الجامعة العربية المفتوحة
Arab Open University

Faculty of Computer Studies
M366

Work Shop TM366

Chapter 1/2

And elimination	Modus ponens
P ^ q ——— P q	P P →q ——— q
And introduction	**Modus Tollens**
P Q ——— P ∧Q	p→q ¬q ——— ¬p
Addition	**Or introduction**
P ——— P ∨Q	P Q ——— P v Q
Unit resolution	**Resolution**
P v q ¬q ——— P	P v q ¬q v r ——— P v r

Problems:-

1) Prove the valid argument

$p \rightarrow (q \vee r)$

P

$\sim r$

$\therefore$ Q

Answer:-

Given 1) $p \rightarrow (q \vee r)$ and 2) P we can deduce 4) $(q \vee r)$ (Modus Ponens)

Given 3) $\sim r$ and 4) $(q \vee r)$ we can deduce 5) Q (Unit Resolution)

2) Prove the valid argument

$(p \vee r) \rightarrow (s \wedge t)$

P

$\therefore$ t

Answer:- Given 2) P We can deduce 3) p v r (Addition)

Given 1) $(p \vee r) \rightarrow (s \wedge t)$ and 3) (p v r) We can deduce 4) $(s \wedge t)$ (Modus ponens)

Given 4) $(s \wedge t)$ We can deduce 5) s and 6) t (And Elimination)

3) Using suitable predicate inference rules deduce t assuming

$\neg p \wedge q,\ r \rightarrow p,\ \neg r \rightarrow s,\ s \rightarrow t$

Answer:-

Given 1) $\neg$ p ¿q We can deduce 5) $\neg$ p and 6) q (And Elimination)

Given 2) r → p and 5) $\neg$ p We can deduce 7) $\neg$ r (Modus Tollens)

Given 3) $\neg$ r → s and 7) $\neg$ r We can deduce 8) s (Modus Ponens)

Given 4) s→t and 8) s We can deduce t (Modus Ponens)

4) Given the following premises:
    1) Either cat fur was found at the scene of the crime, or dog fur was found at the scene of the crime.
    2) If dog fur was found at the scene of the crime, then officer Thompson had an allergy attack.
    3) If cat fur was found at the scene of the crime, then Macavity is responsible for the crime.
    4) Officer Thompson did not have an allergy attack.

Show all intermediate steps mentioning the implication rule used.

Deduce M

Answer:-

Cat fur was found at the scene of the crime (C)

Dog fur was found at the scene of the crime (D)

Officer Thompson had an allergy attack (O)

Macavity is responsible for the crime (M)

5) C v D
6) D → O
7) C → M
8) ¬ O

Given 2) D → O and 4) ¬ O We can deduce 5) ¬ D (Modus Tollens)
Given 1) C v D and 5) ¬ D We can deduce 6) C (Unit Resolution)
Given 3) C→M and 6) C We can deduce 7) M (Modus Ponens)

5) Given the following premises and using propositional calculus rules:

$t \rightarrow (m \vee e)$

$s \rightarrow \neg e$

$t \wedge s$

Show detailed steps for deducing m

Answer:-

1) t → (m ∨ e)

6) s → ~e

7) t^s

Given 3) t^s We can deduce 4) t and 5) s (And Elimination)

Given 1) t → (m ∨ e) and 4) t We can deduce 6) (m ∨ e) (Modus Ponens)

