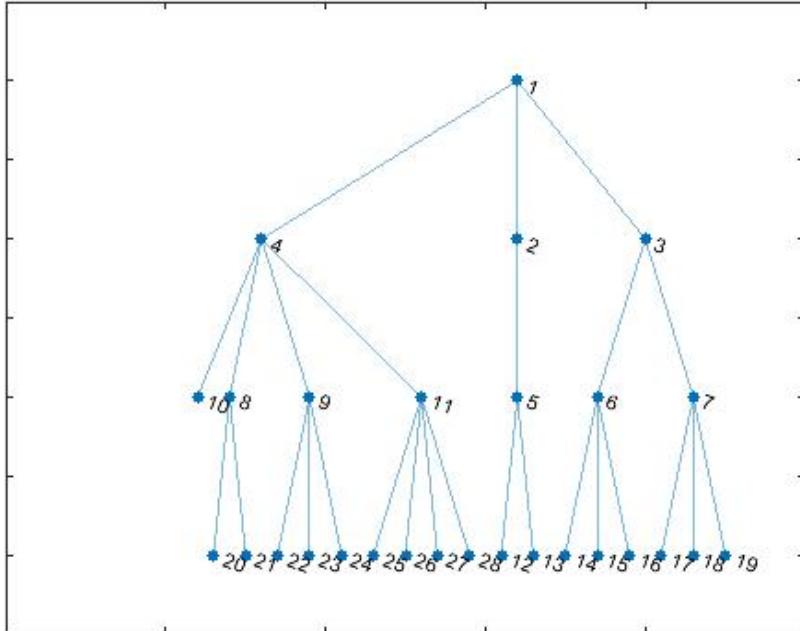
The number of visited states is 18.

## Question 37

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 16.



**Answer:**

1,	{1,},
2,3,4,	{1,2,},{1,3,},{1,4,},
5,3,4,	{1,2,5,},{1,3,},{1,4,},
12,13,3,4,	{1,2,5,12,},{1,2,5,13,},{1,3,},{1,4,},
13,3,4,	{1,2,5,13,},{1,3,},{1,4,},
3,4,	{1,3,},{1,4,},
6,7,4,	{1,3,6,},{1,3,7,},{1,4,},
14,15,16,7,4,	{1,3,6,14,},{1,3,6,15,},{1,3,6,16,},{1,3,7,},{1,4,},
15,16,7,4,	{1,3,6,15,},{1,3,6,16,},{1,3,7,},{1,4,},
16,7,4,	{1,3,6,16,},{1,3,7,},{1,4,},

Path found: 1-3-6-16-

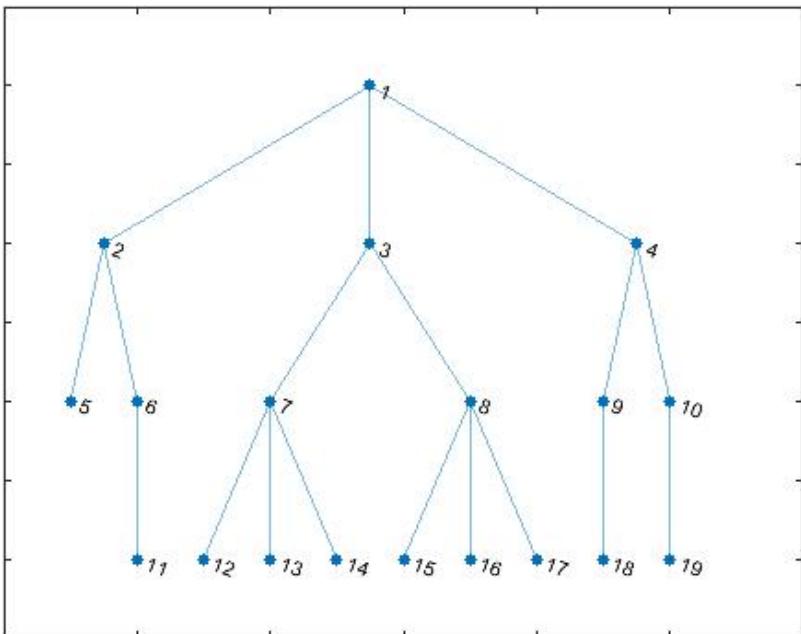
The number of visited states is 10.

## Question 38

Given the following search graph and adopting *best-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 9.



Node ID	Node Heuristic value
1	0
2	8
3	13
4	14
5	11
6	2
7	13
8	3
9	3
10	2
11	3
12	3
13	4
14	6
15	6
16	4
17	5
18	18
19	14

Answer:

1,	{1,},
2,3,4,	{1,2,},{1,3,},{1,4,},
6,5,3,4,	{1,2,6,},{1,2,5,},{1,3,},{1,4,},
11,5,3,4,	{1,2,6,11,},{1,2,5,},{1,3,},{1,4,},
5,3,4,	{1,2,5,},{1,3,},{1,4,},
3,4,	{1,3,},{1,4,},
8,7,4,	{1,3,8,},{1,3,7,},{1,4,},
16,17,15,7,4,	{1,3,8,16,},{1,3,8,17,},{1,3,8,15,},{1,3,7,},{1,4,},

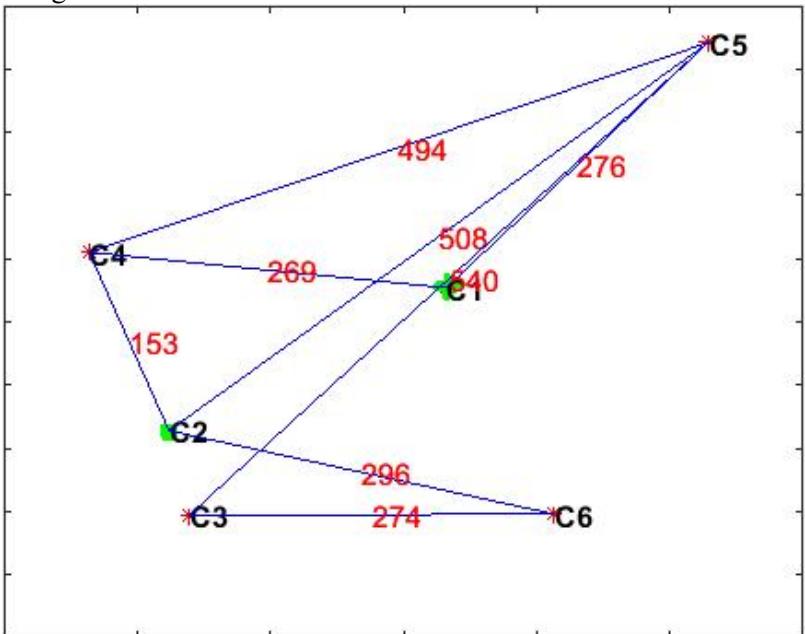
17,15,7,4,	{1,3,8,17},{1,3,8,15},{1,3,7},{1,4},
15,7,4,	{1,3,8,15},{1,3,7},{1,4},
7,4,	{1,3,7},{1,4},
12,13,14,4,	{1,3,7,12},{1,3,7,13},{1,3,7,14},{1,4},
13,14,4,	{1,3,7,13},{1,3,7,14},{1,4},
14,4,	{1,3,7,14},{1,4},
4,	{1,4},
10,9,	{1,4,10},{1,4,9},
19,9,	{1,4,10,19},{1,4,9},
9,	{1,4,9},

Path found: 1-4-9-

The number of visited states is 18.

## Question 39

Given the following search graph, write the sequence of node numbers in the search agenda across the search life-time and using *A\* search*.



Assume the following heuristic value per node:

Node ID	Node Heuristic value
1	237
2	0
3	69
4	153
5	508
6	296

Assume distance between cities are as mentioned on the links

Apply A\* algorithm showing intermediate values for the Agenda, g(n), h(n)

Source city is :C1

Destination city:C2

Answer:

	iteration 1
--	-------------

states	1		
g(n)	0		
h(n)	237		
g(n)+h(n)	237		
visited?	0		

		<b>iteration 2</b>				
states	1		4	5		
g(n)	0		269	276		
h(n)	237		153	508		
g(n)+h(n)	237		423	785		
visited?	1		0	0		

		<b>iteration 3</b>					
states	1		4	5	1	2	5
g(n)	0		269	276	539	423	763
h(n)	237		153	508	237	0	508
g(n)+h(n)	237		423	785	776	423	1271
visited?	1		1	0	0	0	0

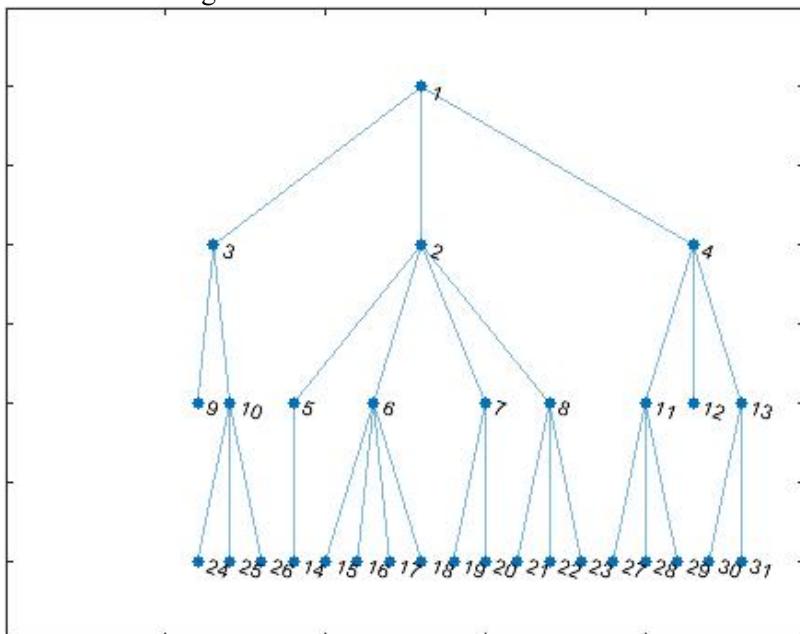
Final path: 1-4-2-

## Question 41

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 19.



Answer:

1,	{1,},
----	-------

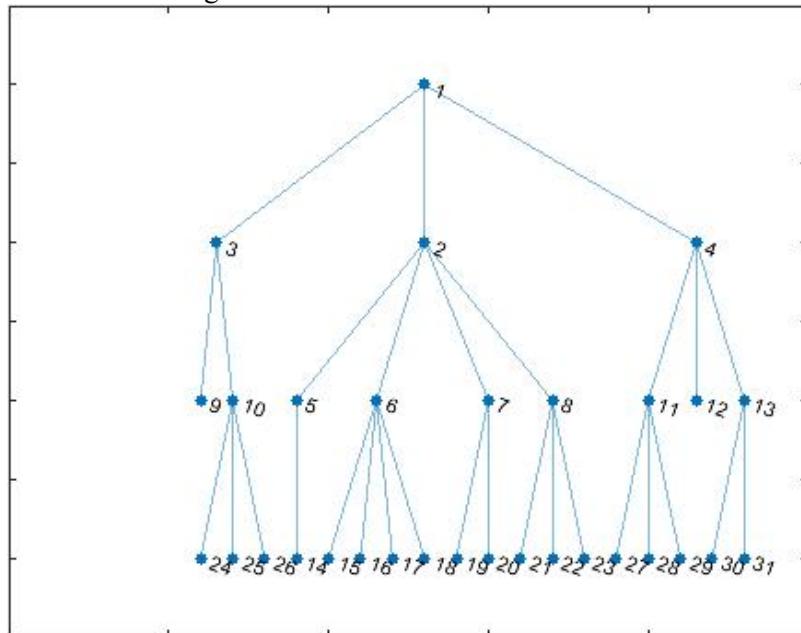
2,3,4,	{1,2,},{1,3,},{1,4,},
3,4,5,6,7,8,	{1,3,},{1,4,},{1,2,5,},{1,2,6,},{1,2,7,},{1,2,8,},
4,5,6,7,8,9,10,	{1,4,},{1,2,5,},{1,2,6,},{1,2,7,},{1,2,8,},{1,3,9,},{1,3,10,},
5,6,7,8,9,10,11,12,13,	{1,2,5,},{1,2,6,},{1,2,7,},{1,2,8,},{1,3,9,},{1,3,10,},{1,4,11,}, ,{1,4,12,},{1,4,13,},
6,7,8,9,10,11,12,13,14,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

**Path found:1-2-7-19-**

The number of visited states is 19. Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 19.



**Answer:**

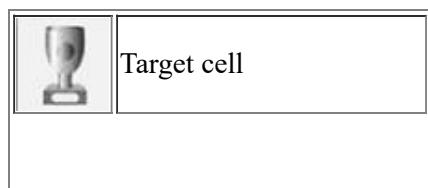
1,	{1,},
2,3,4,	{1,2,},{1,3,},{1,4,},
5,6,7,8,3,4,	{1,2,5,},{1,2,6,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
14,6,7,8,3,4,	{1,2,5,14,},{1,2,6,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
6,7,8,3,4,	{1,2,6,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
15,16,17,18,7,8,3,4,	{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,2,6,18,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
16,17,18,7,8,3,4,	{1,2,6,16,},{1,2,6,17,},{1,2,6,18,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
17,18,7,8,3,4,	{1,2,6,17,},{1,2,6,18,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
18,7,8,3,4,	{1,2,6,18,},{1,2,7,},{1,2,8,},{1,3,},{1,4,},
7,8,3,4,	{1,2,7,},{1,2,8,},{1,3,},{1,4,},
19,20,8,3,4,	{1,2,7,19,},{1,2,7,20,},{1,2,8,},{1,3,},{1,4,},

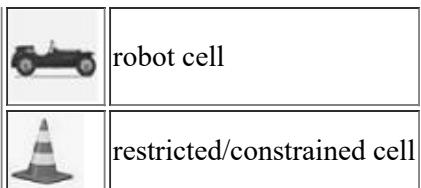
**Path found:1-2-7-19-**

The number of visited states is 11.

## Question 42

Having the following grid and the depicted agent at location (x=2,y=5) and a target object located at (x=1,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 the grid.  
 Assume Euclidian distance from the current location to the target location as the heuristic value.





