23K-0073
BAI-4A

AI Assignment 2

Date: _____

Q2: Dry run of Genetic Algorithm

Step 1 → Initialize population

C_1 : [2, 3, 1, 2, 3, 1, 2]

C_2 : [1, 2, 3, 1, 2, 3, 2]

C_3 : [3, 1, 2, 3, 1, 2, 1]

C_4 : [2, 1, 3, 2, 1, 3, 2]

C_5 : [1, 3, 2, 1, 3, 2, 1]

C_6 : [3, 2, 1, 3, 2, 1, 3]

Step 2 → Evaluate Fitness

C_1 : [2, 3, 1, 2, 3, 1, 2]

Costs :

Task 1, F2 : 5×12 = 60

Task 2, F3 : 8×16 = 128

Task 3, F1 : 4×8 = 32

Task 4, F2 : 7×10 = 70

Task 5, F3 : 6×12 = 72

Task 6, F1 : 3×9 = 27

Task 7, F2 : 9×12 = 108

Total Cost = 497

Loads :

F1 : 4 + 3 = 7

F2 : 5 + 7 + 9 = 21

F3 : 8 + 6 = 14

Capacities : [24, 30, 28]

All within capacity

Fitness = 497

C_2 : [1, 2, 3, 1, 2, 3, 2]

Costs :-

Task 1, F1 : 5×10 = 50

Task 2, F2 : 8×14 = 112

Task 3, F3 : 4×7 = 28

Task 4, F1 : 7×12 = 84

Task 5, F2 : 6×13 = 78

Task 6, F3 : 3×10 = 30

Task 7, F2 : 9×12 = 108

Total Cost = 490

Loads :-

F1 : 5 + 7 = 12

F2 : 8 + 6 + 9 = 23

F3 : 4 + 3 = 7

Capacities : [24, 30, 28]

All within capacities

Fitness = 490

C_3 : [3, 1, 2, 3, 1, 2, 1]

Costs :

Task 1, F3 : 5×9 = 45

Task 2, F1 : 8×15 = 120

Task 3, F2 : 4×9 = 36

Task 4, F3 : 7×13 = 91

Task 5, F1 : 6×14 = 84

Task 6, F2 : 3×8 = 24

Task 7, F1 : 9×11 = 99

Total Cost = 499

Loads

F1 : 8 + 6 + 9 = 23

F2 : 4 + 3 = 7

F3 : 5 + 7 = 12

Capacities : [24, 30, 28]

All within capacity

Fitness = 499

Date: _____

C4 : [2, 1, 3, 2, 1, 3, 2]

Costs :

Task 1, F2 : 5×12 = 60

Task 2, F1 : 8×15 = 120

Task 3, F3 : 4×7 = 28

Task 4, F2 : 7×10 = 70

Task 5, F1 : 6×14 = 84

Task 6, F3 : 3×10 = 30

Task 7, F2 : 9×12 = 108

Total Cost = 500

Loads :

F1 : 8+6 = 14

F2 : 5+7+9 = 21

F3 : 4+3 = 7

Capacities : [24, 30, 28]

All within capacities

Fitness = 500

C5 : [1, 3, 2, 1, 3, 2, 1]

Costs :

Task 1, F1 : 5×10 = 50

Task 2, F3 : 8×16 = 128

Task 3, F2 : 4×9 = 36

Task 4, F1 , 7×12 = 84

Task 5, F3 : 6×12 = 72

Task 6, F2 : 3×8 = 24

Task 7, F1 : 9×11 = 99

Total Cost = 493

Loads :

F1 : 5+7+9 = 21

F2 : 4+3 = 7

F3 : 8+6 = 14

Capacities : [24, 30, 28]

All within capacities

Fitness = 493

C6 : [3, 2, 1, 3, 2, 1, 3]

Costs :

Task 1, F3 : 5×9 = 45

Task 2, F2 , 8×14 = 112

Task 3, F1 ; 4×8 = 32

Task 4, F3 : 7×13 = 91

Task 5, F2 : 6×13 = 78

Task 6, F1 , 3×9 = 27

Task 7, F3 , 9×13 = 117

Total Cost = 502

Loads :