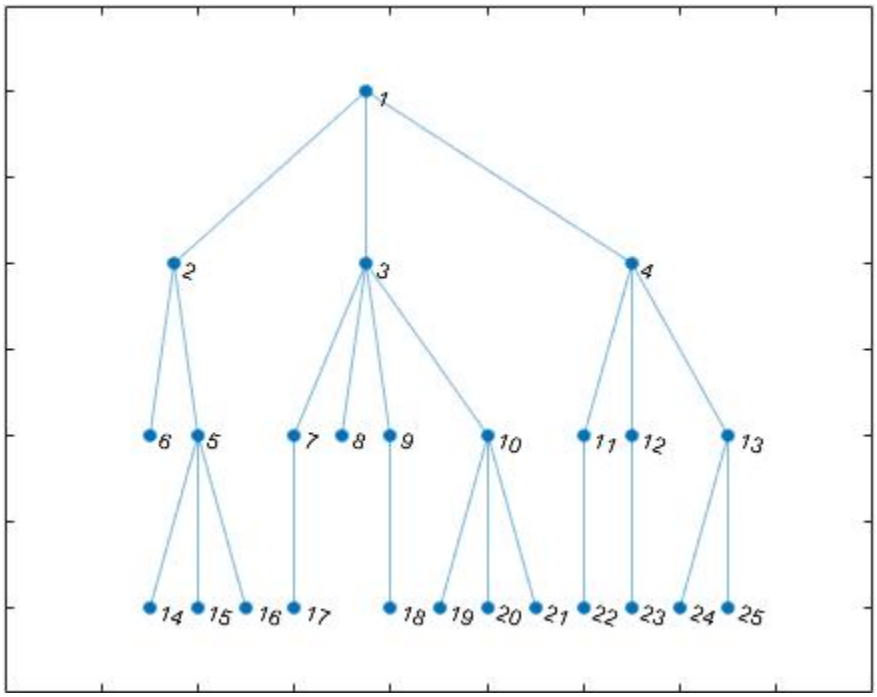
Given 2) s → ~e and 5) s We can deduce 7) ~e (Modus Ponens)

Given 6) (m ∨ e) and 7) ~e We can deduce 8) m (Unit Resolution)

Chapter 2

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

The Goal state is 18



Answer:-

Hint (Depth means children are in the front)

1

2,3,4

6,5,3,4

5,3,4

14,15,16,3,4

15,16,3,4

16,3,4

3,4

7,8,9,10,4

17,8,9,10,4

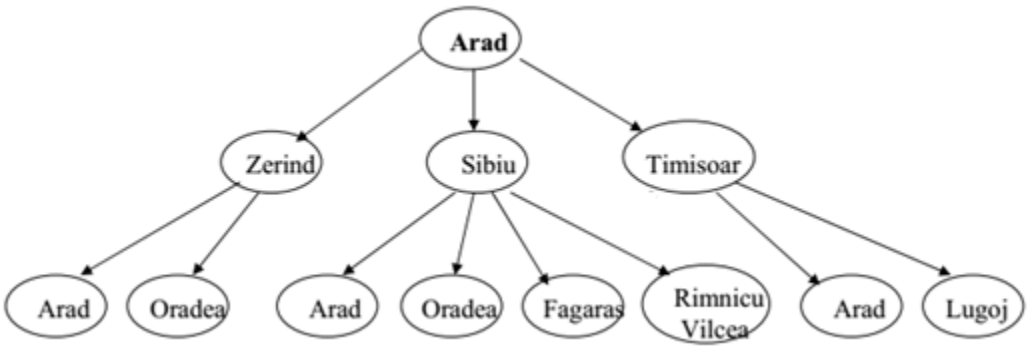
8,9,10,4

9,10,4

18,10,4

The number of visited states is 13

1) Given the following tree of states and using depth-limited search with depth limit=1, show the content of the search agenda at the different times. **[10 Marks]**



Answer:-

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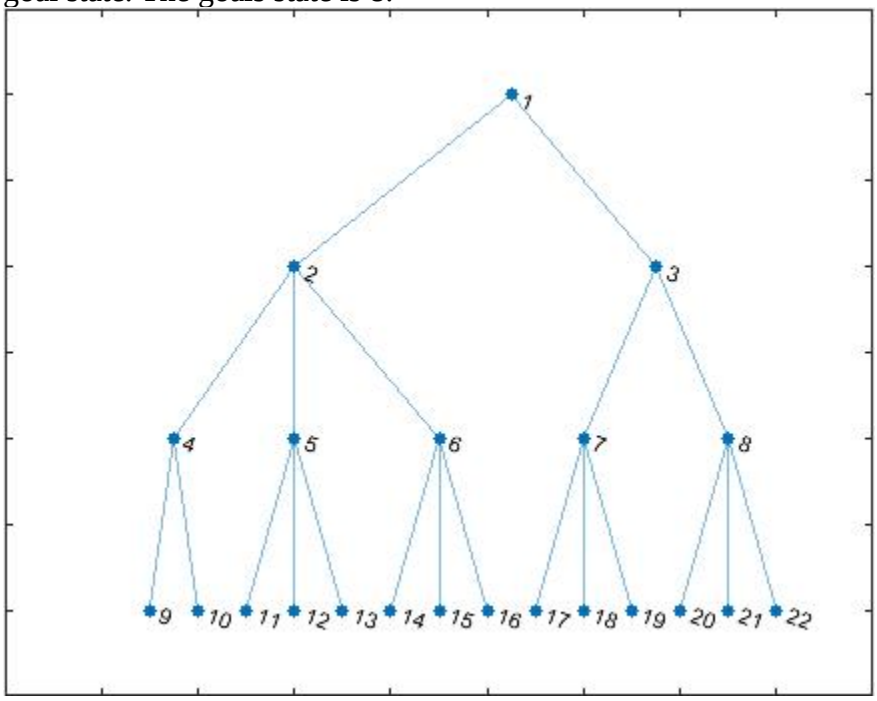
2) Given the following search graph, how many states will be visited until reaching the goal state using *breadth-first search*?. Trace the states inside the search agenda until reaching the goal state. The goals state is 8.



