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AI Assignment #2

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Question #2: Genetic Algo. (Dry run)

Note: Performing 2 iterations.

(i) Initial population - 6 chromosomes:

C_1: {2,3,1,2,3,1,2} C_4: {2,1,3,2,1,3,2}

C_2: {1,2,3,1,2,3,2} C_5: {1,3,2,1,3,2,1}

C_3: {3,1,2,3,1,2,1} C_6: {3,2,1,3,2,1,3}

(ii) Fitness level:

C_1: {2,3,1,2,3,1,2}

$T_1F_2 = 5 \times 12 = 60$

$T_2F_3 = 8 \times 16 = 128$

$T_3F_1 = 4 \times 8 = 32$

$T_4F_2 = 7 \times 10 = 70$

$T_5F_3 = 6 \times 12 = 72$

$T_6F_1 = 3 \times 9 = 27$

$T_7F_2 = 9 \times 12 = 108$

Total cost = 497

Loads:

$F_1 = 4+3 = 7$

$F_2 = 5+7+9 = 21$

$F_3 = 8+6 = 14$

C_2: {1,2,3,1,2,3,2}

$T_1F_1 = 5 \times 10 = 50$

$T_2F_2 = 8 \times 14 = 112$

$T_3F_3 = 4 \times 7 = 28$

$T_4F_1 = 7 \times 12 = 84$

$T_5F_2 = 6 \times 13 = 78$

$T_6F_3 = 3 \times 10 = 30$

$T_7F_2 = 9 \times 12 = 108$

Total cost = 490

Loads:

$F_1 = 5+7 = 12$

$F_2 = 5+6+9 = 23$

$F_3 = 4+3 = 7$

No.

Date _____

C_3 : {3, 1, 2, 3, 1, 2, 1}

$T_1 F_3 = 5 \times 9 = 45$

$T_2 F_1 = 8 \times 15 = 120$

$T_3 F_2 = 4 \times 9 = 36$

$T_4 F_3 = 7 \times 13 = 91$

$T_5 F_1 = 6 \times 14 = 84$

$T_6 F_2 = 3 \times 8 = 24$

$T_7 F_1 = 9 \times 11 = 99$

Total cost = 499

Loads :

$F_1 = 8 + 6 + 9 = 23$

$F_2 = 4 + 3 = 7$

$F_3 = 5 + 7 = 12$

C_4 : {2, 1, 3, 2, 1, 3, 2}

$T_1 F_2 = 5 \times 12 = 60$

$T_2 F_1 = 8 \times 15 = 120$

$T_3 F_3 = 4 \times 7 = 28$

$T_4 F_2 = 7 \times 10 = 70$

$T_5 F_1 = 6 \times 14 = 84$

$T_6 F_3 = 3 \times 10 = 30$

$T_7 F_2 = 9 \times 12 = 108$

Total cost = 500

Loads:

$F_1 = 8 + 6 = 14$

$F_2 = 5 + 7 + 9 = 21$

$F_3 = 4 + 3 = 7$

C_5 : {1, 3, 2, 1, 3, 2, 1}

$T_1 F_1 = 5 \times 10 = 50$

$T_2 F_3 = 8 \times 16 = 128$

$T_3 F_2 = 4 \times 9 = 36$

$T_4 F_1 = 7 \times 12 = 84$

$T_5 F_3 = 6 \times 12 = 72$

$T_6 F_2 = 3 \times 8 = 14$

$T_7 F_1 = 9 \times 11 = 99$

Total cost = 493

Loads:

$F_1 = 5 + 7 + 9 = 21$

$F_2 = 4 + 7 = 7$

$F_3 = 8 + 6 = 14$

C_6 : {3, 2, 1, 3, 2, 1, 3}

$T_1 F_3 = 5 \times 9 = 45$

$T_2 F_2 = 8 \times 14 = 112$

$T_3 F_1 = 4 \times 8 = 32$

$T_4 F_3 = 7 \times 13 = 91$

$T_5 F_2 = 6 \times 13 = 78$

$T_6 F_1 = 3 \times 9 = 27$

$T_7 F_3 = 9 \times 13 = 117$

Total cost = 502

Loads:

$F_1 = 4 + 3 = 7$

$F_2 = 8 + 6 = 14$

$F_3 = 5 + 7 + 9 = 21$

Fitness values = [497, 490, 499, 500, 493, 502].

Signature _____ No. _____

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(iii) Selection - Roulette Wheel : 1/cost.

Inverses : $C_1 = 1/497 = 0.002012$ $C_4 = 1/500 = 0.002000$

$C_2 = 1/490 = 0.002041$ $C_5 = 1/493 = 0.002028$

$C_3 = 1/499 = 0.002004$ $C_6 = 1/502 = 0.001992$.