F1 : 4+3 = 7

F2 : 8+6 = 14

F3 : 5+7+9 = 22

Fitness Values : [497, 490, 499, 500, 493, 502]

Step 3 → Selection

Inverses :

C1 : 1/497 = 0.002012

C2 : 1/490 = 0.002041

C3 : 1/499 = 0.002004

C4 : 1/500 = 0.002000

C5 : 1/493 = 0.002028

C6 : 1/502 = 0.001992

Total = 0.012077

Probabilities :

C1 : 0.002012 / 0.012077 = 0.167

C2 = 0.002041 / 0.012077 = 0.169

C3 = 0.002004 / 0.012077 = 0.166

C4 = 0.002000 / 0.012077 = 0.166

C5 = 0.002028 / 0.012077 = 0.169

C6 = 0.001992 / 0.012077 = 0.165

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Selecting C2, C5, C1, C3, C2, C5

- Step 4 → Crossover

Pair 1) C2: [1,2,3,1,2,3,2]
C5: [1,3,2,1,3,2,1]

Crossover at position 2

Child 1: [1,2,2,1,3,2,1]
Child 2: [1,3,3,1,2,3,2]

Pair 2) C1: [2,3,1,2,3,1,2]
C3: [3,1,2,3,1,2,1]

Crossover at Position 2

Child 3: [2,3,2,3,1,2,1]
Child 4: [3,1,1,2,3,1,2]

Pair 3) C2 - [1,2,3,1,2,3,2]
C5: [1,3,2,1,3,2,1]

Crossover at position 2

Child 5: [1,2,3,1,2,2,1]
Child 6: [1,3,2,1,3,3,2]

Step 5 → Mutation

Child 2 ⇒ [1,3,3,1,2,2,3]
Child 5 ⇒ [1,1,3,2,2,2,1]

(No mutation in the other children)

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]

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C_6. [1, 3, 2, 1, 3, 3, 2]

Total Cost = 508

Loads : F1 = 12 , F2 = 17 , F3 = 13

All within capacities

Fitness = 508

Fitness ⇒ [477, 509, 522, 474, 469, 508]

After 1 iteration, the GA improved the best cost from 490 to 469 w/ the assignment [1, 1, 3, 2, 2, 2, 1] meeting all constraint.