Answer:-

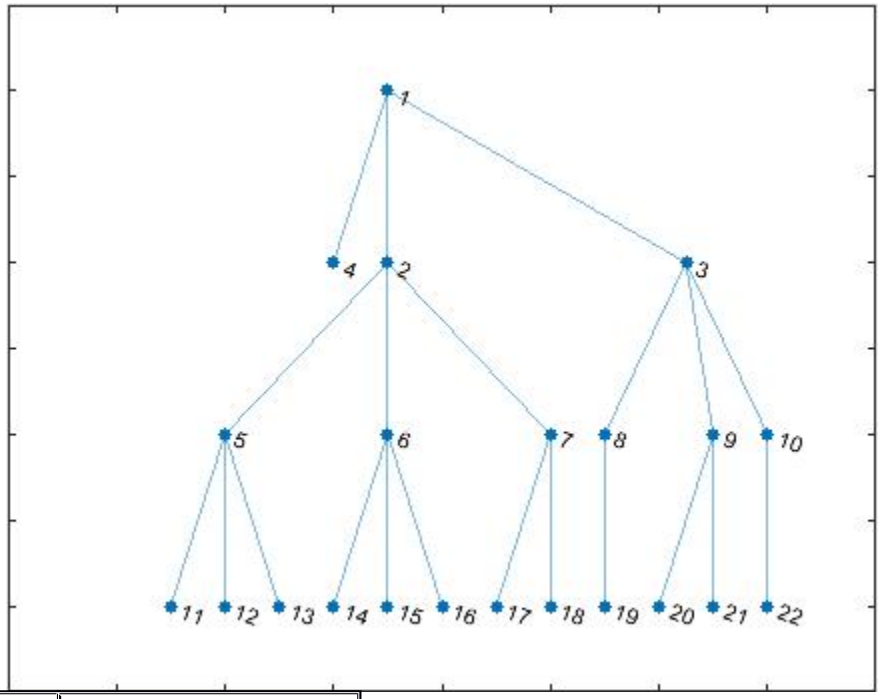
Hint (Breadth means that children are at the end)

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

The number of visited states is 8

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

The Goal state is 20



Node ID	Node Heuristic value
1	7
2	6
3	6
4	6
5	16
6	20
7	6
8	2
9	15
10	17
11	6
12	20

13	1
14	13
15	11
16	17
17	9
18	3
19	2
20	19
21	2
22	17

Answer:-

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

The number of visited states is 17

4) Having the following goal state for the 8-puzzel game:

1	2	3
4	5	6
7	8	

and having the following current state s=

	5	6
3	7	8
2	4	1

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

Answer:-

a. The list of children are:
   Child 1

3	5	6
	7	8
2	4	1

   Child 2

5		6
3	7	8
2	4	1

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

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

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

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

5) Having the following goal state for the 8-puzzel game:

X	X	X
E	E	E
E	E	E

E	E	E
X	X	X
E	E	E

E	E	E
E	E	E
X	X	X

X	E	E
X	E	E
X	E	E

E	X	E
E	X	E
E	X	E

E	E	X
E	E	X
E	E	X

X	E	E
E	X	E
E	E	X

E	E	X
E	X	E
X	E	E

and having the following current state s=

O	O	X
X	E	E
X	E	O

O	X	E
O	E	O
X	X	E

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

Answer:

a. The list of children are:

