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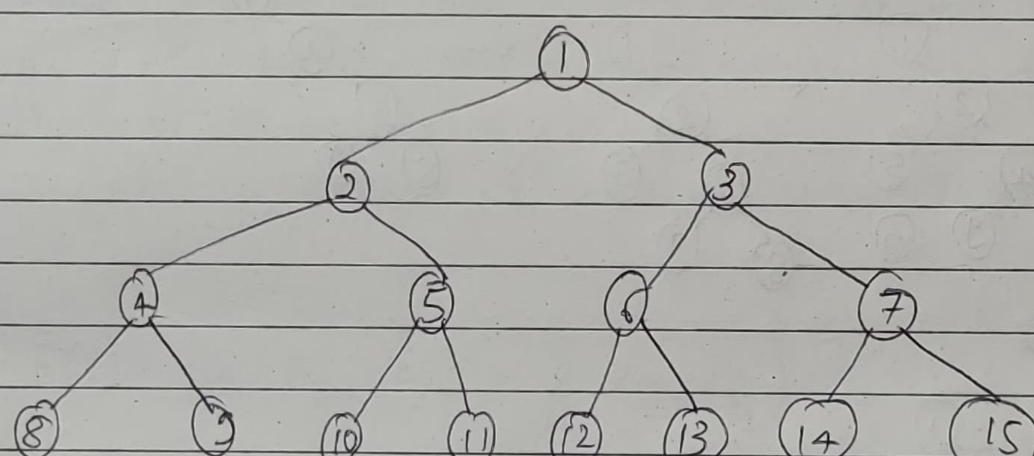
PES2UG20CS209

Assignment - I

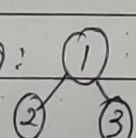
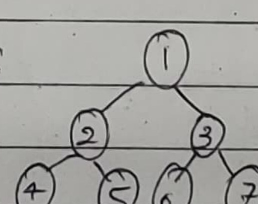
1a) There are an infinite no of states in the state space considering all positions (x,y). Although there is only one optimal path there are an infinite no of paths to the goal.

b) The shortest dist b/w any 2 given points is always a straight line. therefore, the shortest path from 1 polygon vertex to any other, in the scene must consist of straight line segments joining some of the vertices of the polygons.
A good state space now would be all the pairs (x,y) where the pair is the vertex of an obstacle, the state space consists of all the vertices of the obstacles.

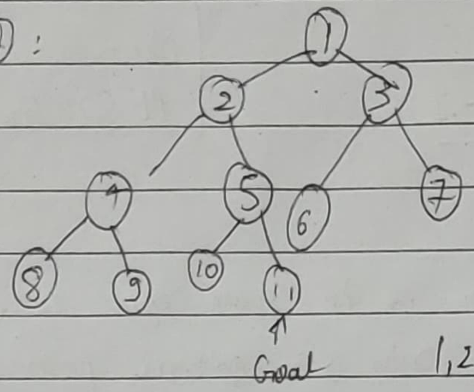
2a)



