Qs 2)

(1) Initial Population:

Chromosome	Tasks
C_1	1,1,2,2,3,3,1
C_2	2,2,1,3,3,1,2
C_3	3,2,2,2,2,3,2
C_4	2,3 1,1,2,2,3
C_5	1,2,3,3,1,1,2
C_6	3,1,1,2 2,3,3

(2) Fitness Evaluation:

assume penalty =

100 units per access hour

C_1:

Facility Time Usage: Facility 1: $5+8+9 = 22$ hrs (within 24hrs)

Facility 2: $4+7 = 11$hrs (within 30hrs)

Facility 3: $6+3 = 9$hrs (within 28 hrs)

Total Cost: $(5\times10)+(8\times15)+(4\times9)+(7\times10)+(6\times12)+(3\times10)+(9\times11) = 477$

Chromosome	T_1	T_2	T_3	T_4	T_5	T_6	T_7	F_1	F_2	F_3	Penalty	Fitness
C_1	1	1	2	2	3	3	1	22	11	9	0	477
C_2	2	2	1	3	3	1	2	7	22	13	0	502
C_3	3	2	2	2	2	3	2	0	34	8	400	879
C_4	2	3	1	1	2	2	3	11	14	17	0	523
C_5	1	2	3	3	1	1	2	14	17	11	0	500
C_6	3	1	1	2	2	3	3	12	13	17	0	492

(3) Selection :

Chromosome	Fitness	Fitness^{-1}	Selection Probability
C_1	477	0.002096	18.76 %
C_2	502	0.001992	17.83 %
C_3	879	0.001138	10.19 %
C_4	523	0.001912	17.12 %
C_5	500	0.002000	17.90 %
C_6	492	0.002033	18.20 %
		0.011171	

$$\frac{(\text{Fitness})^{-1}}{\text{Total}\,(\text{Fitness})^{-1}}$$

(4) Crossover

Crossover Rate = 80% (80% of 6 = 4 chromosomes for crossover)

- C_1 18.76 %
- C_2 17.83 %
- C_5 17.90 %
- C_6 18.20 %

Single Point crossover :-

Pair 1: C_1 1,1,2 | 2,3,3,1 C_2 2,2,1 | 3,3,1,2

C_5 1,2,3 | 3,1,1,2 C_6 3,1,1 | 2,2,3,3

Offsprings → O_1: 1,1,2,3,1,1,2 O_3: 2,2,1,2,2,3,3

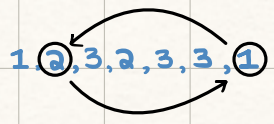
O_2: 1,2,3,2,3,3,1 O_4: 3,1,1,3,3,1,2

(5) Mutation :

- Mutation Rate = 20% (4 offsprings → 20% of 4 = 0.8 ≈ 1)

O_2 : 1,2,3,2,3,3,1

Swap position 1 and 6

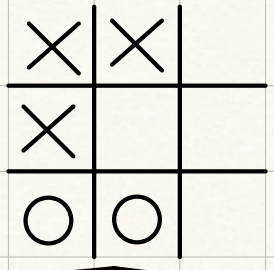


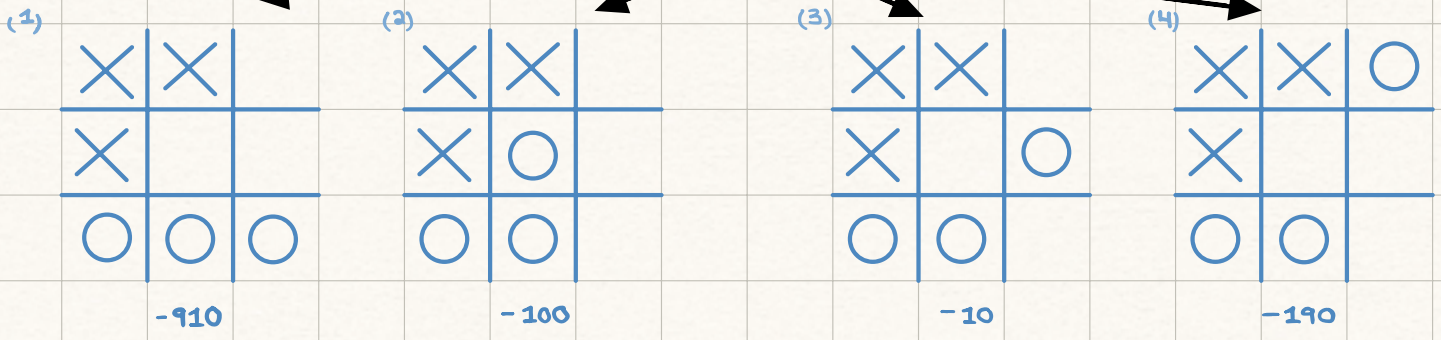
After Mutation : 1,1,3,2,3,3,2

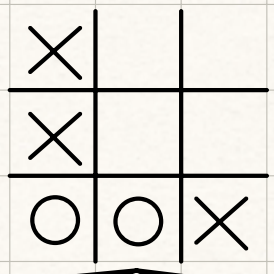
(6) Fitness :