Probabilities : $C_1 = \frac{0.002012}{0.012077} = 0.167$ $C_4 = \frac{0.002000}{''} = 0.166$

$C_2 = \frac{0.002041}{0.012077} = 0.169$ $C_5 = \frac{0.002028}{''} = 0.168$

$C_3 = \frac{0.002004}{''} = 0.166$ $C_6 = \frac{0.001992}{''} = 0.165$.

Total = 0.012077. Selecting : $C_2, C_5, C_1, C_3, C_2, C_5$.

(iv) Crossover - 80% chance.

P1 = C_2 [1,2,3,1,2,3,2] P2 = C_1 [2,3,1,2,3,1,2] P3 = C_2 [1,2,3,1,2,3,2]

C_5 [1,3,2,1,3,2,1] C_3 [3,1,2,3,1,2,1] C_5 [1,3,2,1,3,2,1]

At Pos 2: At Pos 2:

child 1 = [1,2,2,1,3,2,1] child 3 = [2,3,2,3,1,2,1] child 5 = [1,2,3,1,2,2,1]

child 2 = [1,3,3,1,2,3,2] child 4 = [3,1,1,2,3,1,2] child 6 = [1,3,2,1,3,3,2].

(v) Mutation - 20% chance

child 1 - no mutation child 4 - no mutation

child 2 - 20% chance child 5 - 20% chance

child 3 - no mutation child 6 - no mutation

Signature No.

Date

New population :

[1,2,2,1,3,2,1] [3,1,1,2,3,1,2]

[1,3,3,1,2,2,3] [1,1,3,2,2,2,1]

[2,3,2,3,1,2,1] [1,3,2,1,3,3,2].

Fitness of next population :

C_1 = [1,2,2,1,3,2,1] Total cost = 477

Loads : $F_1 = 5+7+9 = 21$, $F_2 = 8+4+3 = 15$, $F_3 = 6$.

All within capacities, ∴ Fitness = 477.

C_2 = [1,3,3,1,2,2,3] Total cost = 509

Loads : $F_1 = 5+7 = 12$, $F_2 = 8+6+3 = 17$, $F_3 = 4+9 = 13$

" " , Fitness = 509.

C_3 = [2,3,2,3,1,2,1] Total cost = 522.

Loads = $F_1 = 6+9 = 15$, $F_2 = 5+4+3 = 12$, $F_3 = 8+7 = 15$.

" " , Fitness = 522.

C_4 = [3,1,1,2,3,1,2] Total cost = 474

Loads = $F_1 = 8+4+3 = 15$, $F_2 = 7+9 = 16$, $F_3 = 5+6 = 11$.

" " , Fitness = 474.

Signature

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(5)

Date

C_5 = [1, 1, 3, 2, 2, 2, 1] Total cost = 469

loads = F_1 = 22, F_2 = 16, F_3 = 4.

All within capacities, fitness = 469.

C_6 = [1, 3, 2, 1, 3, 3, 2] Total cost = 508.

loads = F_1 = 12, F_2 = 17, F_3 = 13.

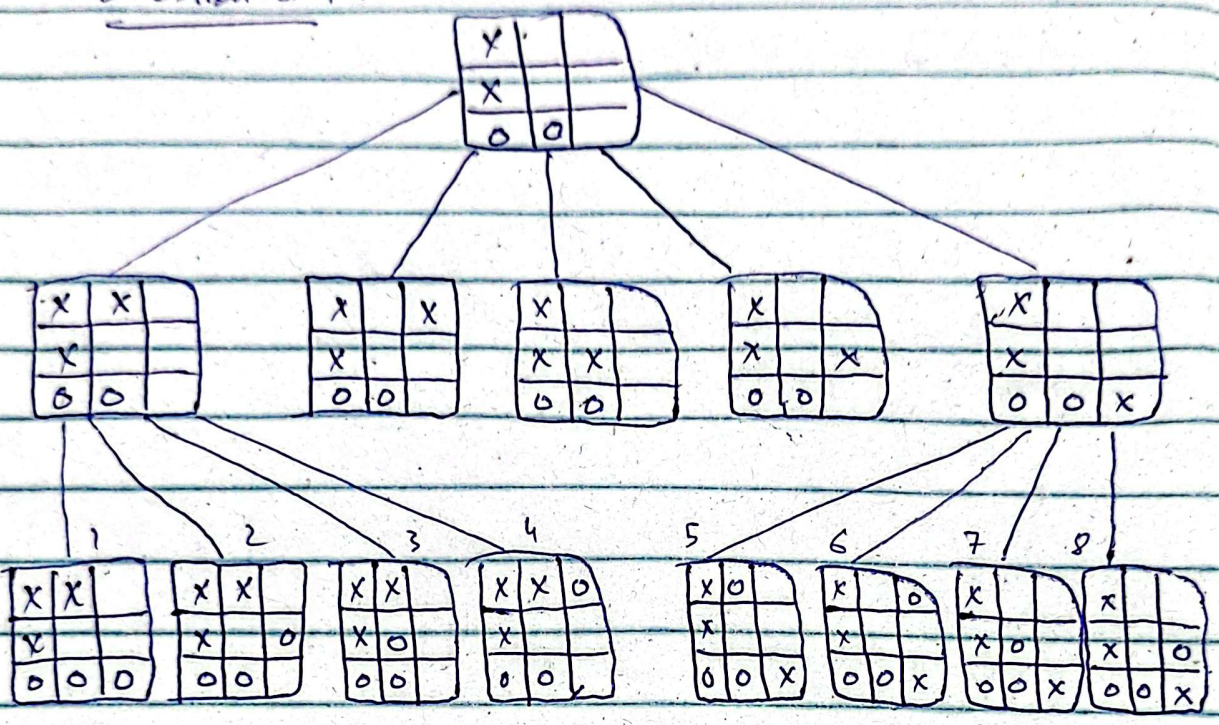
" " , fitness = 508.