b) BFS

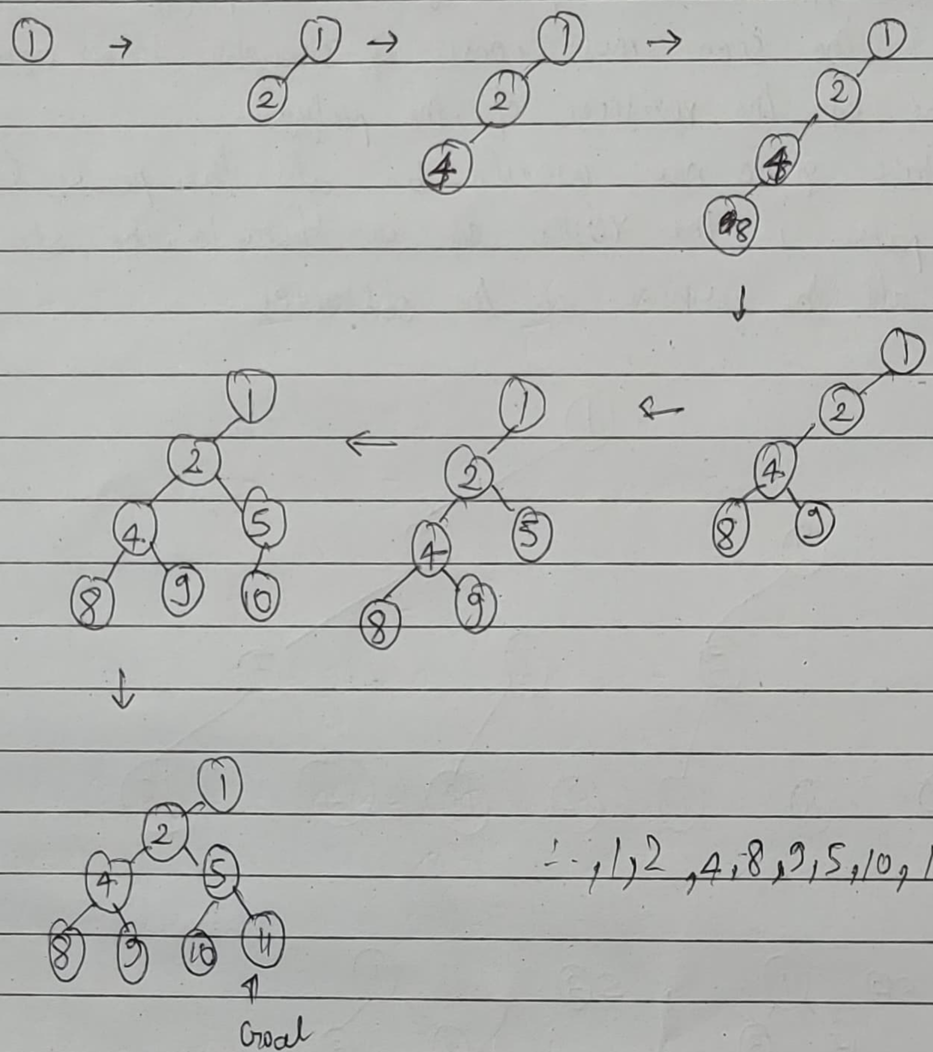
S1: 1 , S2:  , S3: 

S④ :



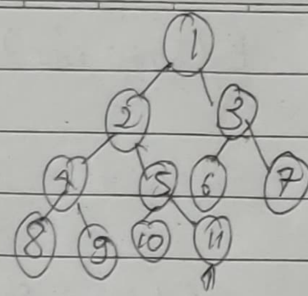
1,2,3,4,5,6,7,8,9,10,11

- DLS w/ limit = 3



∴ 1,2,4,8,9,5,10,11

- IDS



Goal

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

c) $2k \rightarrow$ bit shift
$2k+1 \rightarrow$ bit shift & + 1

4) A^* search
→ Form of Best first search.
$F(n) = g(n) + h(n)$ is both complete & optimal
A heuristic $h(n)$ is admissible if, for every node n, $h(n) \leq h^*(n)$
where $h^*(n)$ is the true cost to reach the goal state from n.
An admissible heuristic never overestimates the cost to reach the goal. It is optimistic
If $h(n)$ is admissible, A^* using Tree search is optimal.

5) $E(S) = -\frac{5}{14} \log_2 \left(\frac{5}{14}\right) - \frac{9}{14} \log_2 \left(\frac{9}{14}\right) = 0.94$

income	buys	comp.
high	1	3
Med	2	4
Low	2	2

$E(\text{income} = \text{high}) = -\left[\frac{1}{4} \log_2 \frac{1}{4} + \frac{3}{4} \log_2 \frac{3}{4}\right]$
$= -[0.5 - 0.31127]$
$= 0.811$

$E(\text{income} = \text{medium}) = -\left[\frac{2}{6} \log_2 \frac{2}{6} + \frac{4}{6} \log_2 \frac{4}{6}\right] = -[-0.528 - 0.194]$
$= 0.7233$

$E(\text{income} = \text{low}) = 0$

$E(\text{Age}) = 0$

Types	Buys	Comp
Employee	1	6
Student	4	3

$E(\text{type} = \text{emp}) = -\frac{1}{7}\log_2\frac{1}{7} + \frac{6}{7}\log_2\frac{6}{7}$

$= -[0.401 - 0.1906]$

$= 0.591$

$E(\text{type} = \text{student}) = 0.985$

Credit Rating.