Chromosome	T_1	T_2	T_3	T_4	T_5	T_6	T_7	F_1	F_2	F_3	Penalty	Fitness
O_1	1	1	2	3	1	1	2	22	13	7	0	516
O_2 (mut)	1	1	3	2	3	3	2	13	16	13	0	478
O_3	2	2	1	2	2	3	3	4	26	12	0	499
O_4	3	1	1	3	3	1	2	15	9	18	0	495

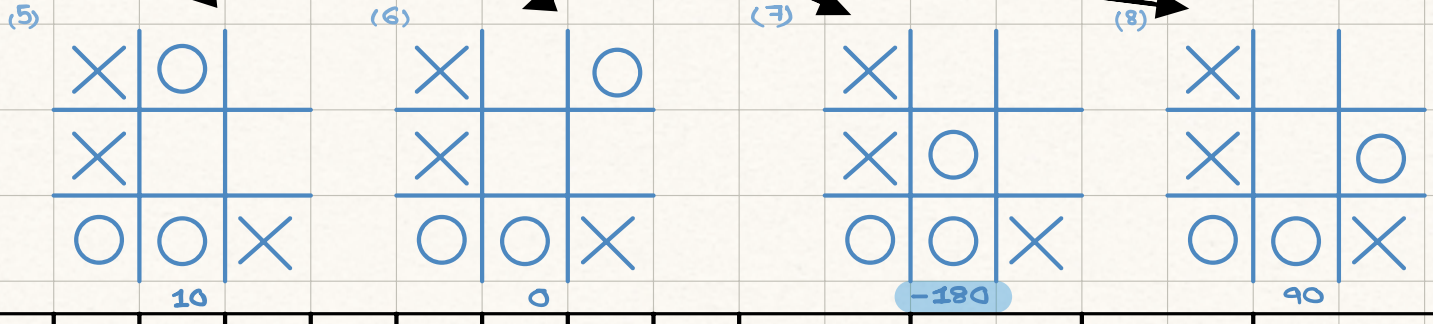
Qs 4)







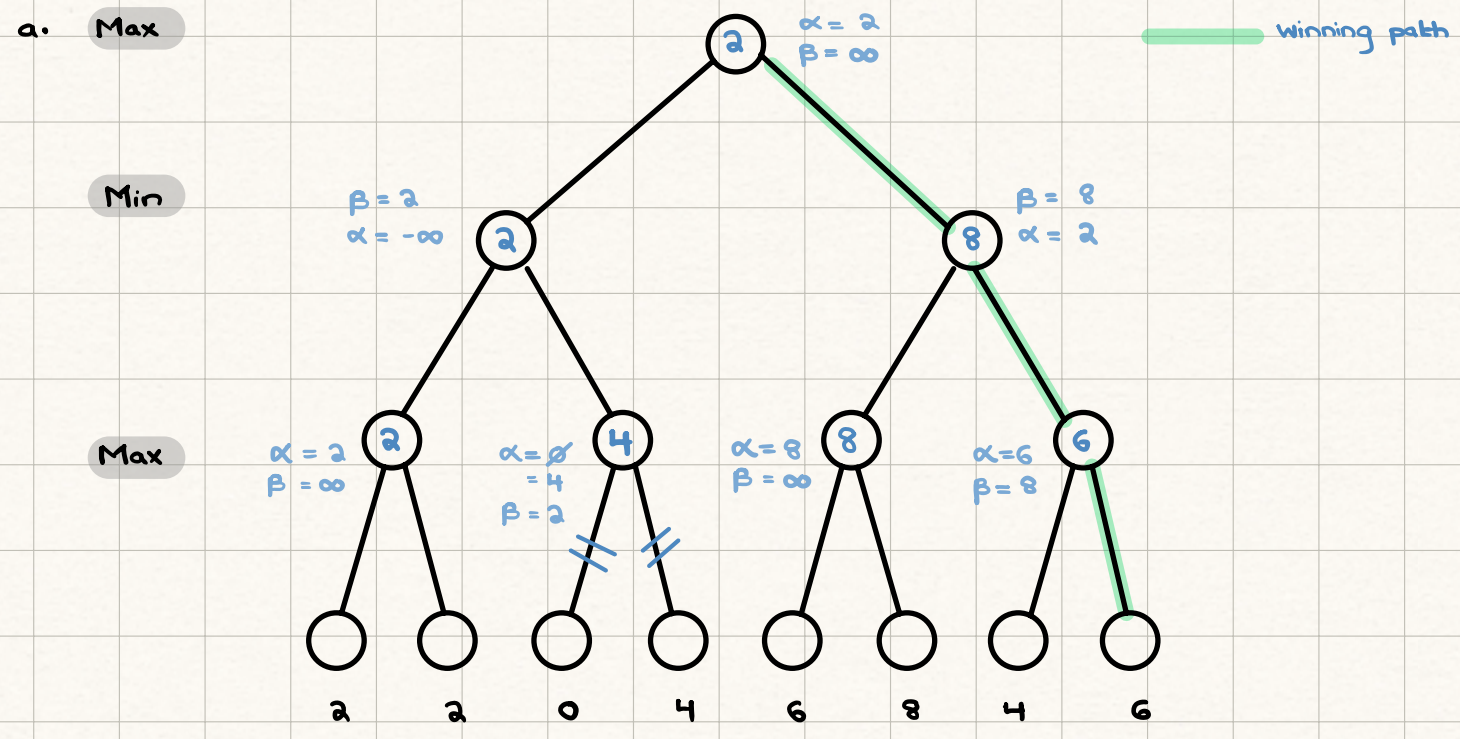
ans) X's best move is the one that Forces O to achieve a position with a score -180 instead of -910