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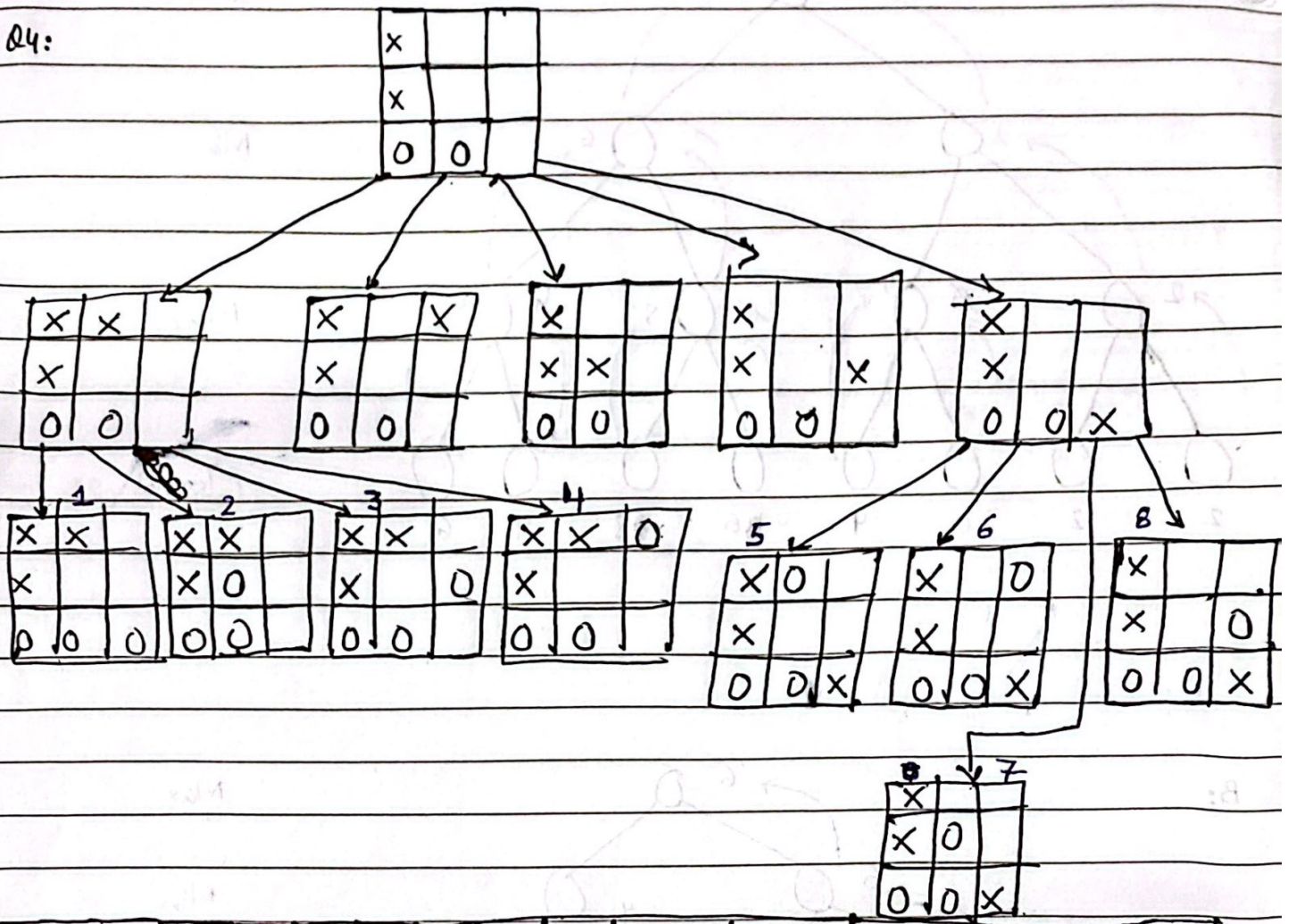
Q4:



States	R1	R2	R3	C1	C2	C3	D1	D2	Sum R	Sum C	Sum D	V = Sum (R, C, D)
State 1	100	10	-100	0	0	-10	0	-10	-890	-10	-10	-910
State 2	100	0	-100	0	0	0	0	-100	0	0	-100	-100
State 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