Fitness = [477, 509, 522, 474, 469, 508].

After 1 iteration, the genetic algo. improved the best cost from 490 to 469 with the alignment [1, 1, 3, 2, 2, 2, 1] meeting all constraints.

Date _____

Question # 4:

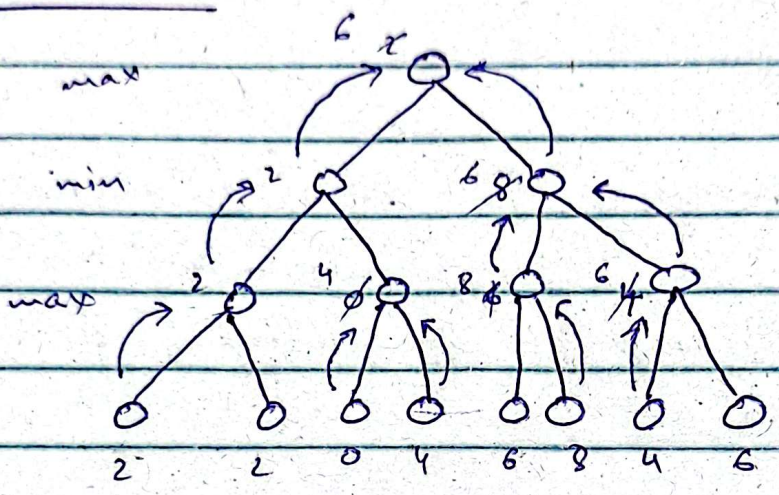


States	R1	R2	R3	C1	C2	C3	D1	D2	SumR	SumC	SumD	V
1	100	10	-1000	0	0	-10	0	-10	-890	-10	-10	-910
2	100	0	-100	0	0	0	0	-100	0	0	-100	-100
3	100	0	-100	0	0	-10	10	-10	0	-10	0	-10
4	0	10	-100	0	0	-10	10	-100	-90	-10	-90	-190
5	0	10	0	0	-100	10	100	-10	10	-90	90	10
6	0	10	0	0	-10	0	100	-100	10	-10	0	0
7	10	0	0	0	-100	10	0	-100	10	-90	-100	-180
8	10	0	0	0	-10	0	100	-10	10	-10	90	90

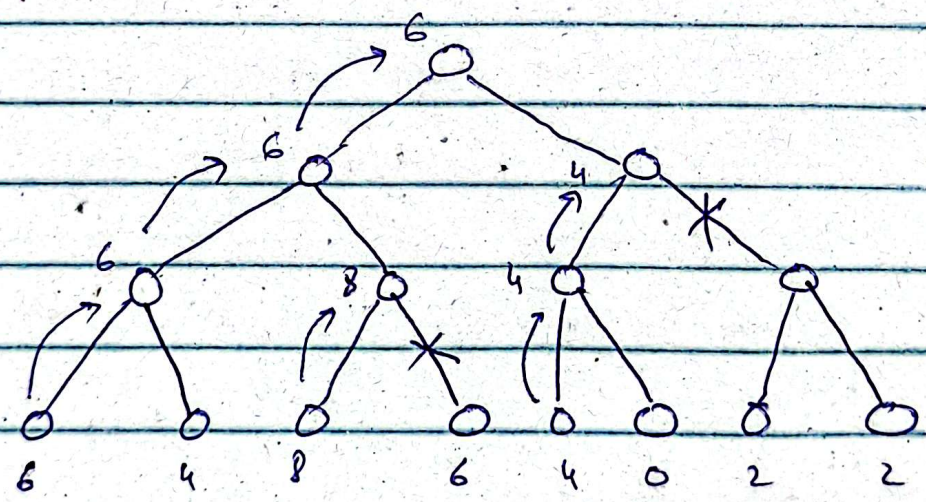
Signature _____ No. _____

Question # 5:

(A)



(B)



Date

Question # 6 :

(a) 1. Players :

Max - Defender : AI - powered IDS will defend the network from external attacks.