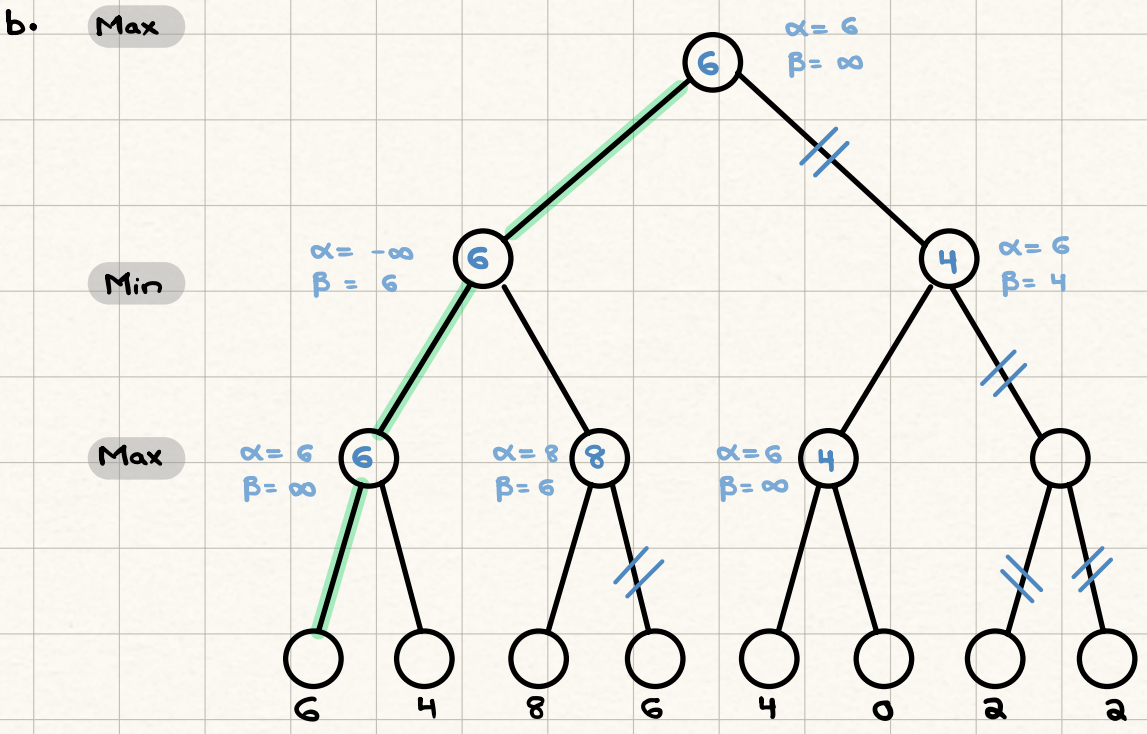
	R_1	R_2	R_3	C_1	C_2	C_3	D_1	D_2	Sum R	Sum C	Sum D	V - Sum (R,C,D)
1	100	10	-1000	0	0	-10	0	-10	-890	-10	-10	-90
2	100	0	-100	0	0	0	0	-100	0	0	-100	-100
3	100	0	-100	0	0	-10	10	-10	0	-10	0	-10
4	0	10	-100	0	0	-10	10	-100	-90	-10	-90	-190
5	0	10	0	0	-100	10	100	-10	10	-90	90	10
6	0	10	0	0	-10	0	100	-100	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

Qs 5)

a.


