

**AI lab 4**

**part b**

***Rock paper scissors***

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## **Q1-4**

### **bots**

**Anti Flat:** deterministic/ predicts opponent's move/exploits

**Copy:** deterministic because it always plays the winning move against the opponents last move/ meta strategic/ exploits

**Freq:** plays the winning move against the most frequent opponent's move  
/deterministic/combo of strategies it tries to predict the opponent move based on past moves

**Flat:** stochastic/random since it uses coin flips/ partially exploits and explores

**Foxtrot:** stochastic/ random since it uses a coin flip/ partially explorative

**Brujn81:** deterministic it uses constant values so it's not random and doesn't use meta strategies/

**Pi:** deterministic since the value of pi is constant /partially exploits and explores

**Play226: stochastic/use random moves  
based on preset probabilities/no meta  
strategies**

**RndPlayer: stochastic/ plays random moves  
/doesn't learn or predict since it just plays  
randomly**

**Rotate: deterministic because it follows a  
pattern rock-> paper-> scissors /doesn't  
learn nor predict/ doesn't use a meta  
strategy**

**Switch: stochastic /partially random/tries to  
learn from the opponent last move/exploits**

**SwitchAlot: stochastic since it uses random  
values it's like switch but it might pick the  
previous choice sometimes/ exploits the  
player's last move**

## Q5-8

### Our player

**We programmed a rock paper scissors player  
to compete with the other bots and  
hopefully win**

**We used coevolution and the genetic  
algorithm concept to build it**

**Firs we initialize our population which  
consists of arrays with 1000 randomly  
generated moves then we initiated the  
parasite population which is a group of bots**

```
def init_population(self): # create popsize citizens

    for i in range(self.args.GA_POPSIZE): # initialize the agents population
        array = [random.randint(0, 2) for i in range(1000)]
        player = Agent(array, 0)
        self.population.append(player)

    for j in range(1):
        self.parasites.append(Dummy.AntiFlat())
        self.parasites.append(Dummy.Copy())
        self.parasites.append(Dummy.Freq())
        self.parasites.append(Dummy.Flat())
        self.parasites.append(Dummy.Foxtrot())
        self.parasites.append(Dummy.Bruijn81())
        self.parasites.append(Dummy.Pi())
        self.parasites.append(Dummy.Play226())
        self.parasites.append(Dummy.RndPlayer())
        self.parasites.append(Dummy.Rotate())
        self.parasites.append(Dummy.Switch())
        self.parasites.append(Dummy.SwitchALot())

def calc_fitness(self, population: list[Agent]):
```

**Then to calculate the fitness of each player in the population we matched it against every bot in the parasite and the fitness was the number of losses it had against them**

**We build a function called Result to check who won each round and if by the end of all rounds the result was >0 then we won**

**Since win=1,draw=0,loss=-1**

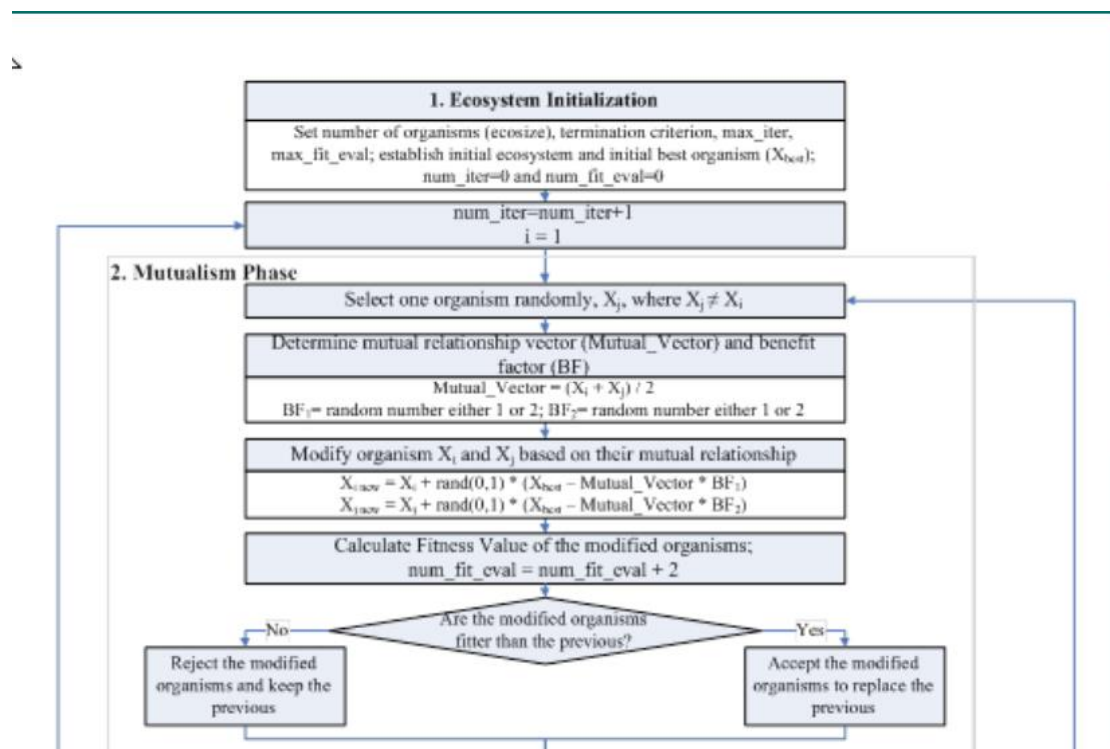
```
def calc_fitness(self, population: list[Agent]):
    loss = 0
    rounds = 0
    for pop in self.population:
        for par in self.parasites:
            par.newGame(len(pop.arr))
            for i in range(len(pop.arr)):
                r = self.result(pop.arr[i], par.nextMove())
                rounds += r
                par.storeMove(pop.arr[i], r)
            if rounds < 0:
                loss += 1
            rounds = 0
        pop.fitness = loss
    loss = 0

def result(self, p1, p2):
    if ((p2 == 0 and p1 == 1) or (p2 == 1 and p1 == 2) or (p2 == 2 and p1 == 0)):
        return 1
    if ((p2 == 0 and p1 == 0) or (p2 == 1 and p1 == 1) or (p2 == 2 and p1 == 2)):
        return 0
    return -1
```