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## Answer

(row=1,col=1) <b>1</b> 	(row=1,col=2) <b>7</b> 	(row=1,col=3) <b>13</b>	(row=1,col=4) <b>19</b>	(row=1,col=5) <b>25</b>	(row=1,col=6) <b>31</b>	(row=1,col=7) <b>37</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>8</b>	(row=2,col=3) <b>14</b>	(row=2,col=4) <b>20</b>	(row=2,col=5) <b>26</b>	(row=2,col=6) <b>32</b>	(row=2,col=7) <b>38</b>
(row=3,col=1) <b>3</b>	(row=3,col=2) <b>9</b>	(row=3,col=3) <b>15</b>	(row=3,col=4) <b>21</b>	(row=3,col=5) <b>27</b>	(row=3,col=6) <b>33</b>	(row=3,col=7) <b>39</b> 
(row=4,col=1) <b>4</b>	(row=4,col=2) <b>10</b>	(row=4,col=3) <b>16</b>	(row=4,col=4) <b>22</b>	(row=4,col=5) <b>28</b> 	(row=4,col=6) <b>34</b>	(row=4,col=7) <b>40</b> 
(row=5,col=1) <b>5</b>	(row=5,col=2) <b>11</b> 	(row=5,col=3) <b>17</b>	(row=5,col=4) <b>23</b>	(row=5,col=5) <b>29</b>	(row=5,col=6) <b>35</b>	(row=5,col=7) <b>41</b>
(row=6,col=1) <b>6</b>	(row=6,col=2) <b>12</b>	(row=6,col=3) <b>18</b>	(row=6,col=4) <b>24</b>	(row=6,col=5) <b>30</b>	(row=6,col=6) <b>36</b>	(row=6,col=7) <b>42</b>

(row=1,col=1) <b>1</b> 	(row=1,col=2) <b>7</b> 	(row=1,col=3) <b>13</b>	(row=1,col=4) <b>19</b>	(row=1,col=5) <b>25</b>	(row=1,col=6) <b>31</b>	(row=1,col=7) <b>37</b>
(row=2,col=1) <b>2</b> 	(row=2,col=2) <b>8</b> 	(row=2,col=3) <b>14</b>	(row=2,col=4) <b>20</b>	(row=2,col=5) <b>26</b>	(row=2,col=6) <b>32</b>	(row=2,col=7) <b>38</b>

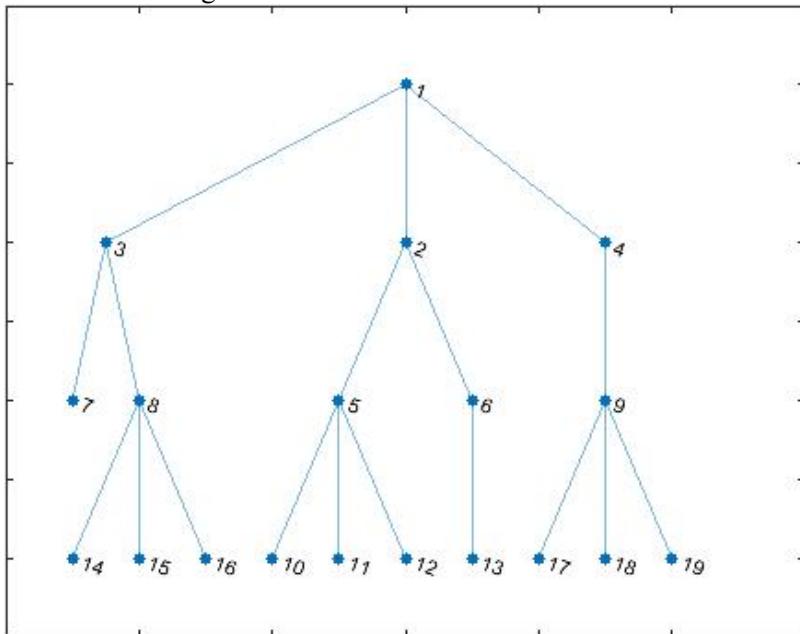
(row=3,col=1) 3	(row=3,col=2) 9 	(row=3,col=3) 15	(row=3,col=4) 21	(row=3,col=5) 27	(row=3,col=6) 33	(row=3,col=7) 39 
(row=4,col=1) 4	(row=4,col=2) 10 	(row=4,col=3) 16	(row=4,col=4) 22	(row=4,col=5) 28 	(row=4,col=6) 34	(row=4,col=7) 40 
(row=5,col=1) 5	(row=5,col=2) 11  	(row=5,col=3) 17	(row=5,col=4) 23	(row=5,col=5) 29	(row=5,col=6) 35	(row=5,col=7) 41
(row=6,col=1) 6	(row=6,col=2) 12	(row=6,col=3) 18	(row=6,col=4) 24	(row=6,col=5) 30	(row=6,col=6) 36	(row=6,col=7) 42

## Question 43

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 15.



Answer:

1,	{1,},
2,3,4,	{1,2,},{1,3,},{1,4,},
3,4,5,6,	{1,3,},{1,4,},{1,2,5,},{1,2,6,},
4,5,6,7,8,	{1,4,},{1,2,5,},{1,2,6,},{1,3,7,},{1,3,8,},
5,6,7,8,9,	{1,2,5,},{1,2,6,},{1,3,7,},{1,3,8,},{1,4,9,},
6,7,8,9,10,11,12,	{1,2,6,},{1,3,7,},{1,3,8,},{1,4,9,},{1,2,5,10,},{1,2,5,11,},{1,2,5,12,},
7,8,9,10,11,12,13,	{1,3,7,},{1,3,8,},{1,4,9,},{1,2,5,10,},{1,2,5,11,},{1,2,5,12,},{1,2,6,13,},

8,9,10,11,12,13,	$\{1,3,8,\}, \{1,4,9,\}, \{1,2,5,10,\}, \{1,2,5,11,\}, \{1,2,5,12,\}, \{1,2,6,13,\},$
9,10,11,12,13,14,15,16,	$\{1,4,9,\}, \{1,2,5,10,\}, \{1,2,5,11,\}, \{1,2,5,12,\}, \{1,2,6,13,\}, \{1,3,8,14,\}, \{1,3,8,15,\},$ $\{1,3,8,16,\},$
10,11,12,13,14,15,16,17,18,19,	$\{1,2,5,10,\}, \{1,2,5,11,\}, \{1,2,5,12,\}, \{1,2,6,13,\}, \{1,3,8,14,\}, \{1,3,8,15,\}, \{1,3,8,16,\},$ $\{1,4,9,17,\}, \{1,4,9,18,\}, \{1,4,9,19,\},$
11,12,13,14,15,16,17,18,19,	$\{1,2,5,11,\}, \{1,2,5,12,\}, \{1,2,6,13,\}, \{1,3,8,14,\}, \{1,3,8,15,\}, \{1,3,8,16,\}, \{1,4,9,17,\},$ $\{1,4,9,18,\}, \{1,4,9,19,\},$
12,13,14,15,16,17,18,19,	$\{1,2,5,12,\}, \{1,2,6,13,\}, \{1,3,8,14,\}, \{1,3,8,15,\}, \{1,3,8,16,\}, \{1,4,9,17,\}, \{1,4,9,18,\},$ $\{1,4,9,19,\},$
13,14,15,16,17,18,19,	$\{1,2,6,13,\}, \{1,3,8,14,\}, \{1,3,8,15,\}, \{1,3,8,16,\}, \{1,4,9,17,\}, \{1,4,9,18,\}, \{1,4,9,19,\},$
14,15,16,17,18,19,	$\{1,3,8,14,\}, \{1,3,8,15,\}, \{1,3,8,16,\}, \{1,4,9,17,\}, \{1,4,9,18,\}, \{1,4,9,19,\},$
15,16,17,18,19,	$\{1,3,8,15,\}, \{1,3,8,16,\}, \{1,4,9,17,\}, \{1,4,9,18,\}, \{1,4,9,19,\},$

Path found: 1-3-8-15-

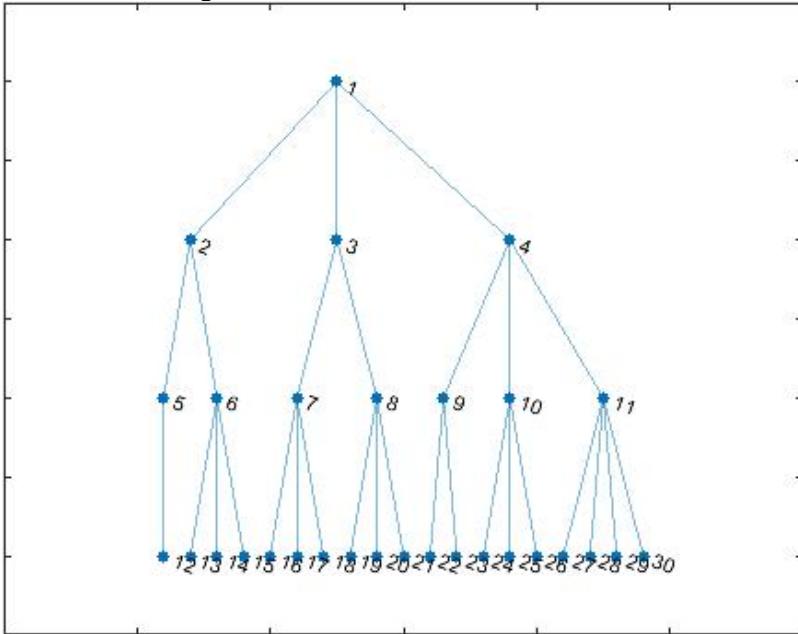
The number of visited states is 15.

## Question 44

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 21.



Answer:

1,	$\{1,\},$
2,3,4,	$\{1,2,\}, \{1,3,\}, \{1,4,\},$
5,6,3,4,	$\{1,2,5,\}, \{1,2,6,\}, \{1,3,\}, \{1,4,\},$
12,6,3,4,	$\{1,2,5,12,\}, \{1,2,6,\}, \{1,3,\}, \{1,4,\},$
6,3,4,	$\{1,2,6,\}, \{1,3,\}, \{1,4,\},$
13,14,15,3,4,	$\{1,2,6,13,\}, \{1,2,6,14,\}, \{1,2,6,15,\}, \{1,3,\}, \{1,4,\},$
14,15,3,4,	$\{1,2,6,14,\}, \{1,2,6,15,\}, \{1,3,\}, \{1,4,\},$
15,3,4,	$\{1,2,6,15,\}, \{1,3,\}, \{1,4,\},$

3,4,	{1,3,},{1,4,},
7,8,4,	{1,3,7,},{1,3,8,},{1,4,},
16,17,18,8,4,	{1,3,7,16,},{1,3,7,17,},{1,3,7,18,},{1,3,8,},{1,4,},
17,18,8,4,	{1,3,7,17,},{1,3,7,18,},{1,3,8,},{1,4,},
18,8,4,	{1,3,7,18,},{1,3,8,},{1,4,},
8,4,	{1,3,8,},{1,4,},
19,20,21,4,	{1,3,8,19,},{1,3,8,20,},{1,3,8,21,},{1,4,},
20,21,4,	{1,3,8,20,},{1,3,8,21,},{1,4,},
21,4,	{1,3,8,21,},{1,4,},

Path found:1-3-8-21-

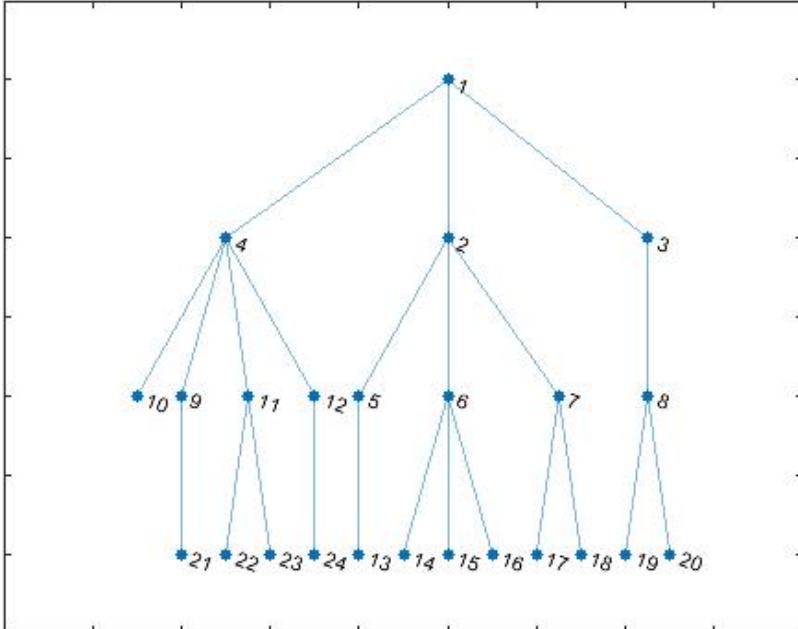
The number of visited states is 17.

## Question 45

Given the following search graph and adopting *best-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 20.



Node ID	Node Heuristic value
1	7
2	17
3	15
4	11
5	4
6	19
7	5
8	18
9	4
10	7

11	2
12	13
13	4
14	1
15	14
16	7
17	13
18	8
19	13
20	0
21	18
22	16
23	15
24	16

**Answer:**

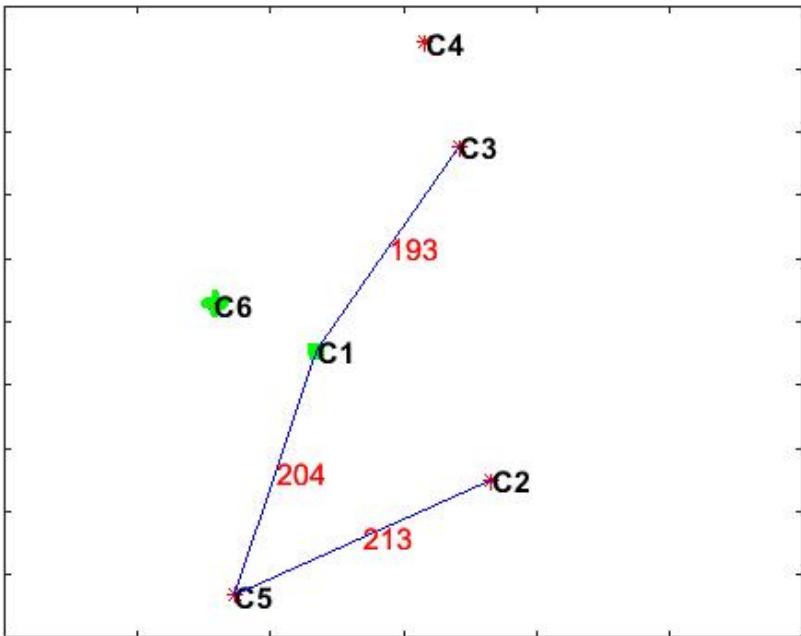
1,	{1,},
4,3,2,	{1,4,},{1,3,},{1,2,},
11,9,10,12,3,2,	{1,4,11,},{1,4,9,},{1,4,10,},{1,4,12,},{1,3,},{1,2,},
23,22,9,10,12,3,2,	{1,4,11,23,},{1,4,11,22,},{1,4,9,},{1,4,10,},{1,4,12,},{1,3,},{1,2,},
22,9,10,12,3,2,	{1,4,11,22,},{1,4,9,},{1,4,10,},{1,4,12,},{1,3,},{1,2,},
9,10,12,3,2,	{1,4,9,},{1,4,10,},{1,4,12,},{1,3,},{1,2,},
21,10,12,3,2,	{1,4,9,21,},{1,4,10,},{1,4,12,},{1,3,},{1,2,},
10,12,3,2,	{1,4,10,},{1,4,12,},{1,3,},{1,2,},
12,3,2,	{1,4,12,},{1,3,},{1,2,},
24,3,2,	{1,4,12,24,},{1,3,},{1,2,},
3,2,	{1,3,},{1,2,},
8,2,	{1,3,8,},{1,2,},
20,19,2,	{1,3,8,20,},{1,3,8,19,},{1,2,},

Path found: 1-3-8-20-

The number of visited states is 13.