	Y	N
low	0	5
high	5	0

$E(cr = \text{low}) = 0$

$E(cr = \text{high}) = -[-0.4711 - 0.519]$

$= \boxed{0.991}$

$I(\text{Age}) = 0$

$I(\text{Income}) = \frac{4}{14} \times 0.811 + \frac{6}{14} \times 0.723 + \frac{4}{14} \times 0 = 0.2317 + 0.3098$

$= \boxed{0.541}$

$I(\text{type}) = \frac{7}{14} \times 0.591 + \frac{7}{14} \times 0.985 = 0.788$

$I(\text{Family Income}) = 0$

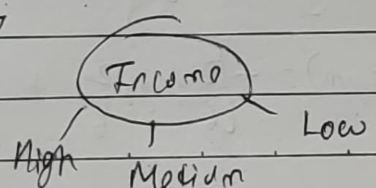
$I(cr) = 0 + \frac{9}{14} \times 0.991 = 0.637$

$G(S, \text{income}) = 0.94 - 0.541 = 0.39$

$G(S, \text{Type}) = 0.94 - 0.788 = 0.15$

$G(S, CR) = 0.94 - 0.637 = 0.30$

Income has the highest G



Income = high

Type	CR	Buys
Emp	L	No
Emp	L	No
Emp	H	No
Stu	H	Yes

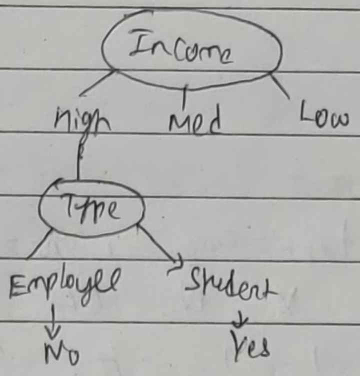
$E(S_{high}) = -\frac{1}{4}\log_2\frac{1}{4} - \frac{3}{4}\log_2\frac{3}{4}$

$= 0.811$

CR	Y	N
low	0	2
high	1	1

$E() = 0$

Type	Y	N
Stu	1	0
Emp	0	3



Income = Medium

Type	CR	Buys
Emp	H	Y
Emp	L	N
Stu	H	Y
Stu	L	N
Emp	H	N

$E(S_{medium}) = 0.97$

Type	Y	N
Emp	1	2
Stud	1	1

$E(type) = -\frac{1}{3}\log_2\left(\frac{1}{3}\right) - \frac{2}{3}\log\left(\frac{2}{3}\right)$

$= -[-0.528 - 0.3899]$

$= 0.917$

$I(type) = \frac{3}{5} \times 0.917 = 0.5502$

$G(S_{medium}\ type) = 0.4198$

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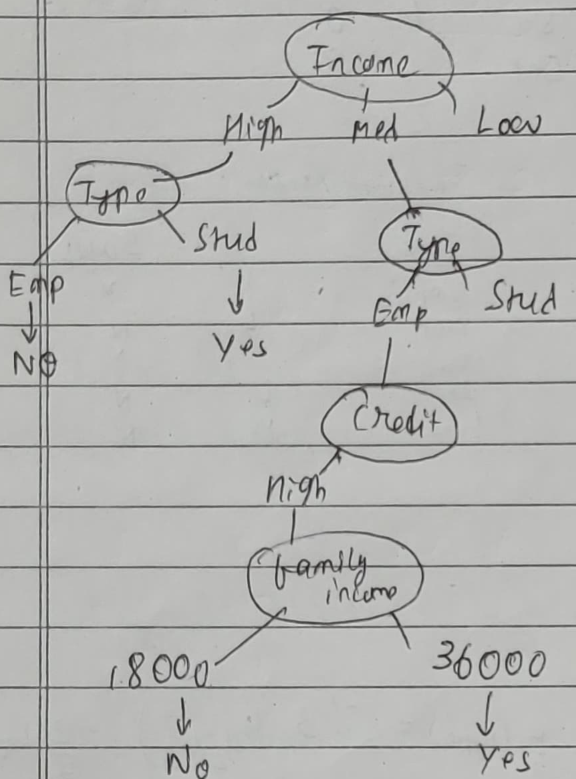
Cr	Y	N
high	2	1
Low	0	2