**And then we need to construct our new generation and so we used the formulas we learned in the lecture to implement the three functions**

**Mutualism,Communalism,Parasitism**

**It's important to say that we saved the best global player and after each generation we compared it with the current generation's best player and if it was better we would switch them**



# Mutualism

```
def mate(self):
    self.elitism(self.population, self.buffer)
    for i in range(self.esize, self.args.GA_POPSIZE):
        i1 = i
        # [num1 * num2 for num1, num2 in zip(a, b)]
        while i1 == i:
            i1 = randint(0, (self.args.GA_POPSIZE) - 1)
        bf1 = randint(1, 2)
        bf2 = randint(1, 2)
        # mv=np.add(self.population[i].arr,self.population[i1].arr)
        mv = [num1 + num2 for num1, num2 in zip(self.population[i].arr, self.population[i1].arr)]
        # mv=np.divide(mv,2)
        res = [int(num1 / 2) for num1 in mv]
        mv = res
        mv2 = mv
        res = [num * bf1 for num in mv]
        res2 = [abs(num1 - num2) for num1, num2 in zip(self.best, res)]
        res3 = [int(num * uniform(0, 1)) for num in res2]
        gene = [num + num2 for num, num2 in zip(self.population[i].arr, res3)]
        mv = mv2
        res = [num * bf2 for num in mv]
        res2 = [abs(num1 - num2) for num1, num2 in zip(self.best, res)]
        res3 = [int(num * uniform(0, 1)) for num in res2]
        gene2 = [num + num2 for num, num2 in zip(self.population[i1].arr, res3)]

        # gene=self.population[i].arr+np.multiply(randint(0,1),(np.subtract(self.best,np.multiply(mv
        # print(gene)
```

# Communalism

```
def commensalism(self):
    for i in range(self.esize, self.args.GA_POPSIZE):
        i1 = i
        while i1 == i:
            i1 = randint(0, (self.args.GA_POPSIZE) - 1)

        res2 = [abs(num1 - num2) for num1, num2 in zip(self.best, self.population[i].arr)]
        res3 = [num * random.choice([-1, 1]) for num in res2]
        gene = [num + num2 for num, num2 in zip(self.population[i].arr, res3)]

        # gene=self.population[i].arr+randint(-1,1)*np.subtract(self.best,self.population[i].arr)
        loss = 0
        rounds = 0

        for par in self.parasites:
            par.newGame(len(gene))
            for k in range(len(gene)):
                r = self.result(gene[k], par.nextMove())
                rounds += r
                par.storeMove(gene[k], r)
            if rounds < 0:
                loss += 1
            rounds = 0

        if (loss < self.population[i].fitness):
            self.population[i] = Agent(gene, loss)
```



