

AI LAB 1-1

פייסל סעדיה 208336321

אחמד גבארין 314722307

1 (חישוב הממוצע וסטטיית תקן:

```
for generation in range(max_generations):
    # Evaluate the fitness of each Gene
    iteration_time = time.time()
    fitnesses = [individual.fitness for individual in population]
    avg=sum(fitnesses)/len(fitnesses)
    all =0
    for i in range(len(fitnesses)):
        all += abs(fitnesses[i] -avg)**2
    standard_dev = all/len(fitnesses)
    standard_dev =math.sqrt(standard_dev)
    print("in generation " +str(generation)+" the average is: "+str(avg)+" std is: "+str(standard_dev)+"best gene:",
          ''.join(max(population, key=lambda individual: individual.fitness).str_))
```

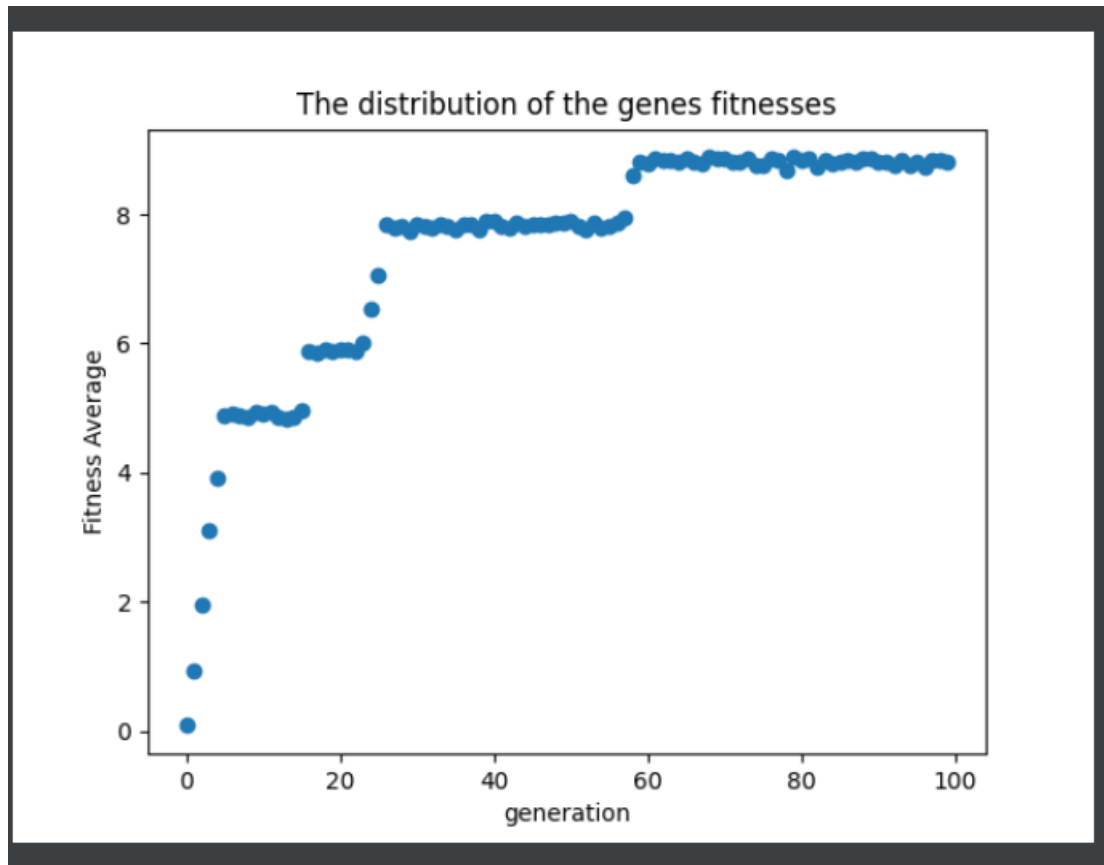
2 (חישוב הזמן בכל איטרציה והזמן הכולל:

```
clock_ticks = time.time() - iteration_time
print("Clock ticks time: ", clock_ticks)
overallclock_ticks = time.time() - overall_time
# Find the Gene with the highest fitness
best_individual = max(population, key=lambda individual: individual.fitness)
best_fitness = best_individual.fitness
if best_fitness == num_genes:
    print("time to get global optimum is "+str(overallclock_ticks))
else:
    print("time to get local optimum is "+str(overallclock_ticks))
```

