

**FUNDAMENTALS OF ARTIFICIAL
INTELLIGENCE
Lab Exercise – 5**

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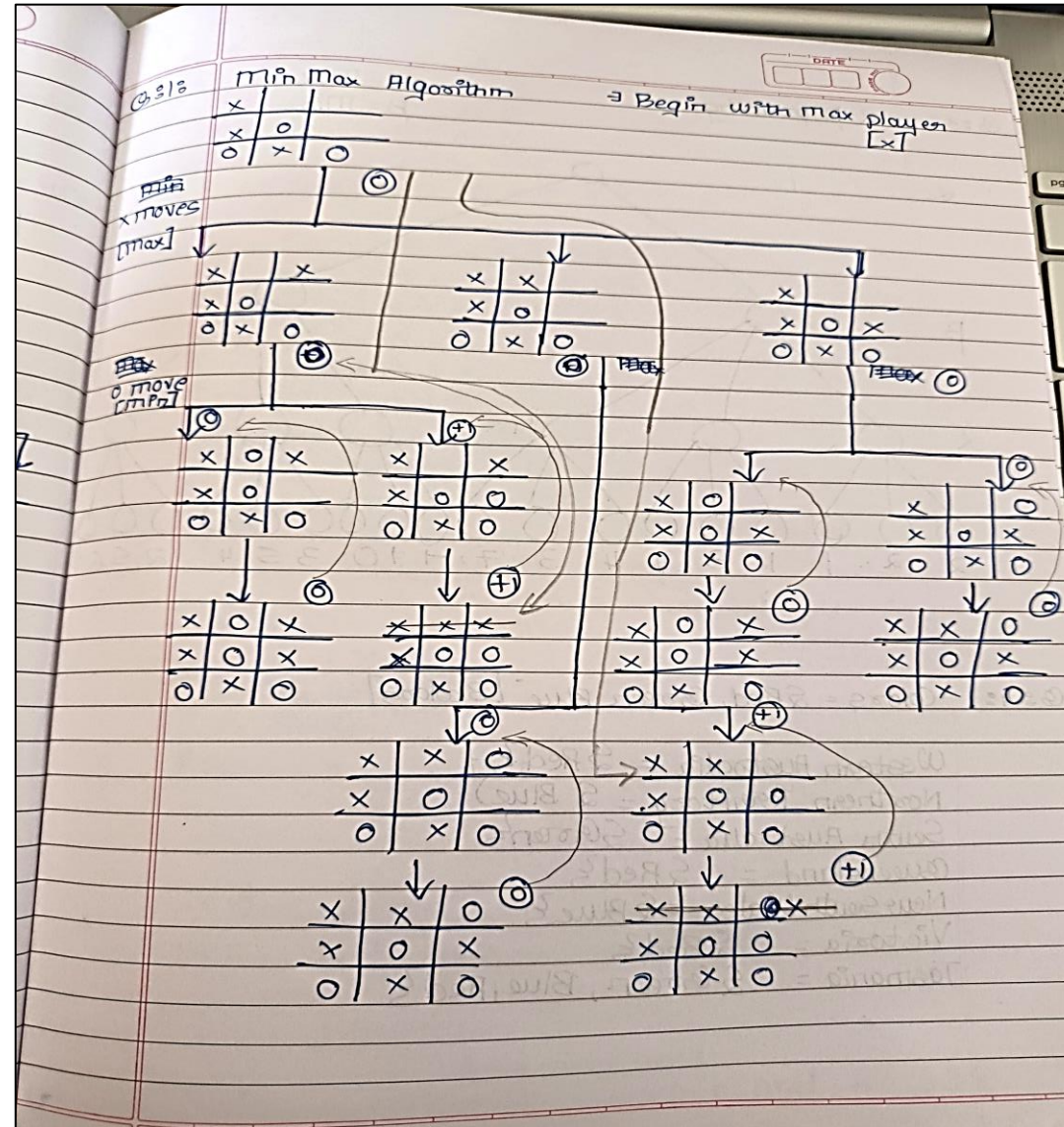
**CDAC – NOIDA
PGDAI**

ASSIGNMENT

Q1. Explore the search space diagram for the tic-tac toe game. Solve using **minmax algorithm** to find the optimal path where the max would win.
Assumption: Selection of appropriate value of utility numbers and begin with the max player



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Q2. Each letter is one digit integer 0,1,2 to 9, each having a different value.
What are the values of each of the letters? Solve to make your agent rationally think in terms of domains and variables as well.