$E(high) = -\left[\frac{2}{3}\log_2\frac{2}{3} + \frac{1}{3}\log_2\frac{1}{3}\right]$

$= -[-0.584 - 0.528] = 1.11$

$I(CR) = \frac{3}{5} \times 1.11 = 0.66$

$G(S, CR) = 0.97 - 0.66 = 0.31$



type = emp , type = stud

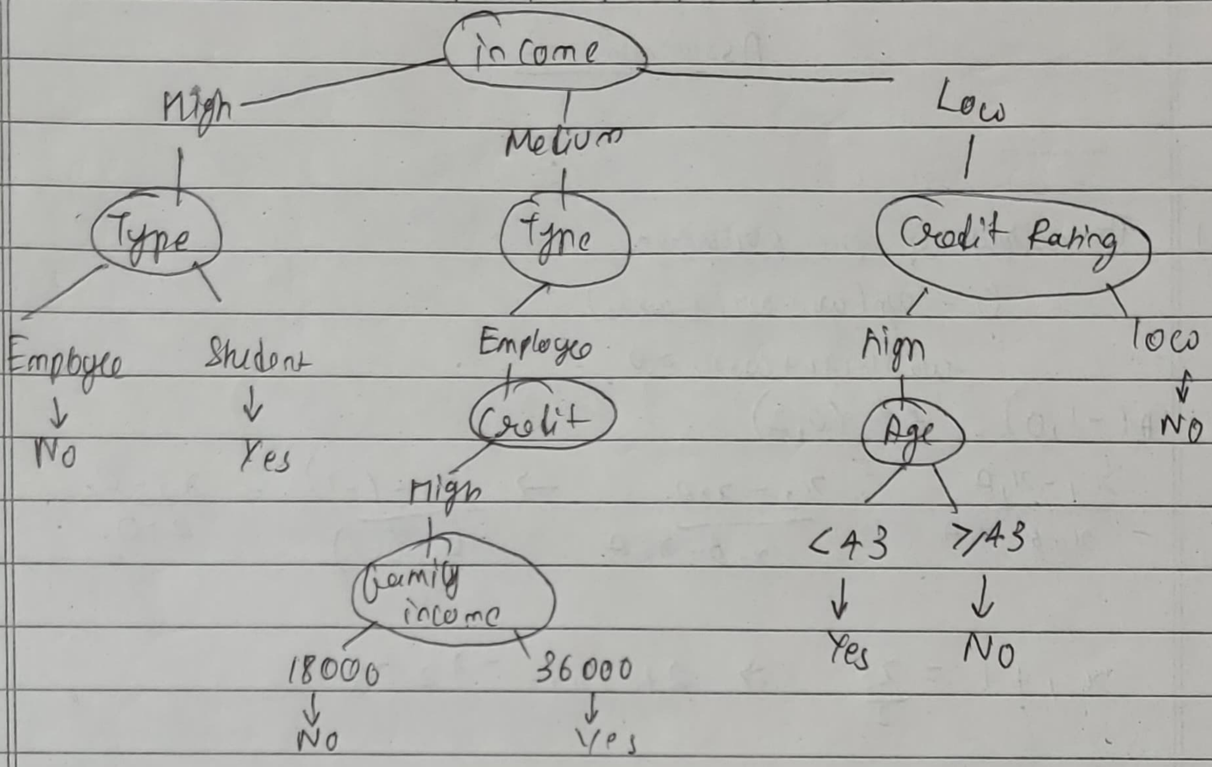
CR	Y	N	CR	Y	N
high	1	1	H	1	0
low	0	1	L	0	1

income = low

type	CR	Buys
Stu	H	Y
Stu	H	N
Stu	h	Y
Stu	L	N

Attributes

age - 12 , income - 3 , type - 2 , family - 13 , CR - 2 , Buys - 2 .



6. a) The instance space is 14
b) $1 + [13 \times 4 \times 3 \times 14 \times 3 \times 3] = 19657$
c) $14 \times 5 \times 4 \times 15 \times 4 \times 4 = 67200$
d) the size of the concept space is 6.