Max
Min
Max
winning path
α = 2
β = ∞
β = 2
α = -∞
β = 8
α = 2
α = 2
β = ∞
α = ∅
= 4
β = 2
α = 8
β = ∞
α = 6
β = 8
2
2
4
8
6
2
2
0
4
6
8
4
6

b.


Max
Min
Max
α = 6
β = ∞
α = -∞
β = 6
α = 6
β = 4
α = 6
β = ∞
α = 8
β = 6
α = 6
β = ∞
6
6
4
6
8
4
6
4
8
6
4
0
2
2

Q5 G)

Part (a) 1. Max : The defender, aims to maximise the score by preventing security breaches

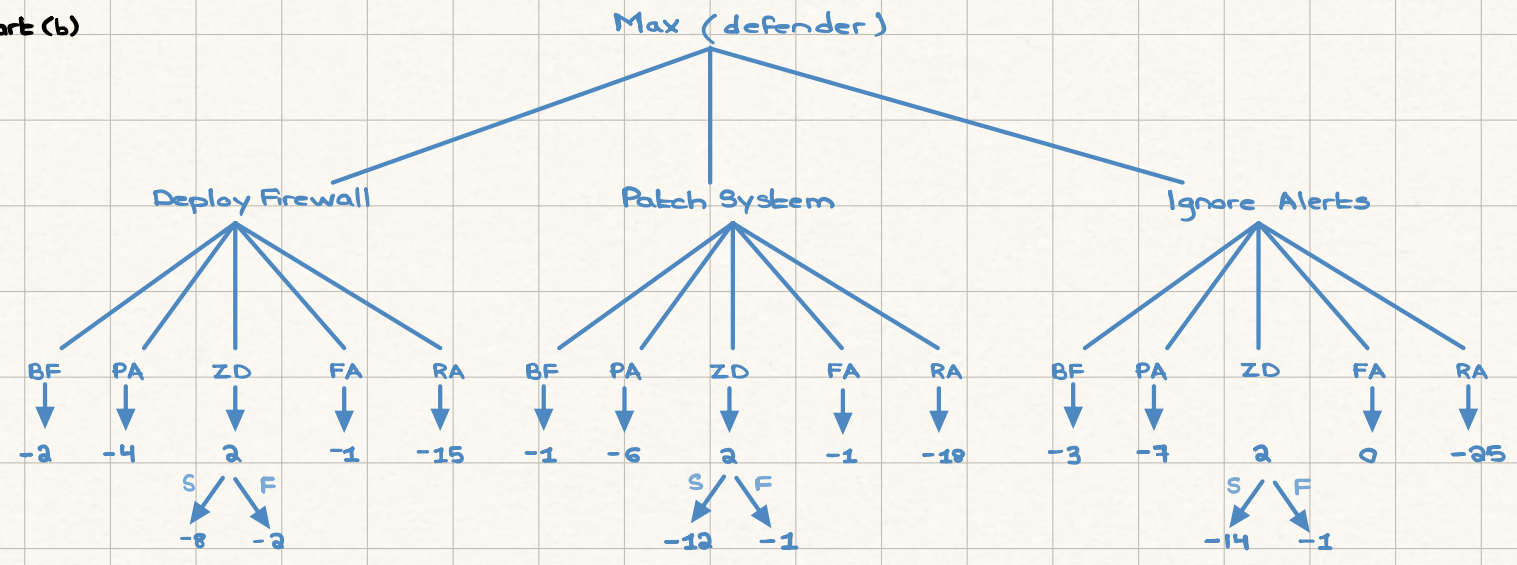
Min : The attacker, aims to maximise the score by successfully breaching security