## Question 46

Given the following search graph, write the sequence of node numbers in the search agenda across the search life-time and using *A\* search*.



Assume the following heuristic value per node:

Node ID	Node Heuristic value
1	0
2	167
3	193
4	256
5	204
6	85

Assume distance between cities are as mentioned on the links

Apply A\* algorithm showing intermediate values for the Agenda,  $g(n)$ ,  $h(n)$

Source city is :C6

Destination city:C1

Answer:

	iteration 1
states	6
$g(n)$	0
$h(n)$	85
$g(n)+h(n)$	85
visited?	0

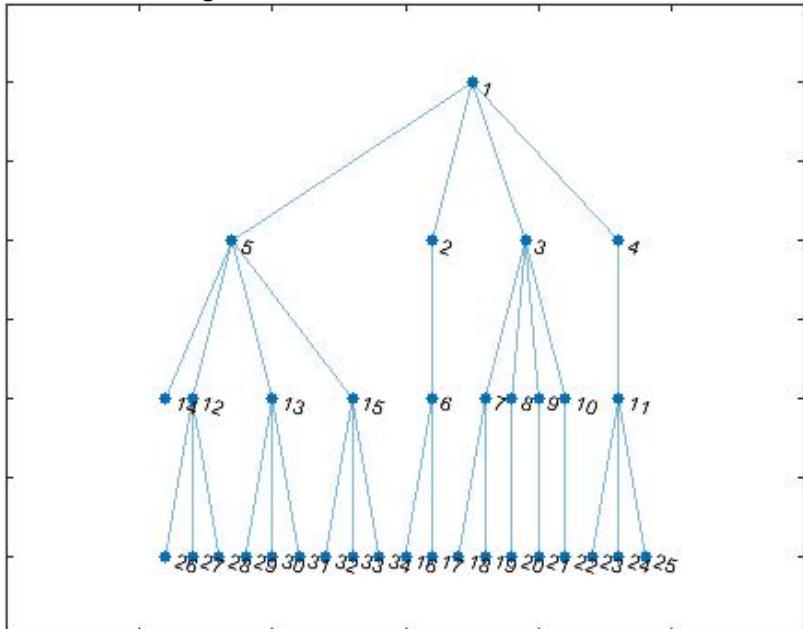
no path found

## Question 48

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 32.



**Answer:**

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



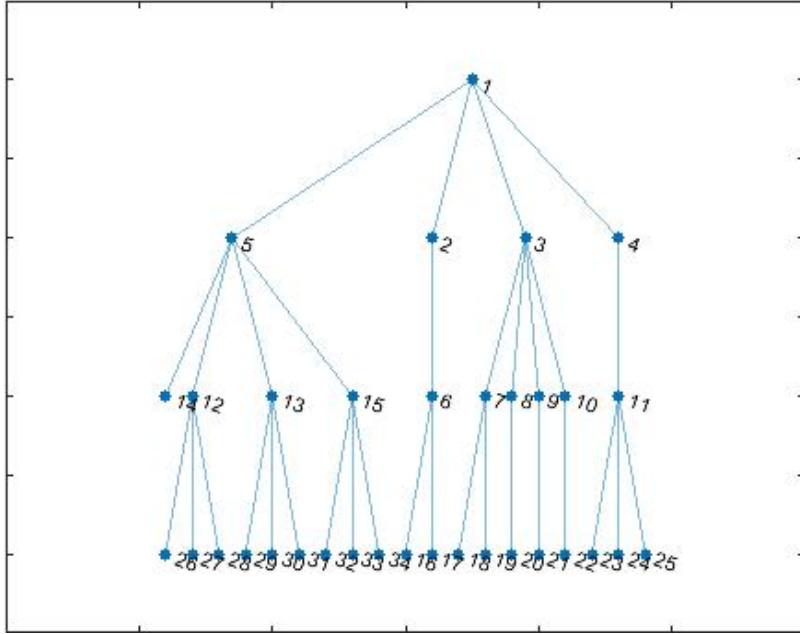
31,32,33,34,	{1,5,13,31},{1,5,15,32},{1,5,15,33},{1,5,15,34},
32,33,34,	{1,5,15,32},{1,5,15,33},{1,5,15,34},

Path found:1-5-15-32-

The number of visited states is 32. Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 32.



Answer:

1,	{1,},
2,3,4,5,	{1,2,},{1,3,},{1,4,},{1,5,},
6,3,4,5,	{1,2,6,},{1,3,},{1,4,},{1,5,},
16,17,3,4,5,	{1,2,6,16,},{1,2,6,17,},{1,3,},{1,4,},{1,5,},
17,3,4,5,	{1,2,6,17,},{1,3,},{1,4,},{1,5,},
3,4,5,	{1,3,},{1,4,},{1,5,},
7,8,9,10,4,5,	{1,3,7,},{1,3,8,},{1,3,9,},{1,3,10,},{1,4,},{1,5,},
18,19,8,9,10,4,5,	{1,3,7,18,},{1,3,7,19,},{1,3,8,},{1,3,9,},{1,3,10,},{1,4,},{1,5,},
19,8,9,10,4,5,	{1,3,7,19,},{1,3,8,},{1,3,9,},{1,3,10,},{1,4,},{1,5,},
8,9,10,4,5,	{1,3,8,},{1,3,9,},{1,3,10,},{1,4,},{1,5,},
20,9,10,4,5,	{1,3,8,20,},{1,3,9,},{1,3,10,},{1,4,},{1,5,},
9,10,4,5,	{1,3,9,},{1,3,10,},{1,4,},{1,5,},
21,10,4,5,	{1,3,9,21,},{1,3,10,},{1,4,},{1,5,},
10,4,5,	{1,3,10,},{1,4,},{1,5,},
22,4,5,	{1,3,10,22,},{1,4,},{1,5,},
4,5,	{1,4,},{1,5,},
11,5,	{1,4,11,},{1,5,},
23,24,25,5,	{1,4,11,23,},{1,4,11,24,},{1,4,11,25,},{1,5,},
24,25,5,	{1,4,11,24,},{1,4,11,25,},{1,5,},
25,5,	{1,4,11,25,},{1,5,},
5,	{1,5,},

12,13,14,15,	{1,5,12,}, {1,5,13,}, {1,5,14,}, {1,5,15,},
26,27,28,13,14,15,	{1,5,12,26,}, {1,5,12,27,}, {1,5,12,28,}, {1,5,13,}, {1,5,14,}, {1,5,15,},
27,28,13,14,15,	{1,5,12,27,}, {1,5,12,28,}, {1,5,13,}, {1,5,14,}, {1,5,15,},
28,13,14,15,	{1,5,12,28,}, {1,5,13,}, {1,5,14,}, {1,5,15,},
13,14,15,	{1,5,13,}, {1,5,14,}, {1,5,15,},
29,30,31,14,15,	{1,5,13,29,}, {1,5,13,30,}, {1,5,13,31,}, {1,5,14,}, {1,5,15,},
30,31,14,15,	{1,5,13,30,}, {1,5,13,31,}, {1,5,14,}, {1,5,15,},
31,14,15,	{1,5,13,31,}, {1,5,14,}, {1,5,15,},
14,15,	{1,5,14,}, {1,5,15,},
15,	{1,5,15,},
32,33,34,	{1,5,15,32,}, {1,5,15,33,}, {1,5,15,34,},

Path found: 1-5-15-32-

The number of visited states is 32.

## Question 49

Having the following grid and the depicted agent at location (x=6,y=6) and a target object located at (x=2,y=5)

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 the grid.

Assume Euclidian distance from the current location to the target location as the heuristic value.

	Target cell
	robot cell
	restricted/constrained cell

Answer

(row=1,col=1) 1	(row=1,col=2) 7	(row=1,col=3) <b>13</b> 	(row=1,col=4) <b>19</b>	(row=1,col=5) <b>25</b>	(row=1,col=6) <b>31</b>	(row=1,col=7) <b>37</b>	(row=1,col=8) <b>43</b>
(row=2,col=1) 2	(row=2,col=2) 8	(row=2,col=3) <b>14</b>	(row=2,col=4) <b>20</b>	(row=2,col=5) <b>26</b>	(row=2,col=6) <b>32</b>	(row=2,col=7) <b>38</b>	(row=2,col=8) <b>44</b>
(row=3,col=1) 3	(row=3,col=2) 9	(row=3,col=3) <b>15</b>	(row=3,col=4) <b>21</b>	(row=3,col=5) <b>27</b>	(row=3,col=6) <b>33</b> 	(row=3,col=7) <b>39</b>	(row=3,col=8) <b>45</b>
(row=4,col=1) 4	(row=4,col=2) 10	(row=4,col=3) <b>16</b>	(row=4,col=4) <b>22</b>	(row=4,col=5) <b>28</b>	(row=4,col=6) <b>34</b>	(row=4,col=7) <b>40</b>	(row=4,col=8) <b>46</b>
(row=5,col=1) 5	(row=5,col=2) <b>11</b> 	(row=5,col=3) 17	(row=5,col=4) <b>23</b> 	(row=5,col=5) <b>29</b>	(row=5,col=6) <b>35</b>	(row=5,col=7) <b>41</b>	(row=5,col=8) <b>47</b>
(row=6,col=1) 6	(row=6,col=2) <b>12</b> 	(row=6,col=3) <b>18</b>	(row=6,col=4) <b>24</b>	(row=6,col=5) <b>30</b> 	(row=6,col=6) <b>36</b>	(row=6,col=7) <b>42</b>	(row=6,col=8) <b>48</b>



states	36															
H	4.12															
states	35	42														
H	4.00	5.10														
states	29	36	34	41	42											
H	3.00	4.12	4.12	5.00	5.10											
states	28	35	36	34	41	42										
H	3.16	4.00	4.12	4.12	5.00	5.10										
states	22	29	27	34	35	36	34	41	42							
H	2.24	3.00	3.61	4.12	4.00	4.12	4.12	5.00	5.10							
states	16	21	28	29	27	34	35	36	34	41	42					
H	1.41	2.83	3.16	3.00	3.61	4.12	4.00	4.12	4.12	5.00	5.10					
states	17	10	15	22	21	28	29	27	34	35	36	34	41	42		
H	1.00	1.00	2.24	2.24	2.83	3.16	3.00	3.61	4.12	4.00	4.12	4.12	5.00	5.10		
states	11	18	16	10	15	22	21	28	29	27	34	35	36	34	41	42
H	0.00	1.41	1.41	1.00	2.24	2.24	2.83	3.16	3.00	3.61	4.12	4.00	4.12	4.12	5.00	5.10

(row=1,col=1) <b>1</b>	(row=1,col=2) <b>7</b>	(row=1,col=3) <b>13</b> 	(row=1,col=4) <b>19</b>	(row=1,col=5) <b>25</b>	(row=1,col=6) <b>31</b>	(row=1,col=7) <b>37</b>	(row=1,col=8) <b>43</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>8</b>	(row=2,col=3) <b>14</b>	(row=2,col=4) <b>20</b>	(row=2,col=5) <b>26</b>	(row=2,col=6) <b>32</b>	(row=2,col=7) <b>38</b>	(row=2,col=8) <b>44</b>
(row=3,col=1) <b>3</b>	(row=3,col=2) <b>9</b>	(row=3,col=3) <b>15</b>	(row=3,col=4) <b>21</b>	(row=3,col=5) <b>27</b>	(row=3,col=6) <b>33</b> 	(row=3,col=7) <b>39</b>	(row=3,col=8) <b>45</b>
(row=4,col=1) <b>4</b>	(row=4,col=2) <b>10</b>	(row=4,col=3) <b>16</b> 	(row=4,col=4) <b>22</b> 	(row=4,col=5) <b>28</b> 	(row=4,col=6) <b>34</b>	(row=4,col=7) <b>40</b>	(row=4,col=8) <b>46</b>
(row=5,col=1) <b>5</b>	(row=5,col=2) <b>11</b> 	(row=5,col=3) <b>17</b> 	(row=5,col=4) <b>23</b> 	(row=5,col=5) <b>29</b> 	(row=5,col=6) <b>35</b> 	(row=5,col=7) <b>41</b>	(row=5,col=8) <b>47</b>
(row=6,col=1) <b>6</b>	(row=6,col=2) <b>12</b> 	(row=6,col=3) <b>18</b>	(row=6,col=4) <b>24</b>	(row=6,col=5) <b>30</b> 	(row=6,col=6) <b>36</b>  	(row=6,col=7) <b>42</b>	(row=6,col=8) <b>48</b>

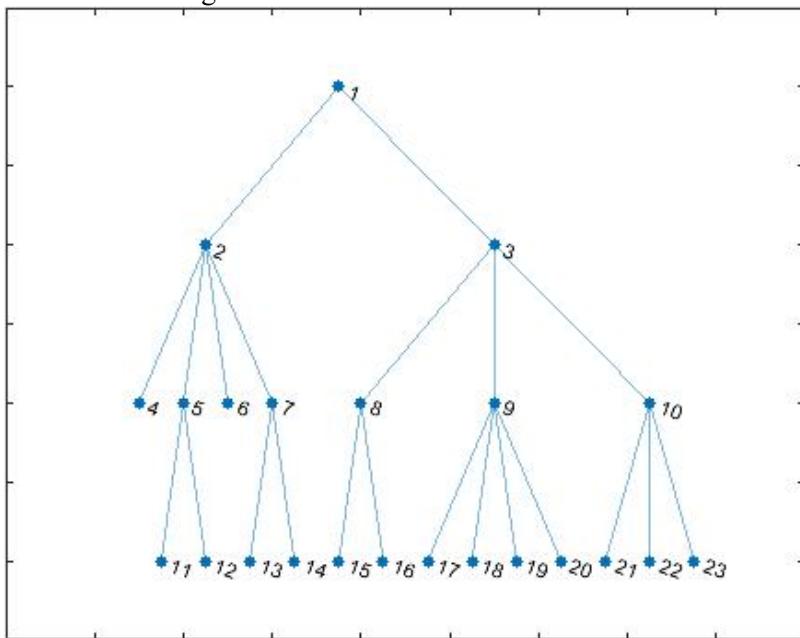
## Question 50

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.

2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 16.