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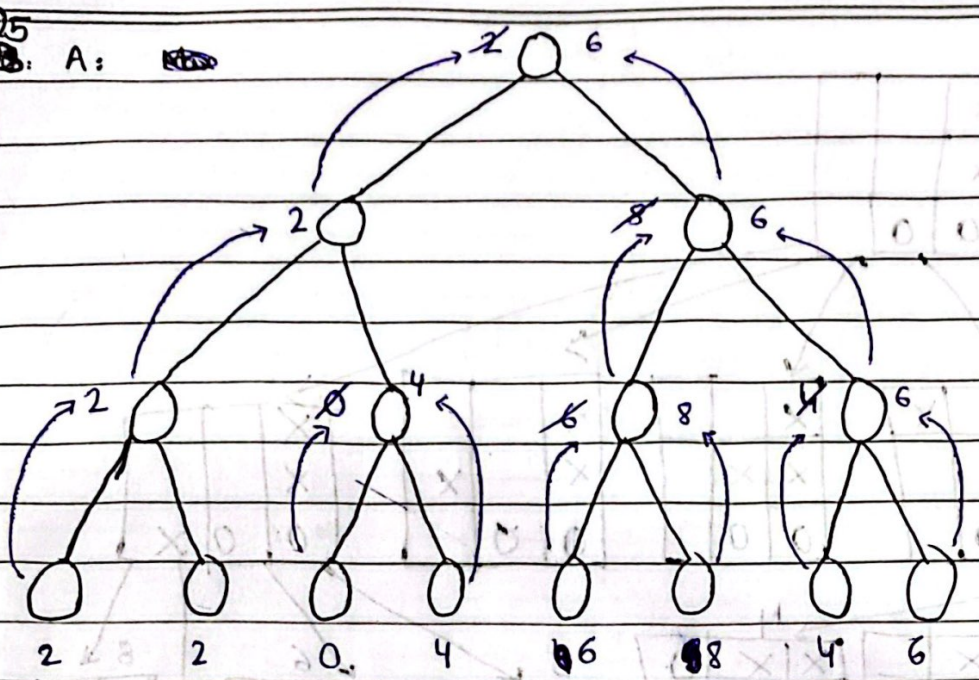
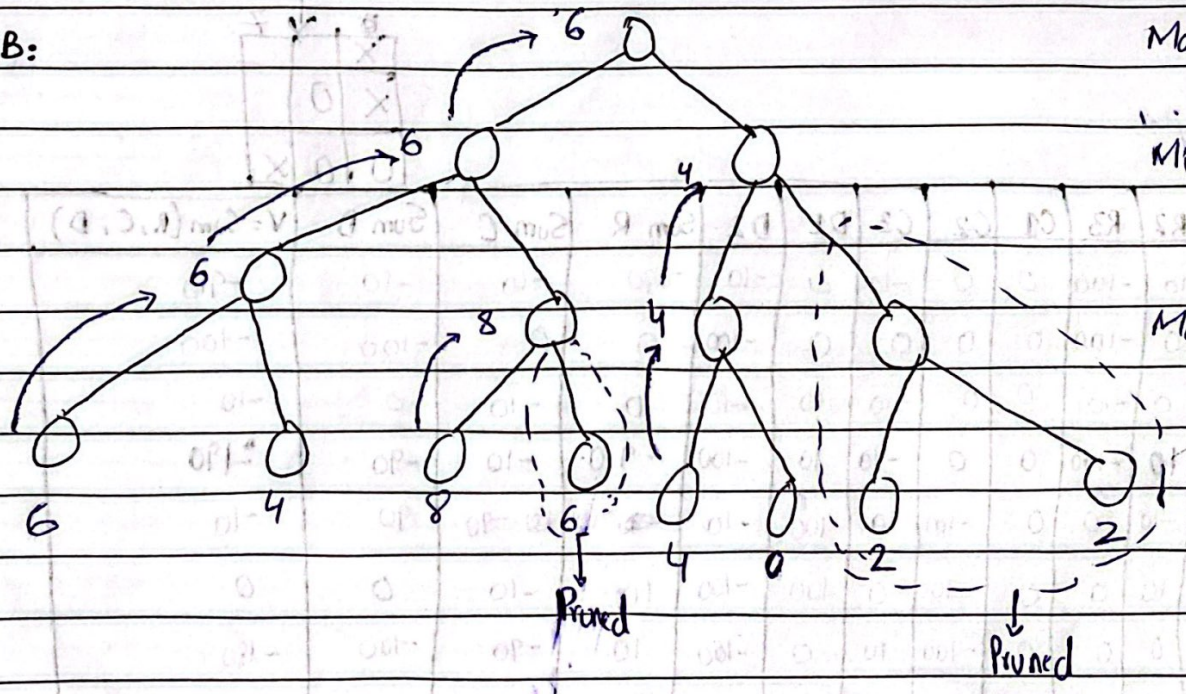
Q5

A:



B:



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Q6: a)

1. Players:

Max (Defender): An AI driven IDS, tasked with protecting the network from cyber threats and external attackers.

Min (Attacker) :- Goal is to penetrate into the network through various attack methods.