SEND

+MORE

MONEY

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$$\begin{array}{r} \text{S} \text{ 4} \text{ 3} \text{ 2} \text{ 1} \\ \text{C}_4 \text{ G} \text{ C}_2 \text{ C}_1 \text{ U} \\ \text{S} \text{ E} \text{ N} \text{ D} \\ + \text{M} \text{ O} \text{ R} \text{ E} \\ \hline \text{M} \text{ O} \text{ N} \text{ E} \text{ Y} \end{array}$$

$V = \{S, E, N, D, M, O, R, Y\}$

$D_3 = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$
 $D_E = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$
 $D_N = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$
 $D_O = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$
 $D_M = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$
 $D_0 = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$
 $D_R = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$
 $D_Y = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$

\because MONEY has 1 letter more than 'SEND' and 'MORE', the carry from C_3 must be 1
 $\therefore C_4 = 1$ i.e. $M = 1$
 $\because S + M = 1$ and $M = 1$
 $\therefore S + 1 \geq 10$
 \because Max Carry is 1
 $\therefore S = 9$

From C_2 , $9 + 1 = 10 + 0$ i.e. $O = 0$

$$\begin{array}{r} \text{9} \text{ E} \text{ N} \text{ D} \\ \text{1} \text{ 0} \text{ R} \text{ E} \\ \hline \text{10} \text{ N} \text{ E} \text{ Y} \end{array}$$

$\because O = 0$ $\therefore N = E + 1$
 In C_1 , $N + R + \text{carry from } U = E + 10$
 $\because N = E + 1$
 $E + 1 + R + \text{carry from } U = E + 10$
 $R + \text{carry from } U = 9$
 $\because S = 9$ \therefore carry from $U = 1$ and $R = 8$

$$\begin{array}{r} \text{C}_4 \text{ C}_3 \text{ C}_2 \text{ C}_1 \text{ U} \\ \text{9} \text{ E} \text{ (E+1)} \text{ D} \\ + \text{1} \text{ 0} \text{ 8} \text{ E} \\ \hline \text{10} \text{ (E+1)} \text{ E} \text{ Y} \end{array}$$

In U , $D + E = Y + 10$ [carry in C_1]
 $\therefore D + E \geq 10$

Now,
 $\because M = 1$
 $S = 9$
 $O = 0$
 $R = 8$

Digits Remaining = $\{2, 3, 4, 5, 6, 7\}$
 $E, N = E + 1$ must be verified from remaining digits
 If $E = 2$
 $N = 3$
 $D + 2 = Y + 10$ [Not possible; taken by R]
 If $E = 3$
 $N = 4$
 $D + 3 = Y + 10$ [Not possible]
 If $E = 4$
 $N = 5$
 $D + 4 = Y + 10$ [Not possible]
 If $E = 5$
 $N = 6$
 $D + 5 = Y + 10$
 $\Rightarrow D = 5$ [Remaining Digits] $\{2, 3, 4, 7\}$
 If $Y = 2; D = 7$ (This Works)
 If $E = 6$
 $N = 7$
 $D + 6 = Y + 10$ [Not possible]

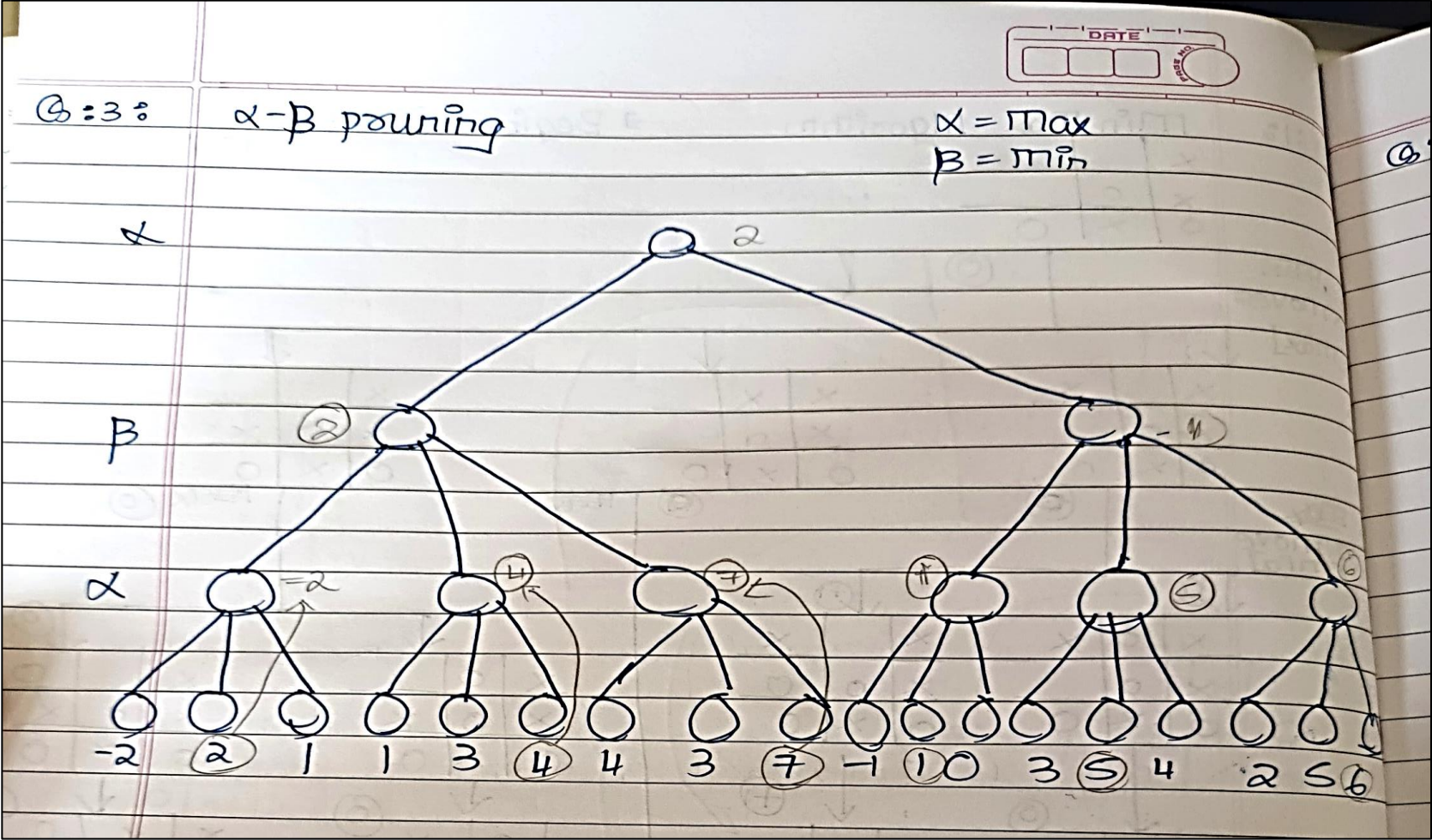
$\because S = 9$
 $E = 5$
 $N = 6$
 $D = 7$
 $M = 1$
 $O = 0$
 $R = 8$
 $Y = 2$