**Answer:**

1,	{1},
2,3,	{1,2,},{1,3,},
3,4,5,6,7,	{1,3,},{1,2,4,},{1,2,5,},{1,2,6,},{1,2,7,},
4,5,6,7,8,9,10,	{1,2,4,},{1,2,5,},{1,2,6,},{1,2,7,},{1,3,8,},{1,3,9,},{1,3,10,},
5,6,7,8,9,10,	{1,2,5,},{1,2,6,},{1,2,7,},{1,3,8,},{1,3,9,},{1,3,10,},
6,7,8,9,10,11,12,	{1,2,6,},{1,2,7,},{1,3,8,},{1,3,9,},{1,3,10,},{1,2,5,11,},{1,2,5,12,},
7,8,9,10,11,12,	{1,2,7,},{1,3,8,},{1,3,9,},{1,3,10,},{1,2,5,11,},{1,2,5,12,},
8,9,10,11,12,13,14,	{1,3,8,},{1,3,9,},{1,3,10,},{1,2,5,11,},{1,2,5,12,},{1,2,7,13,},{1,2,7,14,},
9,10,11,12,13,14,15,16,	{1,3,9,},{1,3,10,},{1,2,5,11,},{1,2,5,12,},{1,2,7,13,},{1,2,7,14,},{1,3,8,15,},{1,3,8,16,},
10,11,12,13,14,15,16,17,18,19,20,	{1,3,10,},{1,2,5,11,},{1,2,5,12,},{1,2,7,13,},{1,2,7,14,},{1,3,8,15,},{1,3,8,16,},{1,3,9,17,},{1,3,9,18,},{1,3,9,19,},{1,3,9,20,},
	{1,2,5,11,},{1,2,5,12,},{1,2,7,13,},{1,2,7,14,},{1,3,8,15,},{1,3,8,16,},
11,12,13,14,15,16,17,18,19,20,21,22,23,	{1,3,9,17,},{1,3,9,18,},{1,3,9,19,},{1,3,9,20,},{1,3,10,21,},{1,3,10,22,},{1,3,10,23,},
12,13,14,15,16,17,18,19,20,21,22,23,	{1,2,5,12,},{1,2,7,13,},{1,2,7,14,},{1,3,8,15,},{1,3,8,16,},{1,3,9,17,},
13,14,15,16,17,18,19,20,21,22,23,	{1,3,9,18,},{1,3,9,19,},{1,3,9,20,},{1,3,10,21,},{1,3,10,22,},{1,3,10,23,},
14,15,16,17,18,19,20,21,22,23,	{1,2,7,14,},{1,3,8,15,},{1,3,8,16,},{1,3,9,17,},{1,3,9,18,},{1,3,9,19,},
15,16,17,18,19,20,21,22,23,	{1,3,9,20,},{1,3,10,21,},{1,3,10,22,},{1,3,10,23,},
16,17,18,19,20,21,22,23,	{1,3,8,16,},{1,3,9,17,},{1,3,9,18,},{1,3,9,19,},{1,3,9,20,},{1,3,10,21,},{1,3,10,22,},{1,3,10,23,},

**Path found:1-3-8-16-**

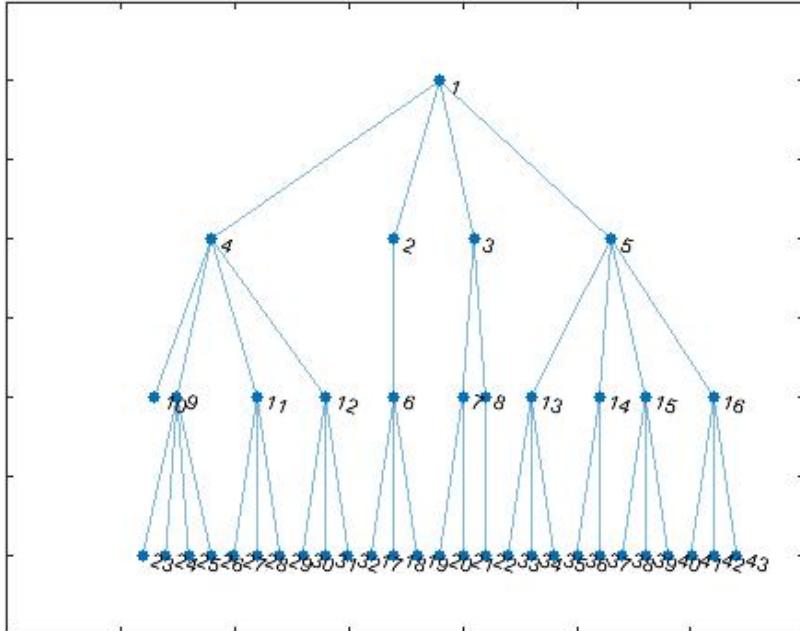
**The number of visited states is 16.**

## Question 51

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 27.



**Answer:**

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

Path found:1-4-11-27-

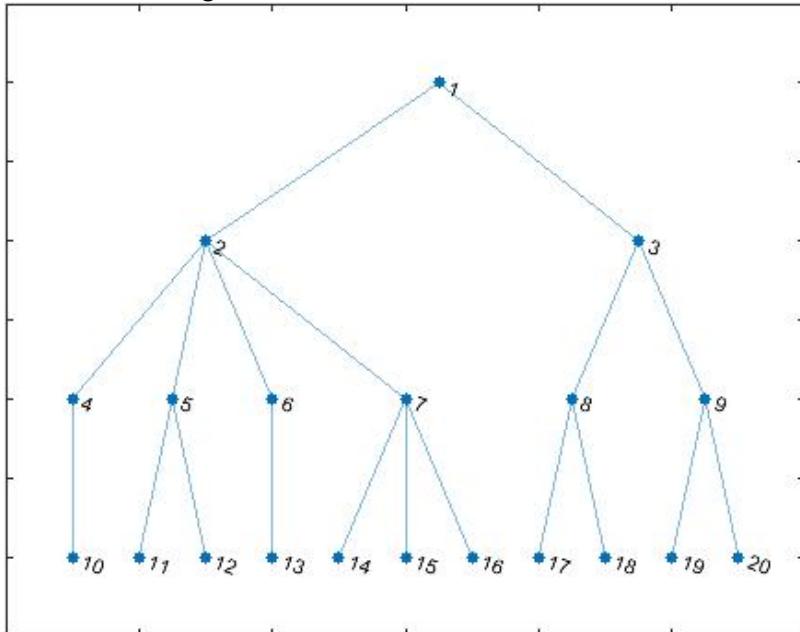
The number of visited states is 21.

## Question 52

Given the following search graph and adopting *best-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 16.



Node ID	Node Heuristic value
1	19
2	7
3	17
4	15
5	19
6	1
7	7
8	13
9	6
10	5
11	14
12	12
13	12
14	13
15	1
16	7
17	9
18	5
19	14

20	17
----	----

Answer:

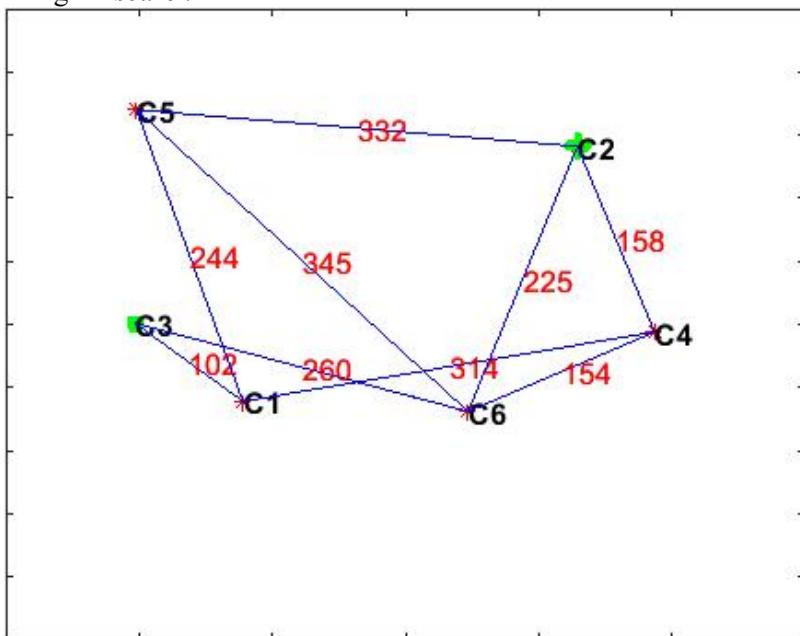
1,	{1},
2,3,	{1,2,},{1,3,},
6,7,4,5,3,	{1,2,6,},{1,2,7,},{1,2,4,},{1,2,5,},{1,3,},
13,7,4,5,3,	{1,2,6,13,},{1,2,7,},{1,2,4,},{1,2,5,},{1,3,},
7,4,5,3,	{1,2,7,},{1,2,4,},{1,2,5,},{1,3,},
15,16,14,4,5,3,	{1,2,7,15,},{1,2,7,16,},{1,2,7,14,},{1,2,4,},{1,2,5,},{1,3,},
16,14,4,5,3,	{1,2,7,16,},{1,2,7,14,},{1,2,4,},{1,2,5,},{1,3,},

Path found: 1-2-7-16-

The number of visited states is 7.

## Question 53

Given the following search graph, write the sequence of node numbers in the search agenda across the search life-time and using *A\* search*.



Assume the following heuristic value per node:

Node ID	Node Heuristic value
1	102
2	360
3	0
4	390
5	169
6	260

Assume distance between cities are as mentioned on the links

Apply A\* algorithm showing intermediate values for the Agenda, g(n), h(n)

Source city is :C2

Destination city:C3

Answer:

	iteration 1
--	-------------

states	2			
g(n)	0			
h(n)	360			
g(n)+h(n)	360			
visited?	0			

		<b>iteration 2</b>					
states	2	4	5	6			
g(n)	0		158	332	225		
h(n)	360		390	169	260		
g(n)+h(n)	360		548	501	485		
visited?	1		0	0	0		

		<b>iteration 3</b>							
states	2	4	5	6	2	3	4	5	
g(n)	0		158	332	225	451	485	379	571
h(n)	360		390	169	260	360	0	390	169
g(n)+h(n)	360		548	501	485	811	485	769	740
visited?	1		0	0	1	0	0	0	0

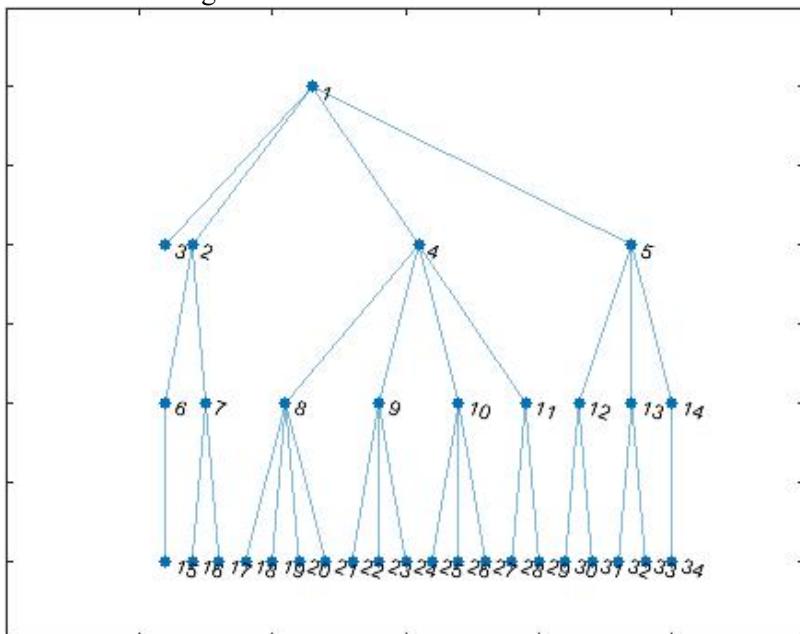
Final path: 2-6-3-

## Question 55

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 29.



Answer:

1,	{1,},
----	-------

2,3,4,5,	{1,2},{1,3},{1,4},{1,5},
3,4,5,6,7,	{1,3},{1,4},{1,5},{1,2,6},{1,2,7},
4,5,6,7,	{1,4},{1,5},{1,2,6},{1,2,7},
5,6,7,8,9,10,11,	{1,5},{1,2,6},{1,2,7},{1,4,8},{1,4,9},{1,4,10}, ,{1,4,11},
6,7,8,9,10,11,12,13,14,	{1,2,6},{1,2,7},{1,4,8},{1,4,9},{1,4,10},{1,4,11}, ,{1,5,12},{1,5,13},{1,5,14},
7,8,9,10,11,12,13,14,15,	{1,2,7},{1,4,8},{1,4,9},{1,4,10},{1,4,11},{1,5,12}, ,{1,5,13},{1,5,14},{1,2,6,15},
8,9,10,11,12,13,14,15,16,17,	{1,4,8},{1,4,9},{1,4,10},{1,4,11},{1,5,12},{1,5,13}, ,{1,5,14},{1,2,6,15},{1,2,7,16},{1,2,7,17},
9,10,11,12,13,14,15,16,17,18,19,20,21,	{1,4,9},{1,4,10},{1,4,11},{1,5,12},{1,5,13},{1,5,14}, ,{1,2,6,15},{1,2,7,16},{1,2,7,17},{1,4,8,18}, ,{1,4,8,19},{1,4,8,20},{1,4,8,21},{1,4,9,22}, ,{1,4,9,23},{1,4,9,24},
10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,	{1,4,10},{1,4,11},{1,5,12},{1,5,13},{1,5,14}, ,{1,2,6,15},{1,2,7,16},{1,2,7,17},{1,4,8,18}, ,{1,4,8,19},{1,4,8,20},{1,4,8,21},{1,4,9,22}, ,{1,4,9,23},{1,4,9,24},
11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,	{1,4,11},{1,5,12},{1,5,13},{1,5,14},{1,2,6,15}, ,{1,2,7,16},{1,2,7,17},{1,4,8,18},{1,4,8,19}, ,{1,4,8,20},{1,4,8,21},{1,4,9,22},{1,4,9,23}, ,{1,4,9,24},{1,4,10,25},{1,4,10,26},{1,4,10,27},
12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,	{1,5,12},{1,5,13},{1,5,14},{1,2,6,15},{1,2,7,16}, ,{1,2,7,17},{1,4,8,18},{1,4,8,19},{1,4,8,20}, ,{1,4,8,21},{1,4,9,22},{1,4,9,23},{1,4,9,24}, ,{1,4,10,25},{1,4,10,26},{1,4,10,27},{1,4,11,28}, ,{1,4,11,29},
13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,	{1,5,13},{1,5,14},{1,2,6,15},{1,2,7,16},{1,2,7,17}, ,{1,4,8,18},{1,4,8,19},{1,4,8,20},{1,4,8,21}, ,{1,4,9,22},{1,4,9,23},{1,4,9,24},{1,4,10,25}, ,{1,4,10,26},{1,4,10,27},{1,4,11,28},{1,4,11,29}, ,{1,5,12,30},{1,5,12,31},
14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,	{1,5,14},{1,2,6,15},{1,2,7,16},{1,2,7,17},{1,4,8,18}, ,{1,4,8,19},{1,4,8,20},{1,4,8,21},{1,4,9,22}, ,{1,4,9,23},{1,4,9,24},{1,4,10,25},{1,4,10,26}, ,{1,4,10,27},{1,4,11,28},{1,4,11,29},{1,5,12,30}, ,{1,5,12,31},{1,5,13,32},{1,5,13,33},
15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,	{1,2,6,15},{1,2,7,16},{1,2,7,17},{1,4,8,18}, ,{1,4,8,19},{1,4,8,20},{1,4,8,21},{1,4,9,22}, ,{1,4,9,23},{1,4,9,24},{1,4,10,25},{1,4,10,26}, ,{1,4,10,27},{1,4,11,28},{1,4,11,29},{1,5,12,30}, ,{1,5,12,31},{1,5,13,32},{1,5,13,33},{1,5,14,34},
16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,	{1,2,7,16},{1,2,7,17},{1,4,8,18},{1,4,8,19}, ,{1,4,8,20},{1,4,8,21},{1,4,9,22},{1,4,9,23}, ,{1,4,9,24},{1,4,10,25},{1,4,10,26},{1,4,10,27}, ,{1,4,11,28},{1,4,11,29},{1,5,12,30},{1,5,12,31}, ,{1,5,13,32},{1,5,13,33},{1,5,14,34},
17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,	{1,2,7,17},{1,4,8,18},{1,4,8,19},{1,4,8,20}, ,{1,4,8,21},{1,4,9,22},{1,4,9,23},{1,4,9,24}, ,{1,4,10,25},{1,4,10,26},{1,4,10,27},{1,4,11,28}, ,{1,4,11,29},{1,5,12,30},{1,5,12,31},{1,5,13,32}, ,{1,5,13,33},{1,5,14,34},