2. Decision Making:

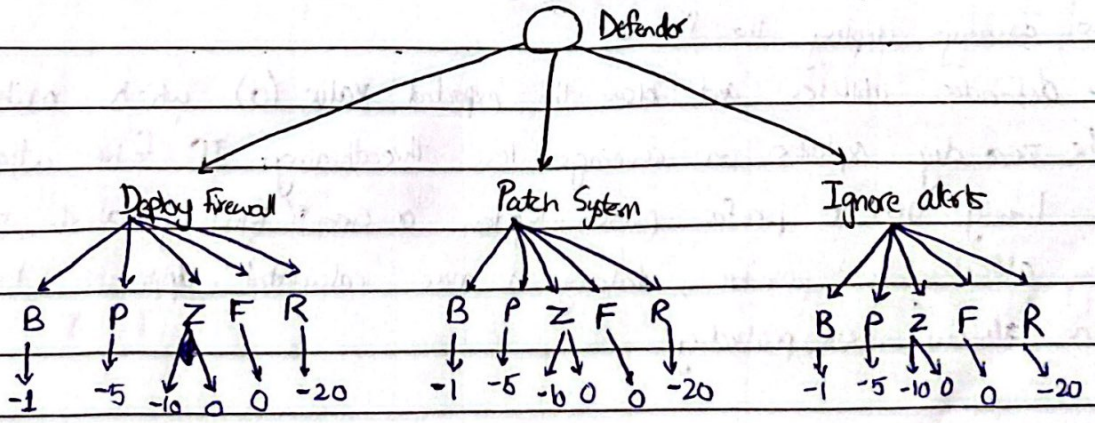
Max (Defender): Decides on actions such as setting up firewalls, applying patches or dismissing alerts to reduce damage while balancing resources used

Min (Attacker): Uses attacks like Brute force, phising, zero day exploit, fake and real attacks to maximize harm on the network.

3- Stochastic Element:

Attack with probabilities such as zero day Exploit (e.g 50% sucess rate). introduces uncertainty as the defender may need to prioritize its focus from worst case to average case based on probability like expectmax.

b)



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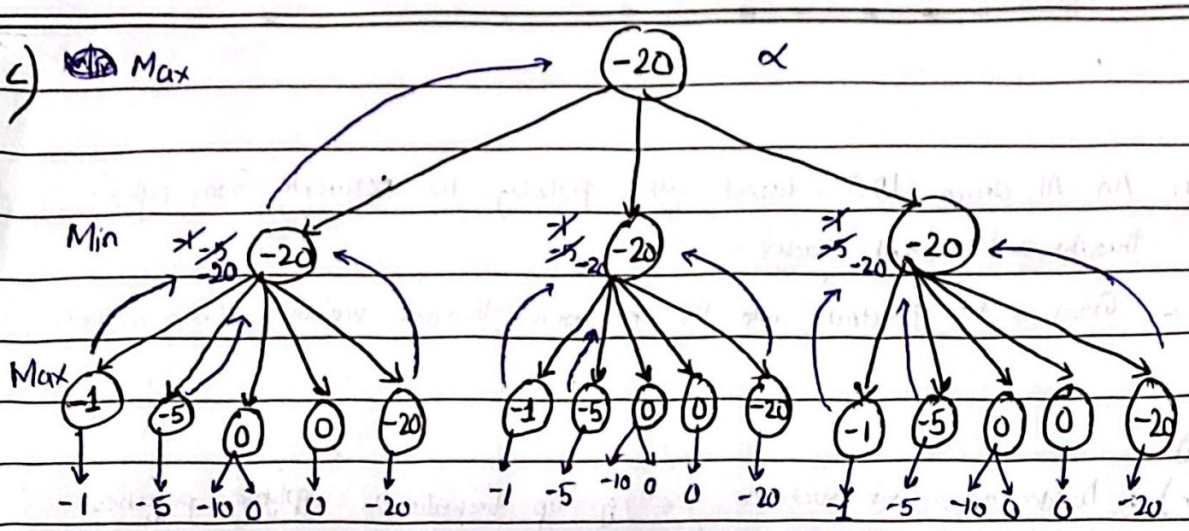
c) Max



d) 1. Success (50%) → damage = -10

fail (50%) → damage = 0

Expected value = [0.5 × (-10)] + [0.5 × (0)] ⇒ -5

This means that, on average, if the attacker chooses zero day exploit, the expected damage to the system will be -5.

2. Minimax → defender assumes worst case scenario (zero-day exploits succeeds then -100), it is better to always deploy the firewall.

Expectimax → defender utilises and uses the expected value (0) which makes the zero day exploits on average, less threathening. If false attacks are likely then it prefer patch system or even ignoring alerts if false attacks are possible, taking a more calculated approach rather than always over protecting