# Parasitism

```
def paraisitsm(self):
    for i in range(self.esize, self.args.GA_POPSIZE):
        i1 = i
        while i1 == i:
            i1 = randint(0, (self.args.GA_POPSIZE) - 1)
        pv = self.population[i].arr
        for j in range(len(self.population[i].arr)):
            if uniform(0, 1) < self.args.GA_MUTATION:
                pv[j] = randint(0, 2)
        loss = 0
        rounds = 0

        for par in self.parasites:
            par.newGame(len(pv))
            for k in range(len(pv)):
                r = self.result(pv[k], par.nextMove())
                rounds += r
                par.storeMove(pv[k], r)

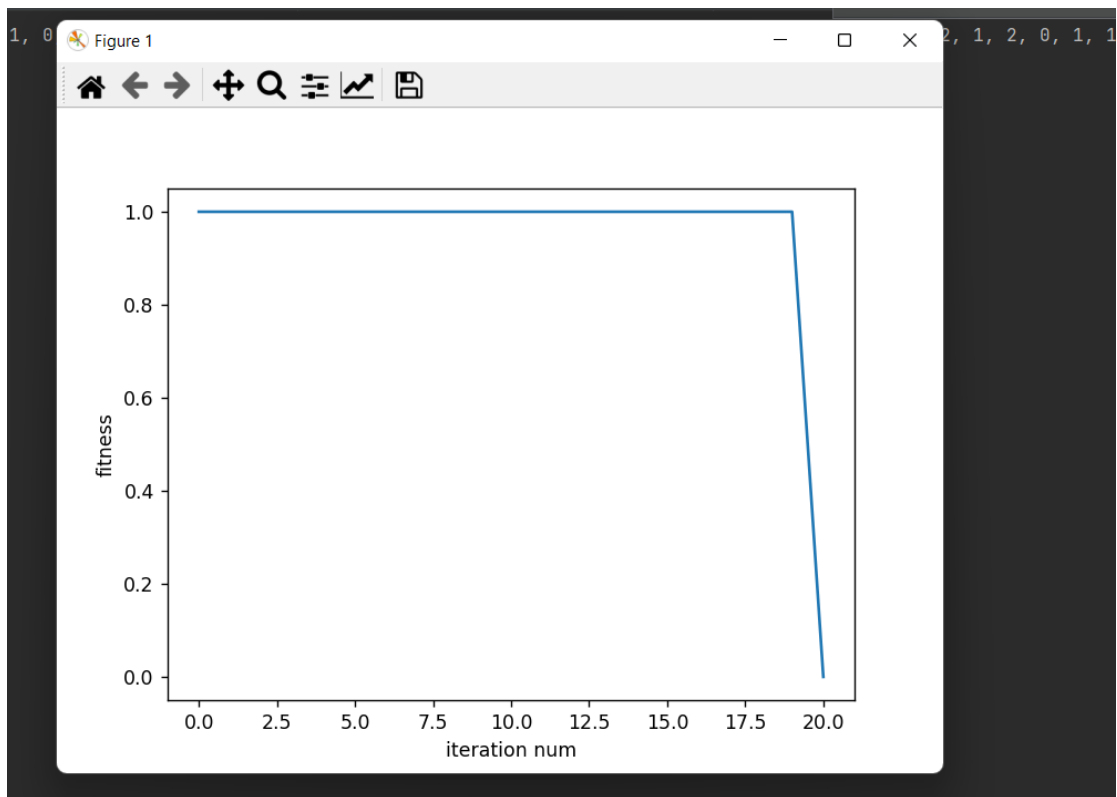
            if rounds < 0:
                loss += 1

            rounds = 0

        if (loss < self.population[i].fitness):
            self.population[i] = Agent(pv, loss)
```