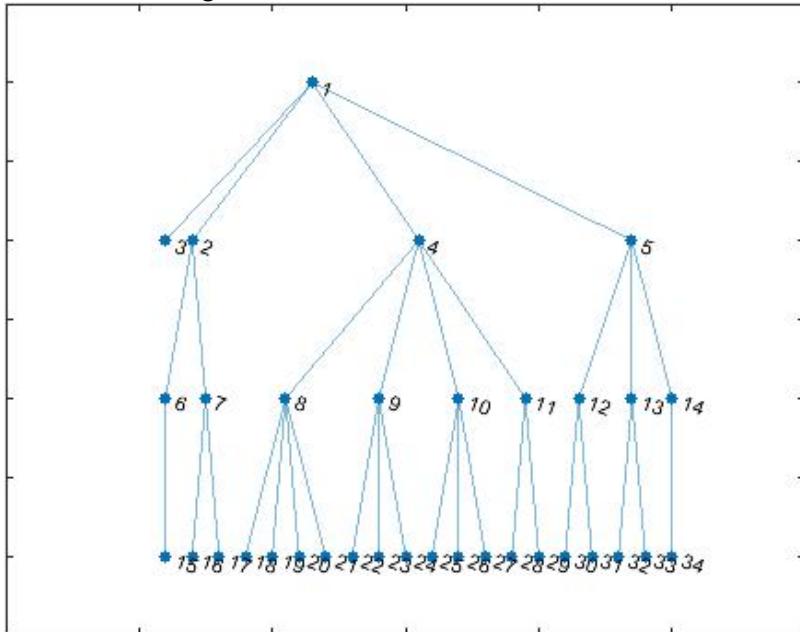
	{1,4,8,18},{1,4,8,19},{1,4,8,20},{1,4,8,21}, {1,4,9,22},{1,4,9,23},{1,4,9,24},{1,4,10,25}, {1,4,10,26},{1,4,10,27},{1,4,11,28},{1,4,11,29}, {1,5,12,30},{1,5,12,31},{1,5,13,32},{1,5,13,33}, {1,5,14,34},
18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,	{1,4,8,19},{1,4,8,20},{1,4,8,21},{1,4,9,22}, {1,4,9,23},{1,4,9,24},{1,4,10,25},{1,4,10,26}, {1,4,10,27},{1,4,11,28},{1,4,11,29},{1,5,12,30}, {1,5,12,31},{1,5,13,32},{1,5,13,33},{1,5,14,34},
19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,	{1,4,8,20},{1,4,8,21},{1,4,9,22},{1,4,9,23}, {1,4,9,24},{1,4,10,25},{1,4,10,26},{1,4,10,27}, {1,4,11,28},{1,4,11,29},{1,5,12,30},{1,5,12,31}, {1,5,13,32},{1,5,13,33},{1,5,14,34},
20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,	{1,4,8,21},{1,4,9,22},{1,4,9,23},{1,4,9,24}, {1,4,10,25},{1,4,10,26},{1,4,10,27},{1,4,11,28}, {1,4,11,29},{1,5,12,30},{1,5,12,31},{1,5,13,32}, {1,5,13,33},{1,5,14,34},
21,22,23,24,25,26,27,28,29,30,31,32,33,34,	{1,4,9,22},{1,4,9,23},{1,4,9,24},{1,4,10,25}, {1,4,10,26},{1,4,10,27},{1,4,11,28},{1,4,11,29}, {1,5,12,30},{1,5,12,31},{1,5,13,32},{1,5,13,33}, {1,5,14,34},
22,23,24,25,26,27,28,29,30,31,32,33,34,	{1,4,9,23},{1,4,9,24},{1,4,10,25},{1,4,10,26}, {1,4,10,27},{1,4,11,28},{1,4,11,29},{1,5,12,30}, {1,5,12,31},{1,5,13,32},{1,5,13,33},{1,5,14,34},
23,24,25,26,27,28,29,30,31,32,33,34,	{1,4,9,24},{1,4,10,25},{1,4,10,26},{1,4,10,27}, {1,4,11,28},{1,4,11,29},{1,5,12,30},{1,5,12,31}, {1,5,13,32},{1,5,13,33},{1,5,14,34},
24,25,26,27,28,29,30,31,32,33,34,	{1,4,10,25},{1,4,10,26},{1,4,10,27},{1,4,11,28}, {1,4,11,29},{1,5,12,30},{1,5,12,31},{1,5,13,32}, {1,5,13,33},{1,5,14,34},
25,26,27,28,29,30,31,32,33,34,	{1,4,10,26},{1,4,10,27},{1,4,11,28},{1,4,11,29}, {1,5,12,30},{1,5,12,31},{1,5,13,32},{1,5,13,33}, {1,5,14,34},
26,27,28,29,30,31,32,33,34,	{1,4,10,27},{1,4,11,28},{1,4,11,29},{1,5,12,30}, {1,5,12,31},{1,5,13,32},{1,5,13,33},{1,5,14,34},
27,28,29,30,31,32,33,34,	{1,4,11,28},{1,4,11,29},{1,5,12,30},{1,5,12,31}, {1,5,13,32},{1,5,13,33},{1,5,14,34},
28,29,30,31,32,33,34,	{1,4,11,29},{1,5,12,30},{1,5,12,31},{1,5,13,32}, {1,5,13,33},{1,5,14,34},
29,30,31,32,33,34,	{1,4,11,29},{1,5,12,30},{1,5,12,31},{1,5,13,32}, {1,5,13,33},{1,5,14,34},

Path found:1-4-11-29-

The number of visited states is 29. Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 29.



**Answer:**

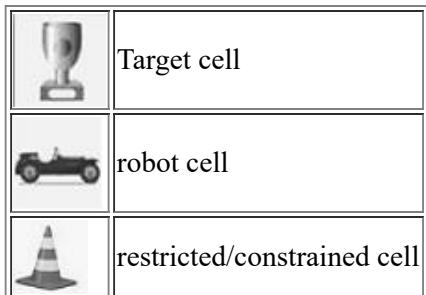
1,	{1,},
2,3,4,5,	{1,2,},{1,3,},{1,4,},{1,5,},
6,7,3,4,5,	{1,2,6,},{1,2,7,},{1,3,},{1,4,},{1,5,},
15,7,3,4,5,	{1,2,6,15,},{1,2,7,},{1,3,},{1,4,},{1,5,},
7,3,4,5,	{1,2,7,},{1,3,},{1,4,},{1,5,},
16,17,3,4,5,	{1,2,7,16,},{1,2,7,17,},{1,3,},{1,4,},{1,5,},
17,3,4,5,	{1,2,7,17,},{1,3,},{1,4,},{1,5,},
3,4,5,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

**Path found:1-4-11-29-**

The number of visited states is 25.

## Question 56

Having the following grid and the depicted agent at location (x=5,y=4) and a target object located at (x=1,y=5)  
 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 the grid.  
 Assume Euclidian distance from the current location to the target location as the heuristic value.



### Answer

(row=1,col=1) <b>1</b> 	(row=1,col=2) <b>6</b>	(row=1,col=3) <b>11</b> 	(row=1,col=4) <b>16</b>	(row=1,col=5) <b>21</b>	(row=1,col=6) <b>26</b>	(row=1,col=7) <b>31</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>7</b>	(row=2,col=3) <b>12</b>	(row=2,col=4) <b>17</b>	(row=2,col=5) <b>22</b>	(row=2,col=6) <b>27</b>	(row=2,col=7) <b>32</b>
(row=3,col=1) <b>3</b>	(row=3,col=2) <b>8</b>	(row=3,col=3) <b>13</b>	(row=3,col=4) <b>18</b>	(row=3,col=5) <b>23</b>	(row=3,col=6) <b>28</b>	(row=3,col=7) <b>33</b> 
(row=4,col=1) <b>4</b>	(row=4,col=2) <b>9</b>	(row=4,col=3) <b>14</b>	(row=4,col=4) <b>19</b>	(row=4,col=5) <b>24</b> 	(row=4,col=6) <b>29</b>	(row=4,col=7) <b>34</b>
(row=5,col=1) <b>5</b> 	(row=5,col=2) <b>10</b>	(row=5,col=3) <b>15</b>	(row=5,col=4) <b>20</b> 	(row=5,col=5) <b>25</b>	(row=5,col=6) <b>30</b>	(row=5,col=7) <b>35</b> 

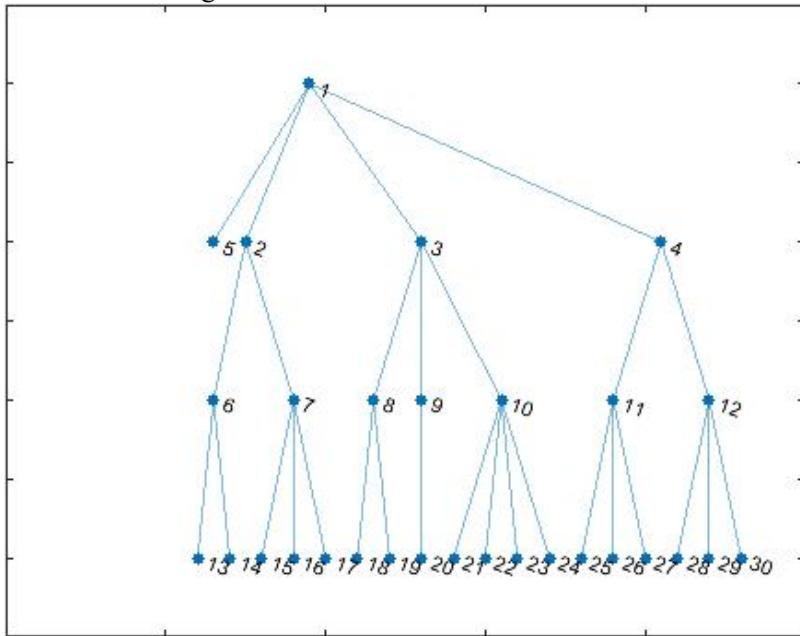
(row=2,col=1) 2	(row=2,col=2) 7	(row=2,col=3) 12	(row=2,col=4) 17	(row=2,col=5) 22	(row=2,col=6) 27	(row=2,col=7) 32
(row=3,col=1) 3	(row=3,col=2) 8	(row=3,col=3) 13	(row=3,col=4) 18	(row=3,col=5) 23	(row=3,col=6) 28	(row=3,col=7) 33 
(row=4,col=1) 4	(row=4,col=2) 9 	(row=4,col=3) 14 	(row=4,col=4) 19 	(row=4,col=5) 24 	(row=4,col=6) 29	(row=4,col=7) 34
(row=5,col=1) 5 	(row=5,col=2) 10 	(row=5,col=3) 15 	(row=5,col=4) 20 	(row=5,col=5) 25	(row=5,col=6) 30	(row=5,col=7) 35 

## Question 57

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 20.



Answer:

1,	{1},
2,3,4,5,	{1,2},{1,3},{1,4},{1,5},
3,4,5,6,7,	{1,3},{1,4},{1,5},{1,2,6},{1,2,7},
4,5,6,7,8,9,10,	{1,4},{1,5},{1,2,6},{1,2,7},{1,3,8},{1,3,9},{1,3,10},
5,6,7,8,9,10,11,12,	{1,5},{1,2,6},{1,2,7},{1,3,8},{1,3,9},{1,3,10},{1,4,11},{1,4,12},

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

Path found:1-3-9-20-

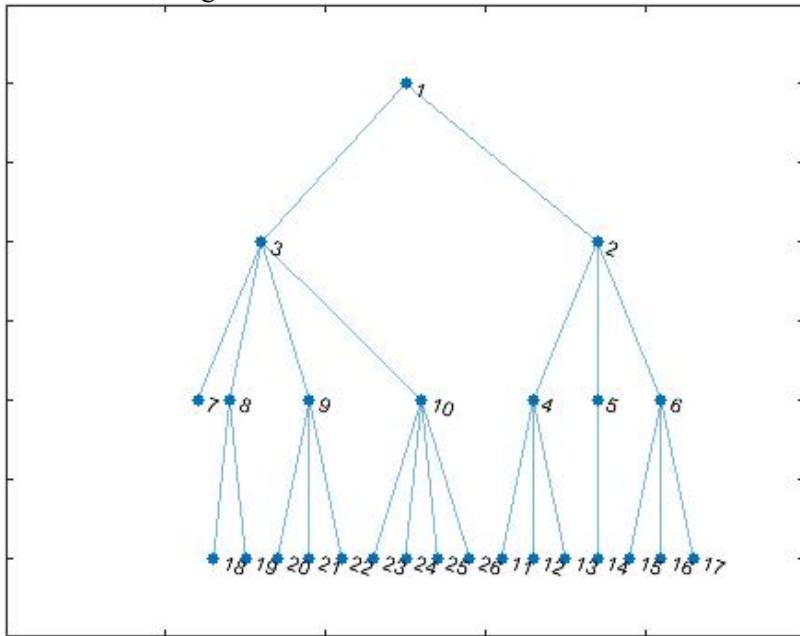
The number of visited states is 20.

## Question 58

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 23.