Child 1

O	O	X
E	X	E
X	E	O

Child 2

O	O	X
X	E	E
E	X	O

Child 3

O	O	E
X	E	X
X	E	O

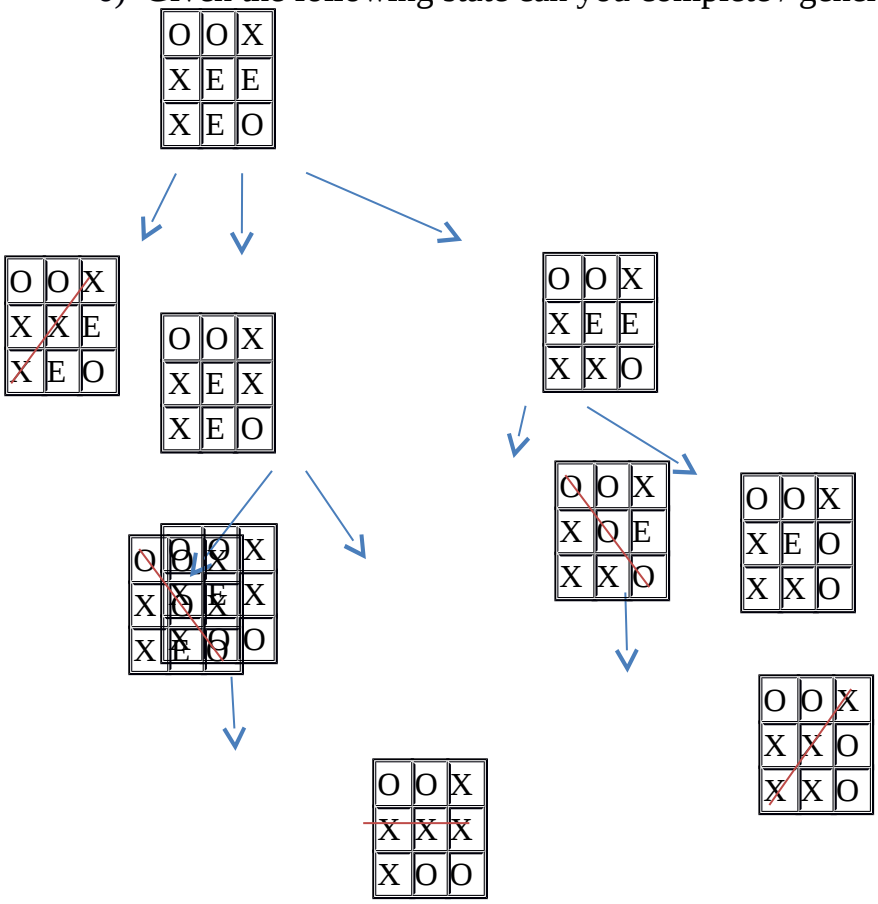
b. Assume the heuristic "the number of misplaced tiles"
c. The heuristic values are:

for child 1 the heuristic=0
for child 2 the heuristic=2
for child 3 the heuristic=1

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

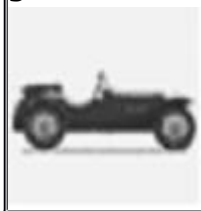
for child 1 the heuristic=0
for child 2 the heuristic=2
for child 3 the heuristic=2

6) Given the following state can you complete / generate the tree



7) Having the following grid and the depicted agent at location (x=1,y=3) and a target object located at (x=2,y=4)
Assume that the agent can just go *forward, backward, upward, downward,* using *best first* search write the content of the search agenda at each time step until reaching the target showing the selected directions on 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) **5**	(row=1,col=3) **9**	(row=1,col=4) **13**	(row=1,col=5) **17**

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

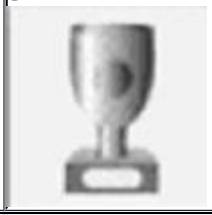
Answer:-

3→4 →8

Note:- X2 and Y2 are always the goal

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

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

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

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

(row=1,col=1)	(row=1,col=2)	(row=1,col=3)	(row=1,col=4)	(row=1,col=5)

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

Answer:-

Note:- X2 and Y2 are always the goal

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

states	15
H	2.24

states	14	19	11	16
H	1.41	2.00	2.83	3.16

states	13	18	19	15	10	11	16
H	1.00	1.00	2.00	2.24	2.24	2.83	3.16

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

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