2. Max : Chooses defense actions based on threat models, past attacks, and predictions

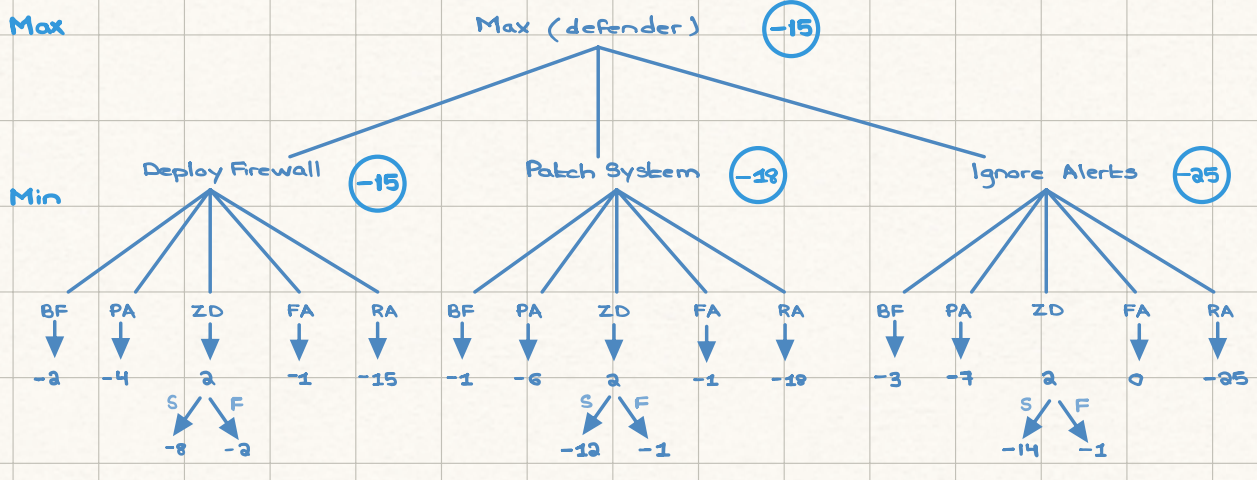
Min : Chooses attack actions based on observed defenses and potential vulnerabilities

3. Probabilistic attacks (like zero days) introduce uncertainity, forcing the defender to create strategies that can handle unknown risks rather than just known threats

Part (b)

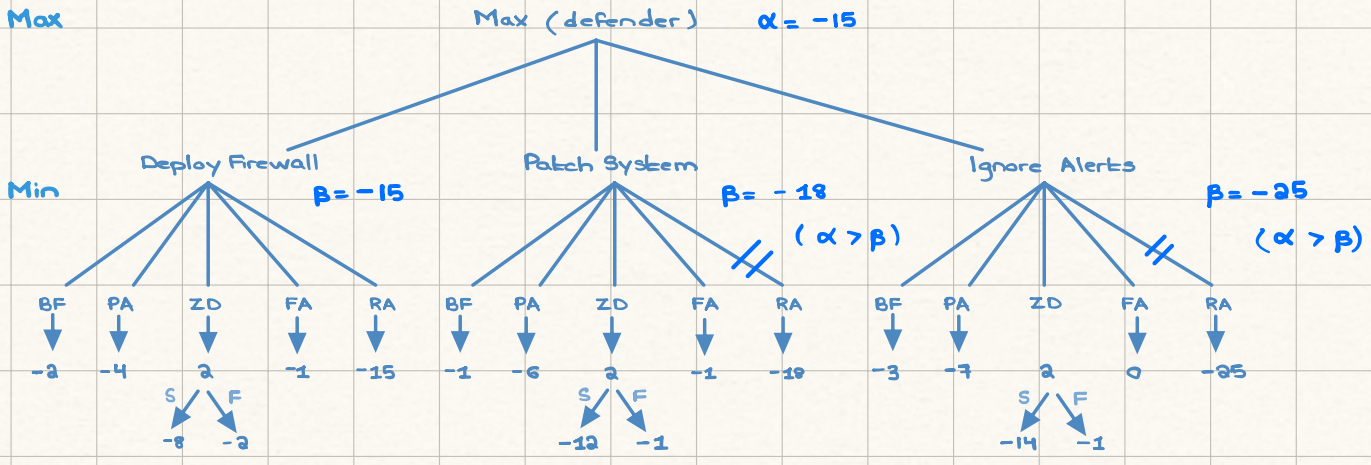


Part (c) 1. Max



- Best Move For defender : Deploy Firewall

a. Max



Branches Pruned : Patch System > RA , Ignore Alerts > RA

- Best Move For defender : Deploy Firewall

Part (d) 1. EV (Deploy Firewall) = $(-8)(0.5) + (-2)(0.5) = -5$

EV (Patch System) = $(-12)(0.5) + (-1)(0.5) = -6.5$

EV (Ignore alerts) = $(-14)(0.5) + (-1)(0.5) = -7.5$

a. Under Expectimax , the Defender chooses actions based on the average (expected) outcomes rather than worst case damage. This means the defender might favor riskier options like handling Zero-Day exploits if their expected cost is lower , even if their worst case outcome is severe