5. b) Rule
(Income = high V type = Student) ∧ (Income = Medium V ((type = employee) V credit = high V family income = 36000)) ∧ (type = student V credit = high)) ∧ (income = low V credit rating = high V age <43)

5 c) If credit rating = Low then the person will not buy a computer.

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Assignment - 2

4.1 The output of the perceptron

$O = \mathrm{sign}(w_0 + w_1 x_1 + w_2 x_2)$

$w_0 + w_1 x_1 + w_2 x_2 = 0$

$A(-1,0) \quad B = (0,2)$

$\dfrac{x_1 - x_{1A}}{x_{1B} - x_{1A}} = \dfrac{x_2 - x_{2A}}{x_{2B} - x_{2A}} \rightarrow \dfrac{x_1 - (-1)}{0 - (-1)} = \dfrac{x_2 - 0}{2 - 0}$

$x_1 + 1 = \dfrac{x_2}{2} \Rightarrow 2 + 2x_1 - x_2 = 0$

$w_0 = -2, \; w_1 = -1, \; w_2 = 1$

4.2

A	B	$A \wedge -B$
-1	-1	-1
-1	1	-1
1	-1	1
1	1	-1

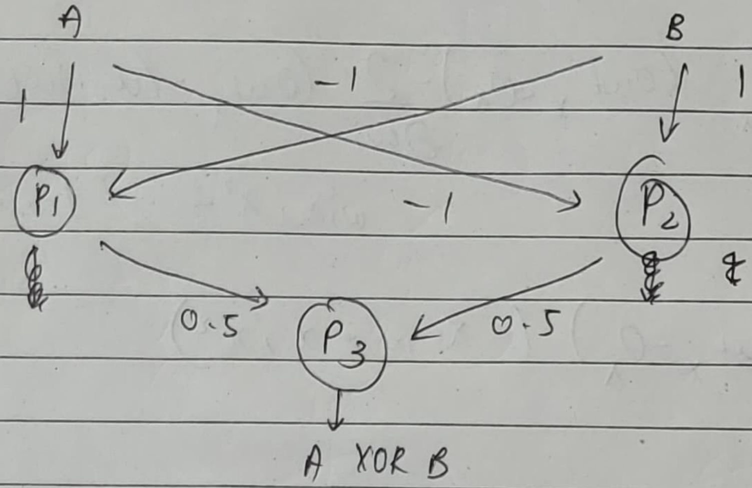
$A = B + 1$

$1 - A + B = 0$

So, 1, -1, 1. for $A = 1$ & $B = -1$

$\Rightarrow w_0 = 1, \; w_1 = 1, \; w_2 = -1$

$A \text{ xor } B = \underbrace{(A \wedge \neg B)}_{P_1} \vee \underbrace{(\neg A \wedge B)}_{P_2}$



4.3 $w_0 + w_1 x_1 + w_2 x_2 > 0$

A:

$w_0 = 1, \quad w_1 = 2, \quad w_2 = 1$

B:

$w_0 = 0, w_1 = 2, w_2 = 1$

$B(<x_1, x_2>) = 1$

$2x_1 + x_2 > 0$

$1 + 2x_1 + x_2 > 0$

$A(<x_1, x_2>) = 1$

4.5 $o = w_0 + w_1 x_1 + w_2 x_2 + \cdots w_n x_n$

$$\frac{\partial E}{\partial w_i} = \sum_{x \in X} (o_{act_x} - o_x) \frac{\partial}{\partial w_i} \left(o_{act_x} - (w_0 + w_1 x_1 + w_i x_i^2 + \cdots + w_n x_n x^2)\right)$$

$$= \sum_{x \in X} (o_{act_x} - o_x)(-x_i x - x_i x^2)$$

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Gradient descent training rule

$$\frac{\partial E_D}{\partial w_i} = \sum_{n \in X} (out_x - O_x) \frac{\partial}{\partial w_i} (out_x - (w_0 + w_i x_i x + w_i x_i x^2 + \cdots + w_n x_n x^2))$$

$$= \sum_{x \in X} (out_x - O_x)(-x_{ix} - x_i x^2)$$