וכן הצגת הפלט לדוגמה:

```
in generation 92 the average is: 11.79 std is: 0.4073082370883259 best gene: !ello, world!
Clock ticks time: 0.0010423660278320312
in generation 93 the average is: 11.82 std is: 0.3841874542459706 best gene: !ello, world!
Clock ticks time: 0.0
in generation 94 the average is: 11.7 std is: 0.4582575694955837 best gene: !ello, world!
Clock ticks time: 0.0009965896606445312
in generation 95 the average is: 11.74 std is: 0.43863424398922624 best gene: !ello, world!
Clock ticks time: 0.0
in generation 96 the average is: 11.67 std is: 0.47021271782034957 best gene: !ello, world!
Clock ticks time: 0.0010037422180175781
in generation 97 the average is: 11.74 std is: 0.4386342439892262 best gene: !ello, world!
Clock ticks time: 0.0
in generation 98 the average is: 11.66 std is: 0.47370877129308075 best gene: !ello, world!
Clock ticks time: 0.0009911060333251953
in generation 99 the average is: 11.75 std is: 0.4330127018922193 best gene: !ello, world!
Clock ticks time: 0.0
time to get local optimum is : 0.05312371253967285
Best Gene: !ello, world!
Best fitness: 12
```

(3) לכל דור אנחנו מציגים את ממוצע פונקצית הפיטנס
עבור כל ה individuals :



(4

```

if cross_type=="SINGLE":
    pos = random.randint(0,pop_size-1)
    child= parent1.str[0: pos]+parent2.str[pos:]
if cross_type=="TWO":
    pos1 = random.randint(0,pop_size/2-1)
    pos2 = random.randint(pop_size/2,pop_size-1)
    child = parent1.str[0:pos1]+parent2.str[pos1:pos2]+parent1.str[pos2:]
if(cross_type=="UNIFORM"):
    child = [parent1.str[i] if random.random() < 0.5 else parent2.str[i] for i in range(num_genes)]
# perform mutation
if random.uniform(0, 1) < 0.3:
    child = mutate(child)

```

(5) מימשנו את הפונקציה כך שאנחנו נותנים קנס עבור
אות שהוא לא נמצא במחרוזת ו נותנים ציון יותר גבוה
לניחוש אות במקום\נמצאת במחרוזת היעד :

```
def bulls_hit(individual):
    target = list("Hello, World!")
    score = 0
    for i in range(len(individual)):
        if(individual[i] == target[i]): # if guessed the correct char at the correct place
            score += 3
        else:
            if not individual[i] in target: # if the char is not in the string then give a penalty
                score -= 1
    return score
```

(6)

בכל המקרים קיבלנו פתרונות יותר טובות עם בול פגיעה ובפחות איטרציות הסיבה לזה ש מוטציה מתרחשת בהסתברות יותר נמוכה ושנותנת יתרון גדול יותר על ניחוש טוב , עבור
 popsize=200,maxgeneration=100 הרצנו וקיבלנו את התצאות הבאות
 הרצה של האלגוריתם הרגיל :

```
in generation 31 the average is: 11.755 std is: 0.44133320745214755 best gene: He$lo, world!
Clock ticks time: 0.000997781753540039
in generation 32 the average is: 11.725 std is: 0.44651427748729333 best gene: He$lo, world!
Clock ticks time: 0.0019941329956054688
in generation 33 the average is: 11.78 std is: 0.41424630354416003 best gene: He$lo, world!
Clock ticks time: 0.00099945068359375
in generation 34 the average is: 11.79 std is: 0.4073082370883259 best gene: He$lo, world!
Clock ticks time: 0.000997304916381836
in generation 35 the average is: 11.76 std is: 0.4386342439892265 best gene: Hello, world!

global optimum found in 35 generations
time to get global optimum is 0.0402836799621582
```