$$\begin{array}{r} \text{SEND} \text{ 9} \text{ 5} \text{ 6} \text{ 7} \\ \text{MORE} \text{ 1} \text{ 0} \text{ 8} \text{ 5} \\ \hline \text{MONEY} \text{ 10652} \end{array}$$

Q3 . Solve the game tree using alpha-beta pruning algorithm. Evaluate the respective utility number at the root of the game tree.



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Q4. Given an undirected graph and a number m , determine if the graph can be coloured with at most 3 colours such that no two adjacent vertices of the graph are colored with the same color. Here coloring of a graph means the assignment of colors to all vertices. (use backtrack)

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Q: 4: Colors = {Red, Green, Blue} [3 colors]

Western Australia = {Red}

Northern Territory = {Blue}

South Australia = {Green}

Queensland = {Red}

New South Wales = {Blue}

Victoria = {Red}

Tasmania = {Green, Blue, Red}

Q5. Solve the N-Queens problem using Genetic Algorithm.

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Q:5: N-Queens Problem using Genetic Algorithm

3	1	4	2	5
---	---	---	---	---

1	3	5	2	4
---	---	---	---	---

2	4	1	5	3
---	---	---	---	---

5					G_5
4			G_3		
3	G_1			\emptyset	
2				G_4	
1		G_2			

A 5x5 grid with handwritten labels in specific cells:

		B3		
				B5
	B2			
B1			B4	

			G ₄	
	G ₂			
				G ₅
G ₁				
		G ₃		

$$F_1 = 4$$
$$F_1 = 4$$
$$F_1 = 3$$
$$F_2 = 3$$
$$F_2 = 3$$
$$F_2 = 3$$
$$F_3 = 2$$
$$F_3 = 2$$
$$F_3 = 1$$
$$F_4 = 1$$
$$F_4 = 1$$
$$F_4 = 1$$
$$F_S = 0$$
$$F_S = 0$$
$$F_s = 0$$
$$F_{\max} = 10$$
$$F_{max} = 10$$
$$F_{\max} = 8$$

Total F = 28

36%

3	1	4	2	5
---	---	---	---	---

$$3 \mid 1 \mid 4 \mid 2 \mid 5$$

$$1/\textcircled{1}/4/2/5 \rightarrow 3/3/4/2/5$$

36%

1	3	5	2	4
---	---	---	---	---

1	3	5	2	4
---	---	---	---	---

3	3	5	2	4	7	3	4	5	3	1
---	--------------	---	---	---	---	--------------	---	---	--------------	---

28%

2	4	1	5	3
---	---	---	---	---

3	1	4	2	5
---	---	---	---	---

3 | 1 | 4 | 2 | 5

3	1	4	2	5
---	---	---	---	---

$$121 = 121$$

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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1	2	3	4	5
---	---	---	---	---

3	5	2	4
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$$\Rightarrow \lambda_{\max} = 10$$