And by the end we managed to get to our  
player that beat all of the other bots

```
fitness: 1
best player: [1, 0, 2, 0, 2, 1, 1, 1, 2, 0, 0, 1, 1, 2, 2, 1, 1, 2, 0, 2, 2, 2, 0, 2, 1, 1, 0, 2, 0, 1, 2, 2, 1, 0, 2, 1, 1, 0, 2, 2, 1, 2, 0, 2, 2, 0, 2, 2, 0, 2, 1, 2, 0,
Clock ticks time: 7.236291170120239
fitness: 1
best player: [1, 0, 2, 0, 2, 1, 1, 1, 2, 0, 0, 1, 1, 2, 2, 1, 1, 2, 0, 2, 2, 2, 0, 2, 1, 1, 0, 2, 0, 1, 2, 2, 1, 0, 2, 2, 1, 2, 0, 2, 2, 0, 2, 2, 0, 2, 2, 1, 2, 0,
Clock ticks time: 7.241596029830933
fitness: 1
best player: [1, 0, 2, 0, 2, 1, 1, 1, 2, 0, 0, 1, 1, 2, 2, 1, 1, 2, 0, 2, 2, 2, 0, 2, 1, 1, 0, 2, 0, 1, 2, 2, 1, 0, 2, 2, 1, 1, 0, 2, 2, 1, 2, 0, 2, 2, 0, 2, 2, 1, 2, 0,
Clock ticks time: 7.259379148483276
fitness: 1
best player: [1, 0, 2, 0, 2, 1, 1, 1, 2, 0, 0, 1, 1, 2, 2, 1, 1, 2, 0, 2, 2, 2, 0, 2, 1, 1, 0, 2, 0, 1, 2, 2, 1, 0, 2, 2, 1, 1, 0, 2, 2, 1, 2, 0, 2, 2, 0, 2, 2, 1, 2, 0,
Clock ticks time: 7.251201629638672
fitness: 1
best player: [1, 0, 2, 0, 2, 1, 1, 1, 2, 0, 0, 1, 1, 2, 2, 1, 1, 2, 0, 2, 2, 2, 0, 2, 1, 1, 0, 2, 0, 1, 2, 2, 1, 0, 2, 2, 1, 1, 0, 2, 2, 1, 2, 0, 2, 2, 0, 2, 2, 1, 2, 0,
Clock ticks time: 7.438626289367676
fitness: 0
best player: [1, 0, 0, 1, 0, 0, 0, 0, 2, 1, 0, 1, 2, 1, 1, 1, 0, 1, 0, 1, 0, 0, 1, 2, 0, 0, 2, 2, 1, 2, 1, 2, 2, 1, 1, 1, 1, 1, 0, 1, 1, 0, 2, 0, 2, 1, 1, 1, 1, 1, 0, 1,
Best string: [1, 0, 0, 1, 0, 0, 0, 0, 2, 1, 0, 1, 2, 1, 1, 1, 0, 1, 0, 1, 0, 0, 1, 2, 0, 0, 2, 2, 1, 2, 1, 2, 2, 1, 1, 1, 1, 1, 0, 1, 1, 0, 2, 0, 2, 1, 1, 1, 1, 1, 0, 1,
Found in 20 iterations out of 100
Elapsed time: 148.1357796
average against Anti Flat Player is: 3.6
sd against Anti Flat Player is: 0.8
average against Copy Player is: 77.36
sd against Copy Player is: 73.76867627929892
average against Freq Player is: 18.736
sd against Freq Player is: 75.30973440399322
average against Flat Player is: 4.2736
sd against Flat Player is: 75.3169956448078
average against Evryone Player is: 5.57716
```



## Q9-10

**First of all we set a match between our player and every other bot and we got the results below, as we can see we managed to win most of the games and clearly our player is better than all of the other bots**

```
average against Anti Flat Player is: 3.6
sd against Anti Flat Player is: 0.8
average against Copy Player is: 77.36
sd against Copy Player is: 73.76867627929892
average against Freq Player is: 18.736
sd against Freq Player is: 75.30973440399322
average against Flat Player is: 4.2736
sd against Flat Player is: 75.3169956448078
average against Foxtrot Player is: 5.52736
sd against Foxtrot Player is: 75.34589935444129
average against Bruijn 81 Player is: 9.552736
sd against Bruijn 81 Player is: 75.58491658667944
average against Pi Player is: 2.9552736
sd against Pi Player is: 75.59189961593864
average against 226 Player is: -4.38447264
sd against 226 Player is: 76.80826254608649
average against Random Player is: -4.238447264
sd against Random Player is: 76.41473601890917
average against Rotating Player is: 25.5769552736
sd against Rotating Player is: 79.51627784746185
average against Switching Player is: -9.54238447264
sd against Switching Player is: 79.62811770385386
average against Switch a Lot Player is: 9.045769552736001
sd against Switch a Lot Player is: 79.81812786083134
{'Anti Flat Player': -19241, 'Copy Player': -19187, 'Freq Player': -9736, 'Flat Player': -5202, 'Foxtrot Player': -4875, 'Bruijn 81 Player': -4524, 'Pi Player': -3454, '226 Player': -4238, 'Random Player': -4238, 'Rotating Player': 25576, 'Switching Player': -9542, 'Switch a Lot Player': 9045}
```

**And to further prove it we arranged a double round robin tournament in which each bot and our player played 2 games against every other player and by the end the player with the highest rating win the tournament**

**Our rating system was the sum of all rounds won by a player and if a player loses he loses a point**

```
sd against Rotating Player is: 77.51627764748185
average against Switching Player is: -0.54238447264
sd against Switching Player is: 79.62811770385386
average against Switch a Lot Player is: 9.845769552736881
sd against Switch a Lot Player is: 79.81812786883134
{'Anti Flat Player': -19241, 'Copy Player': -19187, 'Freq Player': -9736, 'Flat Player': -5282, 'Foxtrot Player': -4875, 'Bruijn 81 Player': -4524, 'Pi Player': -3454, '226 Player': 2182, 'Random Player': 2178, 'Rotating Player': 326, 'Switching Player': 3876, 'Switch a Lot Player': 5016, 'us': 53361}
```

```
Player': -4524, 'Pi Player': -3454, '226 Player': 2182, 'Random Player': 2178, 'Rotating Player': 326, 'Switching Player': 3876, 'Switch a Lot Player': 5016, 'us': 53361}
```

**And as we can see our player had the highest rating by far and with the switch a lot bit in second place**