הרצה של האלגוריתם בול פגיעה:

```
in generation 13 the average is: 29.69 std is: 2.1665410219779657 best gene: eello, world!!
Clock ticks time: 0.0010433197021484375
in generation 14 the average is: 31.425 std is: 1.6983447824278808 best gene: eello, world!
Clock ticks time: 0.0009987354278564453
in generation 15 the average is: 32.51 std is: 1.673290172086119 best gene: eello, world!
Clock ticks time: 0.0009963512420654297
in generation 16 the average is: 33.635 std is: 2.267548235429623 best gene: eello, world!
Clock ticks time: 0.0009930133819580078
in generation 17 the average is: 35.08 std is: 1.6833300330000673 best gene: Hello, world!

global optimum found in 17 generations
time to get local optimum is : 0.023282289505004883
```

```

Genetics X
in generation 20 the average is: 35.02 std is: 1.6434843/4228111 best gene: Hello, wHrld!
Clock ticks time: 0.000997304916381836
in generation 21 the average is: 34.995 std is: 1.6867053684624347 best gene: Hello, wHrld!
Clock ticks time: 0.000997304916381836
in generation 22 the average is: 35.17 std is: 1.6127926091100475 best gene: Hello, wHrld!
Clock ticks time: 0.000997304916381836
in generation 23 the average is: 35.28 std is: 1.507182802449654 best gene: Hello, wHrld!
Clock ticks time: 0.000997304916381836
in generation 24 the average is: 35.03 std is: 1.7056083958517545 best gene: Hello, world!

global optimum found in 24 generations

```

שיפור ב כמעט 50% איטרציות עד להגעה למקסימום גלובלי

(7

exploration: נעשה ב שיחלוף ומוטציה כי בחלקים אלה אנחנו מנחשים פתרונות חדשים

exploitation: נעשה על ידי ה Elitesm כי בוחרים לדור הבא אחוז מסויים מהדור הנוכחי לפי הפיטניסים הכי טובים ומהם יוצרים פתרונות חדשים, כלומר אנחנו מתרכזים באיכות הפתרון הנוכחי ולא מוצאים פתרונות חדשים.

(8

(A

```

in generation 97 the average is: 18.0 std is: 0.0 best gene: eel o, reerlww
Clock ticks time: 0.0005030632019042969
in generation 98 the average is: 18.0 std is: 0.0 best gene: eel o, reerlww
Clock ticks time: 0.0016226768493652344
in generation 99 the average is: 18.0 std is: 0.0 best gene: eel o, reerlww
Clock ticks time: 0.0010409355163574219
time to get local optimum is : 0.10709404945373535
Best Gene: eel o, reerlww
Best fitness: 18

```

(B

```

Clock ticks time: 0.000997943008397375
in generation 94 the average is: -10.94 std is: 2.7343006418460933 best gene: )gM!hS0#0(0m
Clock ticks time: 0.002124309539794922
in generation 95 the average is: -11.615 std is: 2.847239891544074 best gene: f0=0G0\T00qfR
Clock ticks time: 0.0009975433349609375
`0 308BT0/50
Clock ticks time: 0.000997304916381836
pX[X00HwQi00
Clock ticks time: 0.0019943714141845703
in generation 98 the average is: -11.0 std is: 2.6907248094147422 best gene: Y0yC0000Z0890
Clock ticks time: 0.0009975433349609375
in generation 99 the average is: -10.17 std is: 2.785875086934083 best gene: L0TtA,rS0j0V0
Clock ticks time: 0.0009970664978027344
time to get local optimum is : 0.12468147277832031
Best Gene: 40w]0?00[A40i
Best fitness: -2