Min - Attacker : It is meant to breach the network using various attacks.

2. Decision Making :

Max - Defender : Use strategies such as deploying firewalls, patching sys, or ignoring alerts to min. the damage caused while maintaining costs.

Min - Attacker : Use attacks like brute-force, phishing etc.

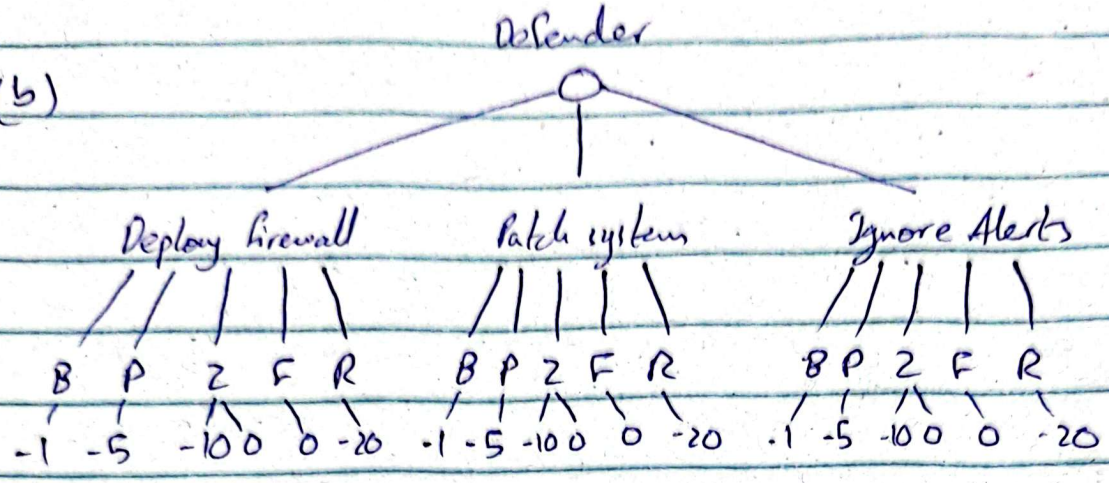
3. Stochastic Elements :

Attacks like zero-day exploit are probabilistic with 50% success rate. They introduce uncertainty and the defender may need to shift it's focus from worst-case to avg-case based on probability.

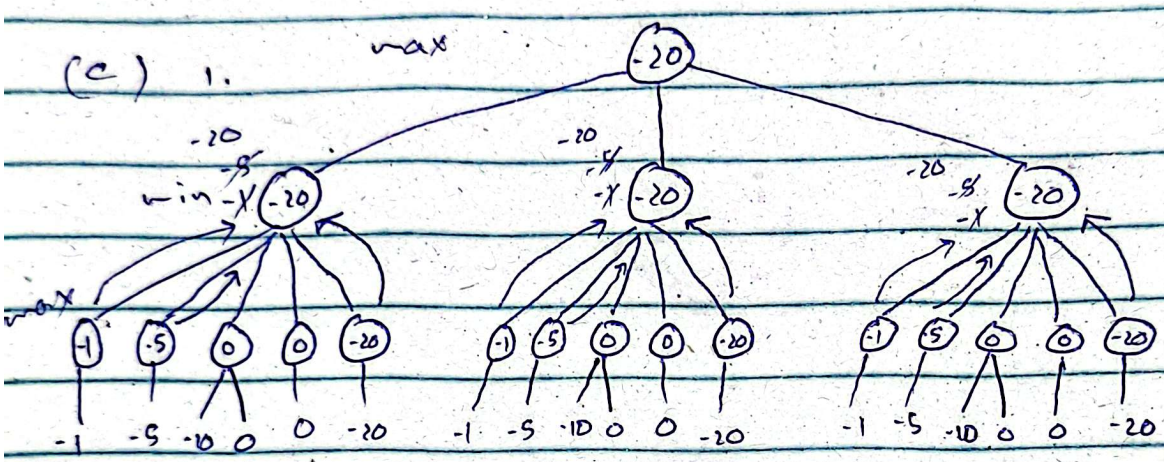
(9)

Date

(b)



(c) 1.



2. same for α, β

(d) i) expected value when firewall = $-50 \times 0.5 = -27.5$

" " " path = $-60 \times 0.5 + 10 \times 0.5 = -35$

" " " ignore = $-80 \times 0.05 + -20 \times 0.5 = -50$

ii) The strategy for defender would be to use ~~the expected value of a mixed terminal node instead~~ expectimax instead of minimax. It doesn't always assume the worst case, instead it takes the probabilities ~~into account~~ of attack successes into account.