**Answer:**

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

Path found: 1-3-10-23-

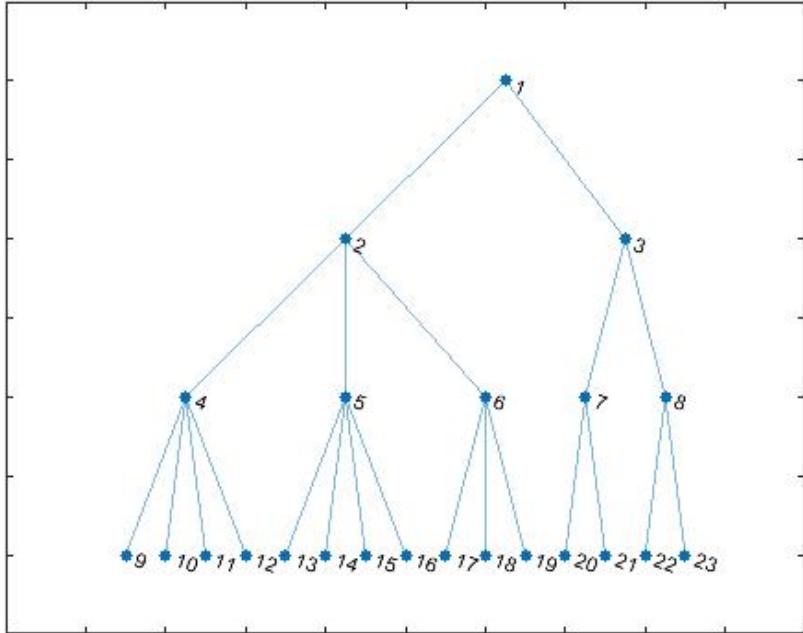
The number of visited states is 23.

## Question 59

Given the following search graph and adopting *best-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 13.



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

23	8
----	---

Answer:

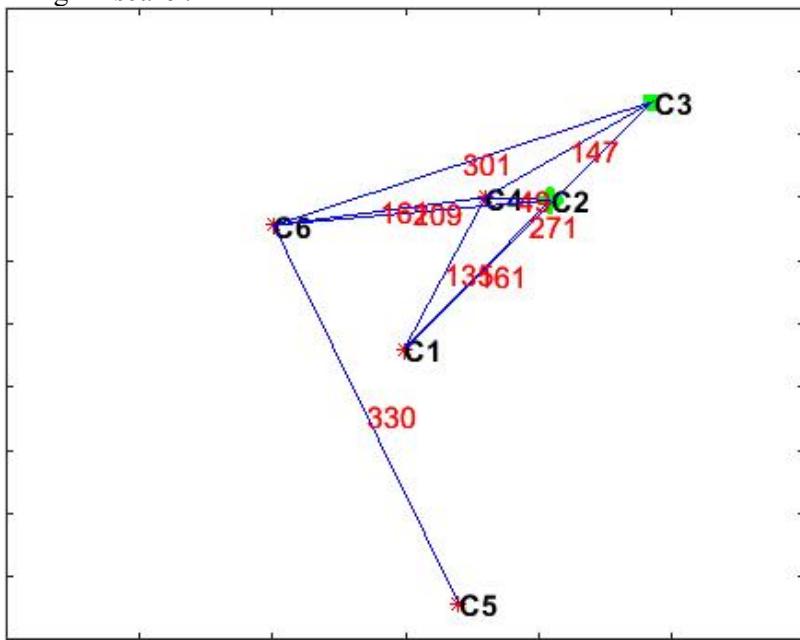
1,	{1,},
2,3,	{1,2,},{1,3,},
6,4,5,3,	{1,2,6,},{1,2,4,},{1,2,5,},{1,3,},
18,17,19,4,5,3,	{1,2,6,18,},{1,2,6,17,},{1,2,6,19,},{1,2,4,},{1,2,5,},{1,3,},
17,19,4,5,3,	{1,2,6,17,},{1,2,6,19,},{1,2,4,},{1,2,5,},{1,3,},
19,4,5,3,	{1,2,6,19,},{1,2,4,},{1,2,5,},{1,3,},
4,5,3,	{1,2,4,},{1,2,5,},{1,3,},
9,11,10,12,5,3,	{1,2,4,9,},{1,2,4,11,},{1,2,4,10,},{1,2,4,12,},{1,2,5,},{1,3,},
11,10,12,5,3,	{1,2,4,11,},{1,2,4,10,},{1,2,4,12,},{1,2,5,},{1,3,},
10,12,5,3,	{1,2,4,10,},{1,2,4,12,},{1,2,5,},{1,3,},
12,5,3,	{1,2,4,12,},{1,2,5,},{1,3,},
5,3,	{1,2,5,},{1,3,},
16,13,14,15,3,	{1,2,5,16,},{1,2,5,13,},{1,2,5,14,},{1,2,5,15,},{1,3,},
13,14,15,3,	{1,2,5,13,},{1,2,5,14,},{1,2,5,15,},{1,3,},

Path found: 1-2-5-13-

The number of visited states is 14.

## Question 60

Given the following search graph, write the sequence of node numbers in the search agenda across the search life-time and using *A\* search*.



Assume the following heuristic value per node:

Node ID	Node Heuristic value
1	271
2	110
3	0
4	147
5	423

6	301
---	-----

Assume distance between cities are as mentioned on the links

Apply A\* algorithm showing intermediate values for the Agenda,  $g(n)$ ,  $h(n)$

Source city is :C2

Destination city:C3

Answer:

		<b>iteration 1</b>					
states		2					
$g(n)$		0					
$h(n)$		110					
$g(n)+h(n)$		110					
visited?		0					

		<b>iteration 2</b>					
states	2		1	4	6		
$g(n)$	0		161	49	209		
$h(n)$	110		271	147	301		
$g(n)+h(n)$	110		432	196	510		
visited?	1		0	0	0		

		<b>iteration 3</b>					
states	2	1	4	6	1	2	3
$g(n)$	0	161	49	209	184	98	196
$h(n)$	110	271	147	301	271	110	0
$g(n)+h(n)$	110	432	196	510	455	208	196
visited?	1	0	1	0	0	0	0

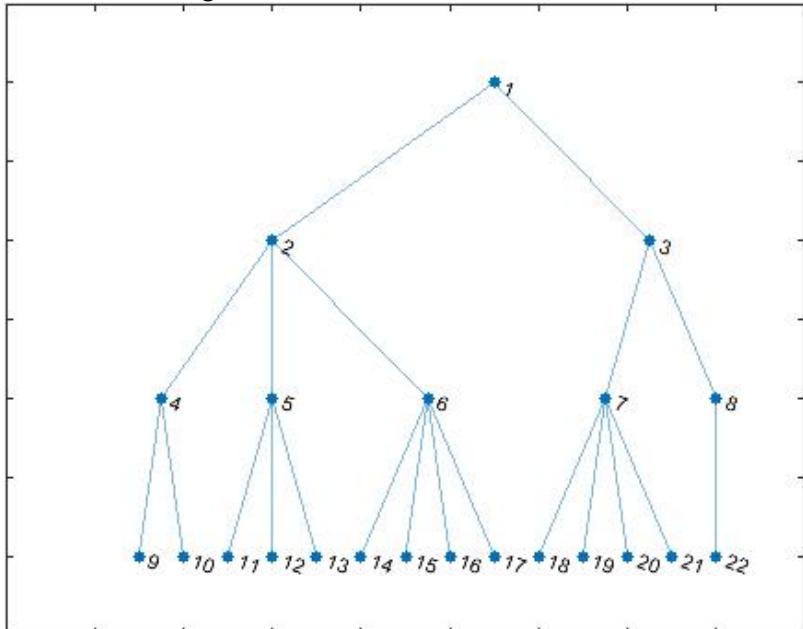
Final path:2-4-3-

## Question 62

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 13.



**Answer:**

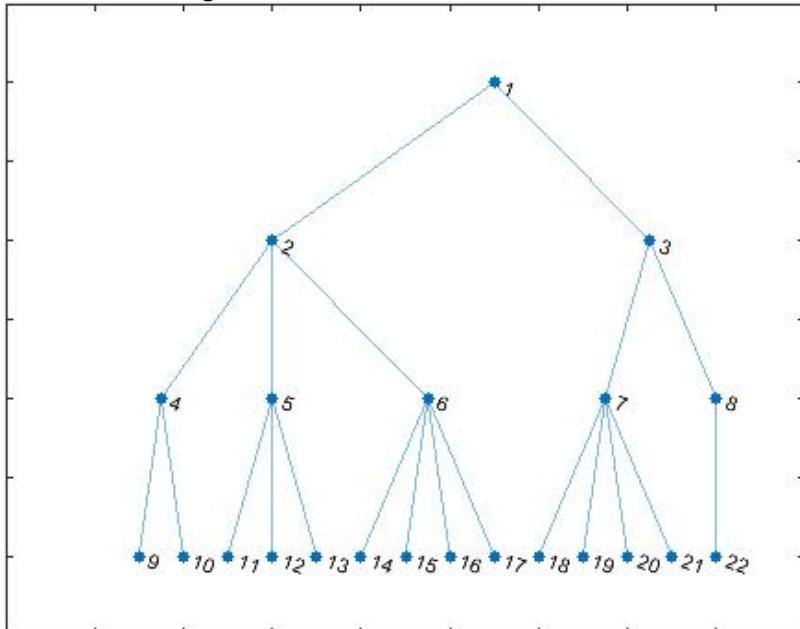
1,	{1,},
2,3,	{1,2,},{1,3,},
4,5,6,3,	{1,2,4,},{1,2,5,},{1,2,6,},{1,3,},
9,10,5,6,3,	{1,2,4,9,},{1,2,4,10,},{1,2,5,},{1,2,6,},{1,3,},
10,5,6,3,	{1,2,4,10,},{1,2,5,},{1,2,6,},{1,3,},
5,6,3,	{1,2,5,},{1,2,6,},{1,3,},
11,12,13,6,3,	{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},{1,2,6,},{1,3,},
12,13,6,3,	{1,2,5,12,},{1,2,5,13,},{1,2,6,},{1,3,},
13,6,3,	{1,2,5,13,},{1,2,6,},{1,3,},

**Path found: 1-2-5-13-**

The number of visited states is 9. Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 13.



**Answer:**

1,	{1},
2,3,	{1,2,},{1,3,},
3,4,5,6,	{1,3,},{1,2,4,},{1,2,5,},{1,2,6,},
4,5,6,7,8,	{1,2,4,},{1,2,5,},{1,2,6,},{1,3,7,},{1,3,8,},
5,6,7,8,9,10,	{1,2,5,},{1,2,6,},{1,3,7,},{1,3,8,},{1,2,4,9,},{1,2,4,10,},
6,7,8,9,10,11,12,13,	{1,2,6,},{1,3,7,},{1,3,8,},{1,2,4,9,},{1,2,4,10,},{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},
7,8,9,10,11,12,13,14,15,16,17,	{1,3,7,},{1,3,8,},{1,2,4,9,},{1,2,4,10,},{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},
8,9,10,11,12,13,14,15,16,17,18,19,20,21,	{1,3,8,},{1,2,4,9,},{1,2,4,10,},{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,3,7,18,},{1,3,7,19,},{1,3,7,20,},{1,3,7,21,},
9,10,11,12,13,14,15,16,17,18,19,20,21,22,	{1,2,4,9,},{1,2,4,10,},{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,2,6,18,},{1,2,6,19,},{1,2,6,20,},{1,2,6,21,},{1,3,7,21,},{1,3,8,22,},
10,11,12,13,14,15,16,17,18,19,20,21,22,	{1,2,4,10,},{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,2,6,18,},{1,2,6,19,},{1,2,6,20,},{1,2,6,21,},{1,3,8,22,},
11,12,13,14,15,16,17,18,19,20,21,22,	{1,2,5,11,},{1,2,5,12,},{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,2,6,18,},{1,2,6,19,},{1,2,6,20,},{1,2,6,21,},{1,3,8,22,},
12,13,14,15,16,17,18,19,20,21,22,	{1,2,5,12,},{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,3,7,18,},{1,3,7,19,},{1,3,7,20,},{1,3,7,21,},{1,3,8,22,},
13,14,15,16,17,18,19,20,21,22,	{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,6,17,},{1,3,7,18,},{1,3,7,19,},{1,3,7,20,},{1,3,7,21,},{1,3,8,22,},

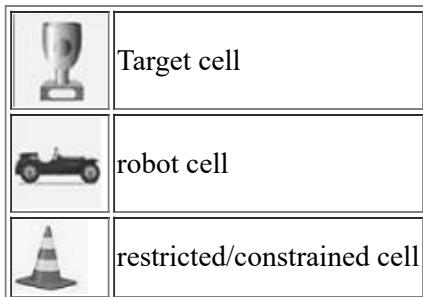
Path found:1-2-5-13-

The number of visited states is 13.

## Question 63

Having the following grid and the depicted agent at location (x=7,y=4) and a target object located at (x=5,y=2)  
 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 the grid.

Assume Euclidian distance from the current location to the target location as the heuristic value.