```

(C

```

in generation 41 the average is: 35.16 std is: 1.5825296205758674 best gene: Hellor world!
Clock ticks time: 0.0009946823120117188
in generation 42 the average is: 35.16 std is: 1.5825296205758674 best gene: Hellor world!
Clock ticks time: 0.001992464065551758
in generation 43 the average is: 35.015 std is: 1.6657655897514503 best gene: Hellor world!
Clock ticks time: 0.0009992122650146484
in generation 44 the average is: 35.015 std is: 1.6747462494360135 best gene: Hellor world!
Clock ticks time: 0.0009996891021728516
in generation 45 the average is: 35.045 std is: 1.6742087683440163 best gene: Hellor world!
Clock ticks time: 0.001992940902709961
in generation 46 the average is: 34.965 std is: 1.7475053647986307 best gene: Hello, world!

global optimum found in 46 generations
time to get local optimum is : 0.06604790687561035
Best Gene: Hello, world!
Best fitness: 39

```

(D

עבור מוטציה ללא שיחלוף קיבלנו תוצאות מאוד גרועות
, ועבור שיחלוף בלבד תוצאות יותר טובות , והכי טוב
התקבל כאשר היה שילוב של השניים.

הרצה של האלגוריתם הרגיל :

```

In generation 31 the average is: 11.75 std is: 0.44133320/45214/55 best gene: He$lo, world!
Clock ticks time: 0.000997781753540039
in generation 32 the average is: 11.725 std is: 0.44651427748729333 best gene: He$lo, world!
Clock ticks time: 0.0019941329956054688
in generation 33 the average is: 11.78 std is: 0.41424630354416003 best gene: He$lo, world!
Clock ticks time: 0.00099945068359375
in generation 34 the average is: 11.79 std is: 0.4073082370883259 best gene: He$lo, world!
Clock ticks time: 0.000997304916381836
in generation 35 the average is: 11.76 std is: 0.4386342439892265 best gene: Hello, world!

global optimum found in 35 generations
time to get global optimum is 0.0402836799621582

```

הרצה של האלגוריתם בול פגיעה:

```

In generation 13 the average is: 29.69 std is: 2.16654102199/965/ best gene: eello, world!
Clock ticks time: 0.0010433197021484375
in generation 14 the average is: 31.425 std is: 1.6983447824278808 best gene: eello, world!
Clock ticks time: 0.0009987354278564453
in generation 15 the average is: 32.51 std is: 1.673290172086119 best gene: eello, world!
Clock ticks time: 0.0009963512420654297
in generation 16 the average is: 33.635 std is: 2.267548235429623 best gene: eello, world!
Clock ticks time: 0.0009930133819580078
in generation 17 the average is: 35.08 std is: 1.6833300330000673 best gene: Hello, world!

global optimum found in 17 generations
time to get local optimum is : 0.023282289505004883

```

```

Genetics X
In generation 20 the average is: 35.02 std is: 1.6939893/4228/// best gene: Hello, wHrld!
Clock ticks time: 0.000997304916381836
in generation 21 the average is: 34.995 std is: 1.6867053684624347 best gene: Hello, wHrld!
Clock ticks time: 0.000997304916381836
in generation 22 the average is: 35.17 std is: 1.6127926091100475 best gene: Hello, wHrld!
Clock ticks time: 0.000997304916381836
in generation 23 the average is: 35.28 std is: 1.507182802449654 best gene: Hello, wHrld!
Clock ticks time: 0.000997304916381836
in generation 24 the average is: 35.03 std is: 1.7056083958517545 best gene: Hello, world!

global optimum found in 24 generations

```

שיפור ב כמעט 50% איטרציות עד להגעה למקסימום גלובלי