---

## Answer

(row=1,col=1) <b>1</b>	(row=1,col=2) <b>7</b>	(row=1,col=3) <b>13</b>	(row=1,col=4) <b>19</b>	(row=1,col=5) <b>25</b>	(row=1,col=6) <b>31</b>	(row=1,col=7) <b>37</b>	(row=1,col=8) <b>43</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>8</b>	(row=2,col=3) <b>14</b>	(row=2,col=4) <b>20</b>	(row=2,col=5) <b>26</b> 	(row=2,col=6) <b>32</b>	(row=2,col=7) <b>38</b>	(row=2,col=8) <b>44</b>
(row=3,col=1) <b>3</b>	(row=3,col=2) <b>9</b>	(row=3,col=3) <b>15</b>	(row=3,col=4) <b>21</b> 	(row=3,col=5) <b>27</b>	(row=3,col=6) <b>33</b>	(row=3,col=7) <b>39</b>	(row=3,col=8) <b>45</b>
(row=4,col=1) <b>4</b>	(row=4,col=2) <b>10</b> 	(row=4,col=3) <b>16</b>	(row=4,col=4) <b>22</b> 	(row=4,col=5) <b>28</b>	(row=4,col=6) <b>34</b>	(row=4,col=7) <b>40</b> 	(row=4,col=8) <b>46</b>
(row=5,col=1) <b>5</b>	(row=5,col=2) <b>11</b>	(row=5,col=3) <b>17</b>	(row=5,col=4) <b>23</b>	(row=5,col=5) <b>29</b>	(row=5,col=6) <b>35</b>	(row=5,col=7) <b>41</b>	(row=5,col=8) <b>47</b> 
(row=6,col=1) <b>6</b>	(row=6,col=2) <b>12</b>	(row=6,col=3) <b>18</b>	(row=6,col=4) <b>24</b>	(row=6,col=5) <b>30</b> 	(row=6,col=6) <b>36</b>	(row=6,col=7) <b>42</b>	(row=6,col=8) <b>48</b>

(row=1,col=1) <b>1</b>	(row=1,col=2) <b>7</b>	(row=1,col=3) <b>13</b>	(row=1,col=4) <b>19</b>	(row=1,col=5) <b>25</b>	(row=1,col=6) <b>31</b>	(row=1,col=7) <b>37</b>	(row=1,col=8) <b>43</b>
(row=2,col=1) <b>2</b>	(row=2,col=2) <b>8</b>	(row=2,col=3) <b>14</b>	(row=2,col=4) <b>20</b>	(row=2,col=5) <b>26</b>	(row=2,col=6) <b>32</b>	(row=2,col=7) <b>38</b>	(row=2,col=8) <b>44</b>

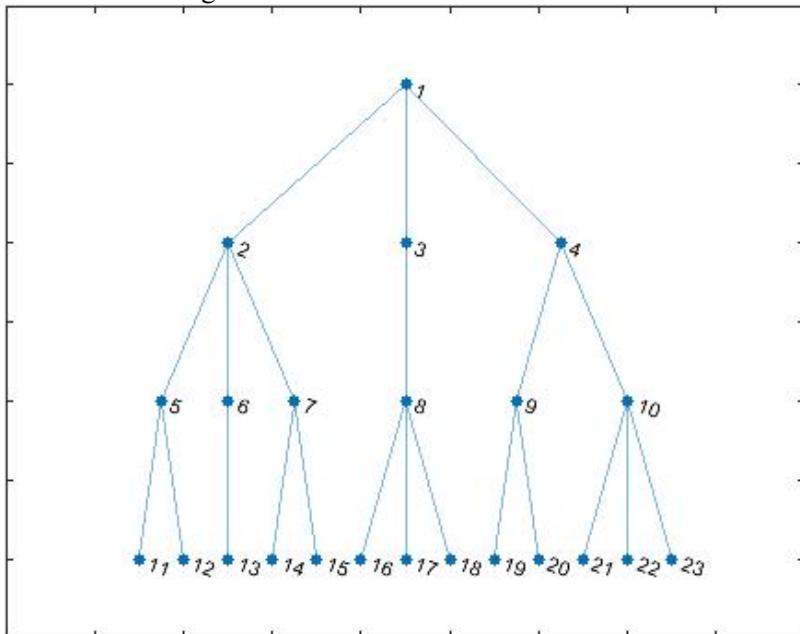
(row=3,col=1) 3	(row=3,col=2) 9	(row=3,col=3) 15	(row=3,col=4) 21	(row=3,col=5) 27	(row=3,col=6) 33 	(row=3,col=7) 39 	(row=3,col=8) 45
(row=4,col=1) 4	(row=4,col=2) 10	(row=4,col=3) 16	(row=4,col=4) 22	(row=4,col=5) 28	(row=4,col=6) 34	(row=4,col=7) 40 	(row=4,col=8) 46 
(row=5,col=1) 5	(row=5,col=2) 11	(row=5,col=3) 17	(row=5,col=4) 23	(row=5,col=5) 29	(row=5,col=6) 35	(row=5,col=7) 41	(row=5,col=8) 47 
(row=6,col=1) 6	(row=6,col=2) 12	(row=6,col=3) 18	(row=6,col=4) 24	(row=6,col=5) 30	(row=6,col=6) 36	(row=6,col=7) 42	(row=6,col=8) 48

## Question 64

Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 19.



Answer:

1,	{1,},
2,3,4,	{1,2,},{1,3,},{1,4,},
3,4,5,6,7,	{1,3,},{1,4,},{1,2,5,},{1,2,6,},{1,2,7,},
4,5,6,7,8,	{1,4,},{1,2,5,},{1,2,6,},{1,2,7,},{1,3,8,},

5,6,7,8,9,10,	$\{1,2,5\}, \{1,2,6\}, \{1,2,7\}, \{1,3,8\}, \{1,4,9\}, \{1,4,10\},$
6,7,8,9,10,11,12,	$\{1,2,6\}, \{1,2,7\}, \{1,3,8\}, \{1,4,9\}, \{1,4,10\}, \{1,2,5,11\}, \{1,2,5,12\},$
7,8,9,10,11,12,13,	$\{1,2,7\}, \{1,3,8\}, \{1,4,9\}, \{1,4,10\}, \{1,2,5,11\}, \{1,2,5,12\}, \{1,2,6,13\},$
8,9,10,11,12,13,14,15,	$\{1,3,8\}, \{1,4,9\}, \{1,4,10\}, \{1,2,5,11\}, \{1,2,5,12\}, \{1,2,6,13\}, \{1,2,7,14\}, \{1,2,7,15\},$
9,10,11,12,13,14,15,16,17,18,	$\{1,4,9\}, \{1,4,10\}, \{1,2,5,11\}, \{1,2,5,12\}, \{1,2,6,13\}, \{1,2,7,14\}, \{1,2,7,15\}, \{1,3,8,16\}, \{1,3,8,17\}, \{1,3,8,18\},$
10,11,12,13,14,15,16,17,18,19,20,	$\{1,4,10\}, \{1,2,5,11\}, \{1,2,5,12\}, \{1,2,6,13\}, \{1,2,7,14\}, \{1,2,7,15\}, \{1,3,8,16\}, \{1,3,8,17\}, \{1,3,8,18\}, \{1,4,9,19\}, \{1,4,9,20\},$
11,12,13,14,15,16,17,18,19,20,21,22,23,	$\{1,2,5,11\}, \{1,2,5,12\}, \{1,2,6,13\}, \{1,2,7,14\}, \{1,2,7,15\}, \{1,3,8,16\}, \{1,3,8,17\}, \{1,3,8,18\}, \{1,3,8,19\}, \{1,3,8,18\}, \{1,4,9,19\}, \{1,4,9,20\}, \{1,4,10,21\}, \{1,4,10,22\}, \{1,4,10,23\},$
12,13,14,15,16,17,18,19,20,21,22,23,	$\{1,2,5,12\}, \{1,2,6,13\}, \{1,2,7,14\}, \{1,2,7,15\}, \{1,3,8,16\}, \{1,3,8,17\}, \{1,3,8,18\}, \{1,4,9,19\}, \{1,4,9,20\}, \{1,4,10,21\}, \{1,4,10,22\}, \{1,4,10,23\},$
13,14,15,16,17,18,19,20,21,22,23,	$\{1,2,6,13\}, \{1,2,7,14\}, \{1,2,7,15\}, \{1,3,8,16\}, \{1,3,8,17\}, \{1,3,8,18\}, \{1,4,9,19\}, \{1,4,9,20\}, \{1,4,10,21\}, \{1,4,10,22\}, \{1,4,10,23\},$
14,15,16,17,18,19,20,21,22,23,	$\{1,2,7,14\}, \{1,2,7,15\}, \{1,3,8,16\}, \{1,3,8,17\}, \{1,3,8,18\}, \{1,4,9,19\}, \{1,4,9,20\}, \{1,4,10,21\}, \{1,4,10,22\}, \{1,4,10,23\},$
15,16,17,18,19,20,21,22,23,	$\{1,2,7,15\}, \{1,3,8,16\}, \{1,3,8,17\}, \{1,3,8,18\}, \{1,4,9,19\}, \{1,4,9,20\}, \{1,4,10,21\}, \{1,4,10,22\}, \{1,4,10,23\},$
16,17,18,19,20,21,22,23,	$\{1,3,8,16\}, \{1,3,8,17\}, \{1,3,8,18\}, \{1,4,9,19\}, \{1,4,9,20\}, \{1,4,10,21\},$
17,18,19,20,21,22,23,	$\{1,3,8,17\}, \{1,3,8,18\}, \{1,4,9,19\}, \{1,4,9,20\}, \{1,4,10,21\}, \{1,4,10,22\}, \{1,4,10,23\},$
18,19,20,21,22,23,	$\{1,3,8,18\}, \{1,4,9,19\}, \{1,4,9,20\}, \{1,4,10,21\}, \{1,4,10,22\}, \{1,4,10,23\},$
19,20,21,22,23,	$\{1,4,9,19\}, \{1,4,9,20\}, \{1,4,10,21\}, \{1,4,10,22\}, \{1,4,10,23\},$

Path found: 1-4-9-19-

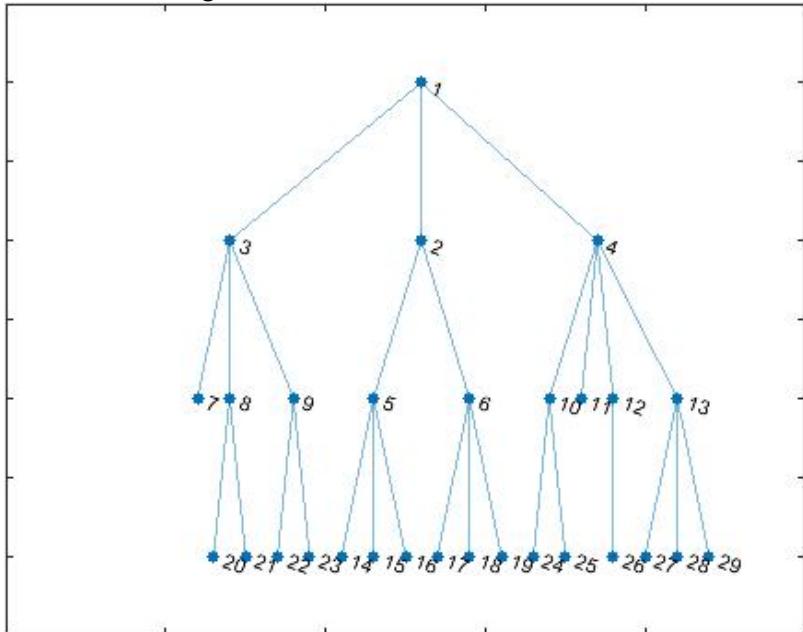
The number of visited states is 19.

## Question 65

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 14.



Answer:

1,	{1},
2,3,4,	{1,2},{1,3},{1,4},
5,6,3,4,	{1,2,5},{1,2,6},{1,3},{1,4},
14,15,16,6,3,4,	{1,2,5,14},{1,2,5,15},{1,2,5,16},{1,2,6},{1,3},{1,4},

Path found: 1-2-5-14-

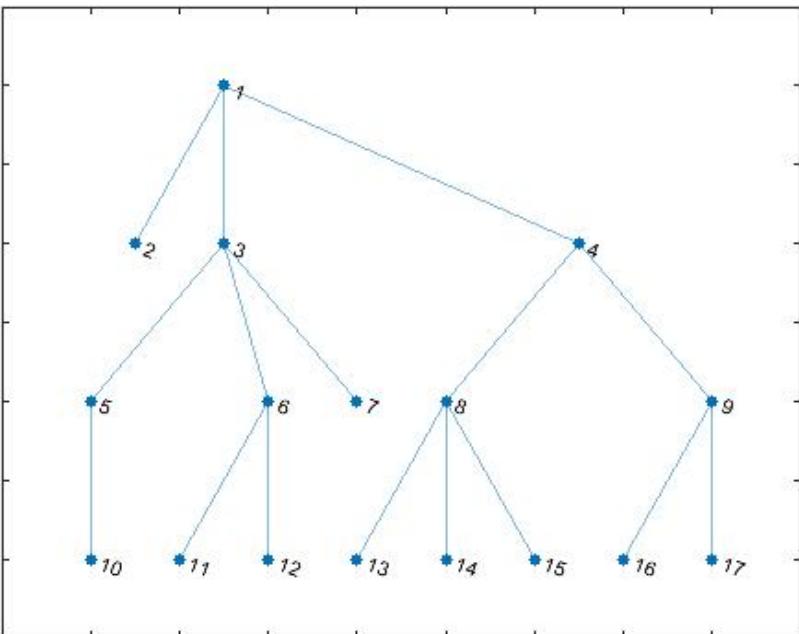
The number of visited states is 4.

## Question 66

Given the following search graph and adopting *best-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 8.



Node ID	Node Heuristic value
1	1
2	3
3	0
4	9
5	17
6	12
7	10
8	17
9	2
10	18
11	2
12	10
13	3
14	11
15	0
16	15
17	17

Answer:

1,	{1,},
3,2,4,	{1,3,},{1,2,},{1,4,},
7,6,5,2,4,	{1,3,7,},{1,3,6,},{1,3,5,},{1,2,},{1,4,},
6,5,2,4,	{1,3,6,},{1,3,5,},{1,2,},{1,4,},
11,12,5,2,4,	{1,3,6,11,},{1,3,6,12,},{1,3,5,},{1,2,},{1,4,},
12,5,2,4,	{1,3,6,12,},{1,3,5,},{1,2,},{1,4,},
5,2,4,	{1,3,5,},{1,2,},{1,4,},
10,2,4,	{1,3,5,10,},{1,2,},{1,4,},
2,4,	{1,2,},{1,4,},
4,	{1,4,},

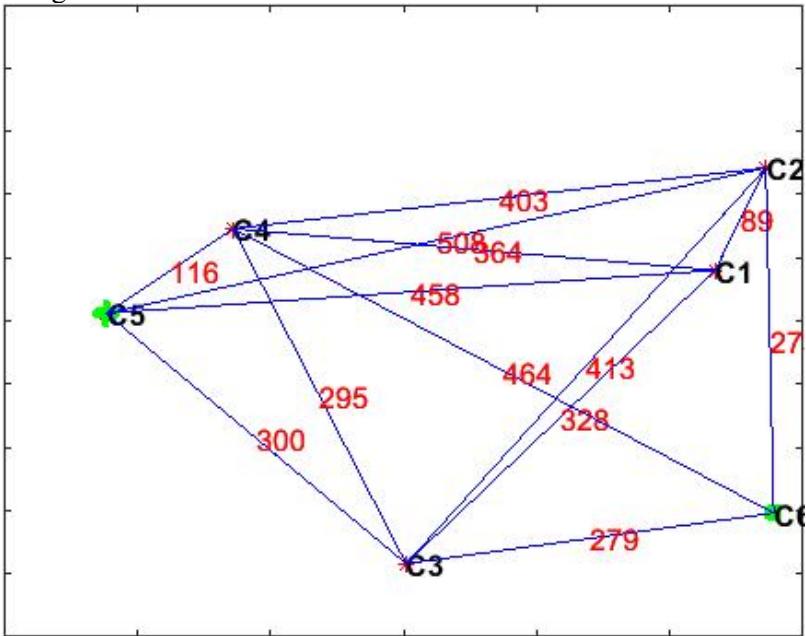
9,8,	{1,4,9,},{1,4,8,},
16,17,8,	{1,4,9,16,},{1,4,9,17,},{1,4,8,},
17,8,	{1,4,9,17,},{1,4,8,},
8,	{1,4,8,},

Path found: 1-4-8-

The number of visited states is 14.

## Question 67

Given the following search graph, write the sequence of node numbers in the search agenda across the search life-time and using  $A^*$  search.



Assume the following heuristic value per node:

Node ID	Node Heuristic value
1	197
2	273
3	279
4	464
5	525
6	0

Assume distance between cities are as mentioned on the links

Apply  $A^*$  algorithm showing intermediate values for the Agenda,  $g(n)$ ,  $h(n)$

Source city is :C5

Destination city:C6

Answer:

	iteration 1
states	5
$g(n)$	0
$h(n)$	525
$g(n)+h(n)$	525
visited?	0

		<b>iteration 2</b>					
states	5	1	2	3	4		
g(n)	0	458	508	300	116		
h(n)	525	197	273	279	464		
g(n)+h(n)	525	655	781	579	580		
visited?	1	0	0	0	0		

		<b>iteration 3</b>										
states	5	1	2	3	4	1	2	4	5	6		
g(n)	0	458	508	300	116	628	713	595	599	579		
h(n)	525	197	273	279	464	197	273	464	525	0		
g(n)+h(n)	525	655	781	579	580	825	986	1059	1125	579		
visited?	1	0	0	1	0	0	0	0	0	0		

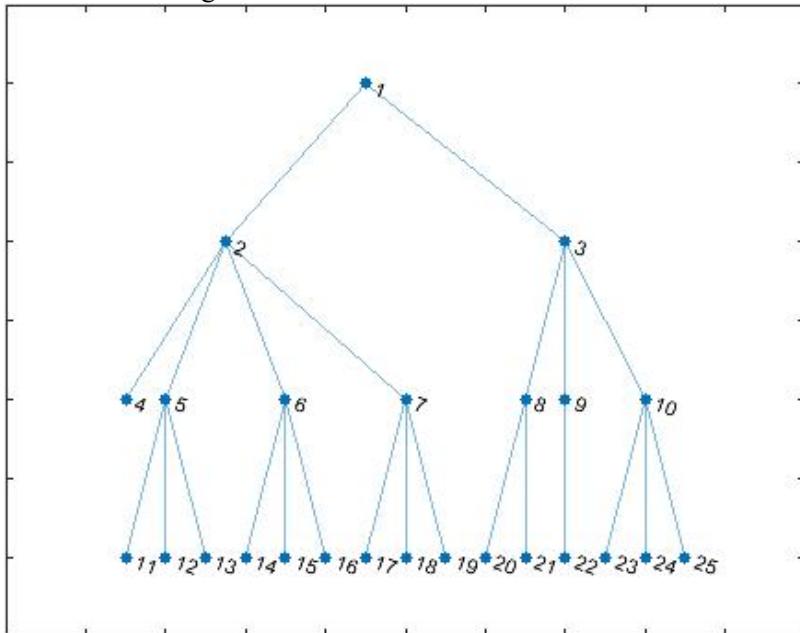
Final path: 5-3-6-

## Question 69

Given the following search graph and adopting *depth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goal state is 14.



Answer:

1,	{1},
2,3,	{1,2,}, {1,3,},
4,5,6,7,3,	{1,2,4,}, {1,2,5,}, {1,2,6,}, {1,2,7,}, {1,3,},
5,6,7,3,	{1,2,5,}, {1,2,6,}, {1,2,7,}, {1,3,},
11,12,13,6,7,3,	{1,2,5,11,}, {1,2,5,12,}, {1,2,5,13,}, {1,2,6,}, {1,2,7,}, {1,3,},
12,13,6,7,3,	{1,2,5,12,}, {1,2,5,13,}, {1,2,6,}, {1,2,7,}, {1,3,},

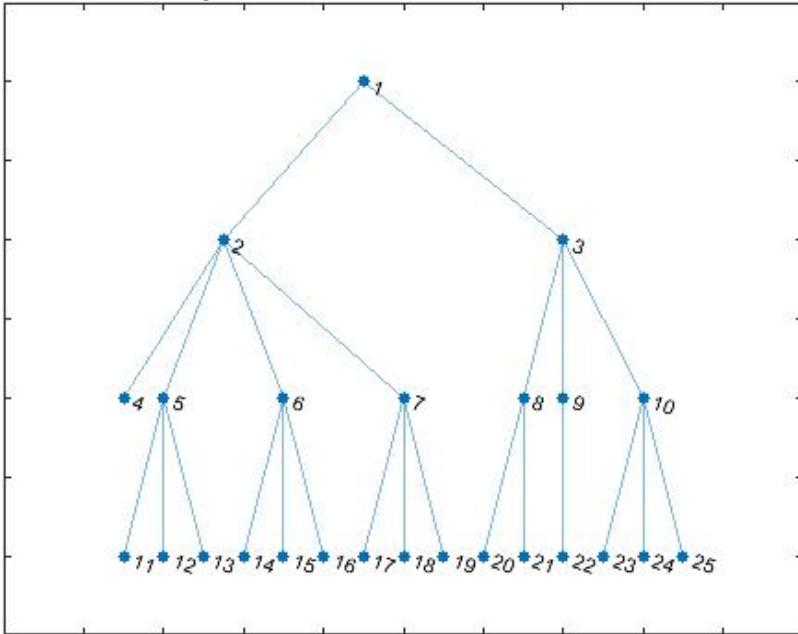
13,6,7,3,	$\{1,2,5,13,\}, \{1,2,6,\}, \{1,2,7,\}, \{1,3,\},$
6,7,3,	$\{1,2,6,\}, \{1,2,7,\}, \{1,3,\},$
14,15,16,7,3,	$\{1,2,6,14,\}, \{1,2,6,15,\}, \{1,2,6,16,\}, \{1,2,7,\}, \{1,3,\},$

Path found: 1-2-6-14-

The number of visited states is 9. Given the following search graph and adopting *breadth-first search*:

1. Trace the states inside the search agenda until reaching the goal state.
2. How many states will be visited until reaching the goal state?
3. Mention the solution path if exist to the goal state.

Assume that the goals state is 14.



Answer:

1,	$\{1,\},$
2,3,	$\{1,2,\}, \{1,3,\},$
3,4,5,6,7,	$\{1,3,\}, \{1,2,4,\}, \{1,2,5,\}, \{1,2,6,\}, \{1,2,7,\},$
4,5,6,7,8,9,10,	$\{1,2,4,\}, \{1,2,5,\}, \{1,2,6,\}, \{1,2,7,\}, \{1,3,8,\}, \{1,3,9,\}, \{1,3,10,\},$
5,6,7,8,9,10,	$\{1,2,5,\}, \{1,2,6,\}, \{1,2,7,\}, \{1,3,8,\}, \{1,3,9,\}, \{1,3,10,\},$
6,7,8,9,10,11,12,13,	$\{1,2,6,\}, \{1,2,7,\}, \{1,3,8,\}, \{1,3,9,\}, \{1,3,10,\}, \{1,2,5,11,\}, \{1,2,5,12,\}, \{1,2,5,13,\},$
7,8,9,10,11,12,13,14,15,16,	$\{1,2,7,\}, \{1,3,8,\}, \{1,3,9,\}, \{1,3,10,\}, \{1,2,5,11,\}, \{1,2,5,12,\}, \{1,2,5,13,\}, \{1,2,6,14,\}, \{1,2,6,15,\}, \{1,2,6,16,\},$
8,9,10,11,12,13,14,15,16,17,18,19,	$\{1,3,8,\}, \{1,3,9,\}, \{1,3,10,\}, \{1,2,5,11,\}, \{1,2,5,12,\}, \{1,2,5,13,\}, \{1,2,6,14,\}, \{1,2,6,15,\}, \{1,2,6,16,\}, \{1,2,7,17,\}, \{1,2,7,18,\}, \{1,2,7,19,\},$
9,10,11,12,13,14,15,16,17,18,19,20,21,	$\{1,3,9,\}, \{1,3,10,\}, \{1,2,5,11,\}, \{1,2,5,12,\}, \{1,2,5,13,\}, \{1,2,6,14,\}, \{1,2,6,15,\}, \{1,2,6,16,\}, \{1,2,6,17,\}, \{1,2,6,18,\}, \{1,2,7,17,\}, \{1,2,7,18,\}, \{1,2,7,19,\}, \{1,3,8,20,\}, \{1,3,8,21,\}, \{1,3,8,22,\}, \{1,3,8,23,\}$
10,11,12,13,14,15,16,17,18,19,20,21,22,	$\{1,3,10,\}, \{1,2,5,11,\}, \{1,2,5,12,\}, \{1,2,5,13,\}, \{1,2,6,14,\}, \{1,2,6,15,\}, \{1,2,6,16,\}, \{1,2,6,17,\}, \{1,2,7,17,\}, \{1,2,7,18,\}, \{1,2,7,19,\}, \{1,3,8,20,\}, \{1,3,8,21,\}, \{1,3,8,22,\}, \{1,3,9,22,\}, \{1,3,10,23,\}$
11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,	$\{1,2,5,11,\}, \{1,2,5,12,\}, \{1,2,5,13,\}, \{1,2,6,14,\}, \{1,2,6,15,\}, \{1,2,6,16,\}, \{1,2,6,17,\}, \{1,2,7,17,\}, \{1,2,7,18,\}, \{1,2,7,19,\}, \{1,3,8,20,\}, \{1,3,8,21,\}, \{1,3,8,22,\}, \{1,3,9,22,\}, \{1,3,10,23,\}, \{1,3,10,24,\}, \{1,3,10,25,\}$
12,13,14,15,16,17,18,19,20,21,22,23,24,25,	$\{1,2,5,12,\}, \{1,2,5,13,\}, \{1,2,6,14,\}, \{1,2,6,15,\}, \{1,2,6,16,\}, \{1,2,7,17,\}, \{1,2,7,18,\}, \{1,2,7,19,\}, \{1,3,8,20,\}, \{1,3,8,21,\}, \{1,3,9,22,\}, \{1,3,10,23,\}, \{1,3,10,24,\}, \{1,3,10,25,\}$

13,14,15,16,17,18,19,20,21,22,23,24,25,	{1,2,5,13,},{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,7,17,},{1,2,7,18,}, {1,2,7,19,},{1,3,8,20,},{1,3,8,21,},{1,3,9,22,},{1,3,10,23,},{1,3,10,24,}, {1,3,10,25,},
14,15,16,17,18,19,20,21,22,23,24,25,	{1,2,6,14,},{1,2,6,15,},{1,2,6,16,},{1,2,7,17,},{1,2,7,18,},{1,2,7,19,}, {1,3,8,20,},{1,3,8,21,},{1,3,9,22,},{1,3,10,23,},{1,3,10,24,}, {1,3,10,25,},

Path found:1-2-6-14-

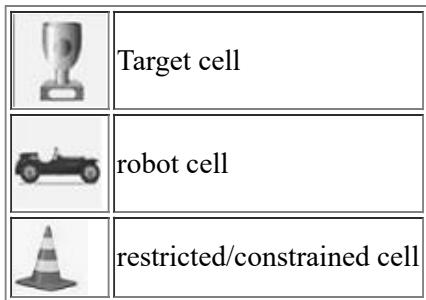
The number of visited states is 14.

## Question 70

Having the following grid and the depicted agent at location (x=5,y=1) and a target object located at (x=3,y=3)

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 the grid.

Assume Euclidian distance from the current location to the target location as the heuristic value.



Answer

(row=1,col=1) 1	(row=1,col=2) 8	(row=1,col=3) 15	(row=1,col=4) 22 	(row=1,col=5) 29 	(row=1,col=6) 36	(row=1,col=7) 43
(row=2,col=1) 2 	(row=2,col=2) 9	(row=2,col=3) 16	(row=2,col=4) 23	(row=2,col=5) 30	(row=2,col=6) 37	(row=2,col=7) 44
(row=3,col=1) 3	(row=3,col=2) 10	(row=3,col=3) 17 	(row=3,col=4) 24	(row=3,col=5) 31	(row=3,col=6) 38	(row=3,col=7) 45 
(row=4,col=1) 4	(row=4,col=2) 11	(row=4,col=3) 18	(row=4,col=4) 25	(row=4,col=5) 32	(row=4,col=6) 39	(row=4,col=7) 46
(row=5,col=1) 5	(row=5,col=2) 12	(row=5,col=3) 19	(row=5,col=4) 26	(row=5,col=5) 33	(row=5,col=6) 40	(row=5,col=7) 47
(row=6,col=1) 6	(row=6,col=2) 13	(row=6,col=3) 20	(row=6,col=4) 27 	(row=6,col=5) 34	(row=6,col=6) 41	(row=6,col=7) 48
(row=7,col=1) 7	(row=7,col=2) 14	(row=7,col=3) 21	(row=7,col=4) 28	(row=7,col=5) 35	(row=7,col=6) 42 	(row=7,col=7) 49
states	29					
H	2.83					

states	30	36								
H	2.24	3.61								
states	23	31	29	37	36					
H	1.41	2.00	2.83	3.16	3.61					
states	24	16	30	31	29	37	36			
H	1.00	1.00	2.24	2.00	2.83	3.16	3.61			
states	17	25	23	31	16	30	31	29	37	36
H	0.00	1.41	1.41	2.00	1.00	2.24	2.00	2.83	3.16	3.61

(row=1,col=1) <b>1</b>	(row=1,col=2) <b>8</b>	(row=1,col=3) <b>15</b>	(row=1,col=4) <b>22</b> 	(row=1,col=5) <b>29</b> 	(row=1,col=6) <b>36</b> 	(row=1,col=7) <b>43</b>
(row=2,col=1) <b>2</b> 	(row=2,col=2) <b>9</b>	(row=2,col=3) <b>16</b>	(row=2,col=4) <b>23</b> 	(row=2,col=5) <b>30</b> 	(row=2,col=6) <b>37</b>	(row=2,col=7) <b>44</b>
(row=3,col=1) <b>3</b>	(row=3,col=2) <b>10</b>	(row=3,col=3) <b>17</b> 	(row=3,col=4) <b>24</b> 	(row=3,col=5) <b>31</b>	(row=3,col=6) <b>38</b>	(row=3,col=7) <b>45</b> 
(row=4,col=1) <b>4</b>	(row=4,col=2) <b>11</b>	(row=4,col=3) <b>18</b>	(row=4,col=4) <b>25</b>	(row=4,col=5) <b>32</b>	(row=4,col=6) <b>39</b>	(row=4,col=7) <b>46</b>
(row=5,col=1) <b>5</b>	(row=5,col=2) <b>12</b>	(row=5,col=3) <b>19</b>	(row=5,col=4) <b>26</b>	(row=5,col=5) <b>33</b>	(row=5,col=6) <b>40</b>	(row=5,col=7) <b>47</b>
(row=6,col=1) <b>6</b>	(row=6,col=2) <b>13</b>	(row=6,col=3) <b>20</b>	(row=6,col=4) <b>27</b> 	(row=6,col=5) <b>34</b>	(row=6,col=6) <b>41</b>	(row=6,col=7) <b>48</b>
(row=7,col=1) <b>7</b>	(row=7,col=2) <b>14</b>	(row=7,col=3) <b>21</b>	(row=7,col=4) <b>28</b>	(row=7,col=5) <b>35</b>	(row=7,col=6) <b>42</b> 	(row=7,col=7) <b>49</b>