COMSATS UNIVERSITY ISLAMABAD, ABBOTTABAD CAMPUS

Lab Assignment # 01 – Artificial Intelligence

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Maximize the value of the function F(X) = - X2 + 2X, over the range of real number from 0 to 2 with initial population ['11010', '00111', '10110', '00101'] and with random numbers [0.4, 0.15, 0.7, 0.9] adjust the numbers in range of 0 to 2. Select the crossover between the first and fifth digit. Run the algorithm in 2 iterations.

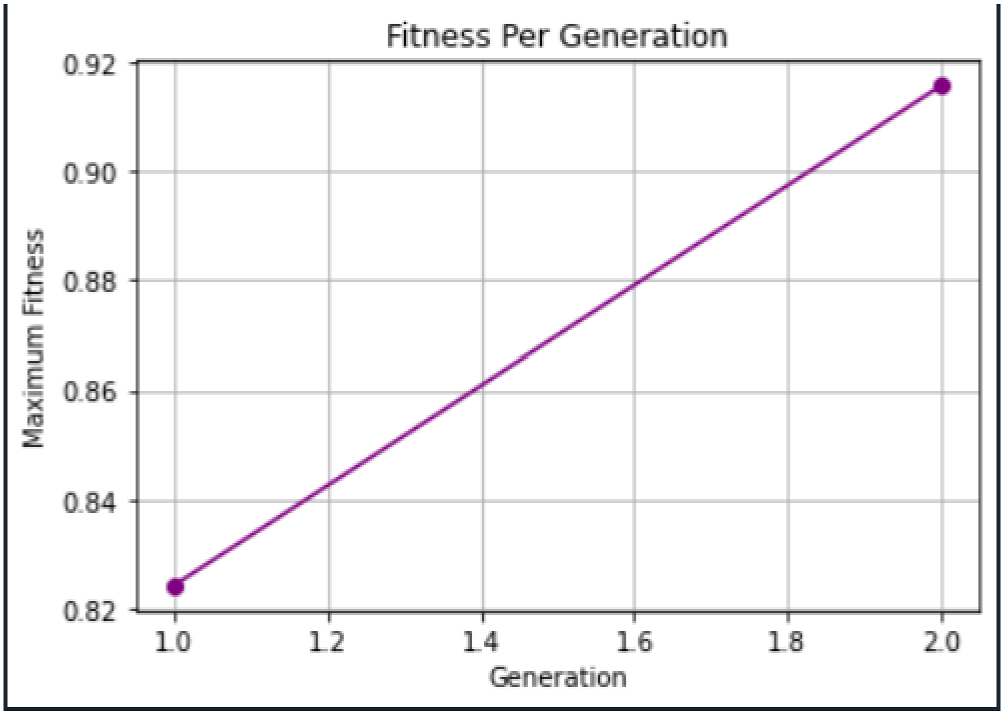
Code:

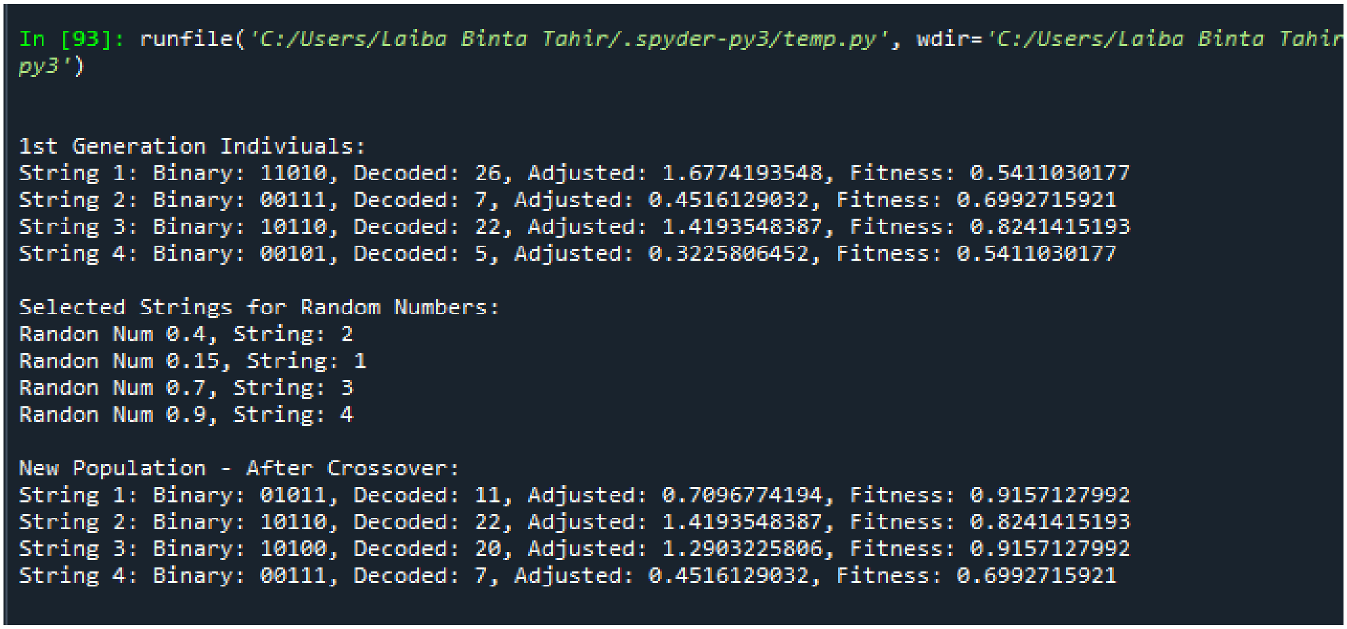
```
"""Created on Mon Apr 29 11:56:03 2024

@author: Laiba Binta Tahir
"""

import numpy as np
import matplotlib.pyplot as plt

def FitnessFunction(x):
   return -x**2 + 2*x

def DecodeBinary(binary_str):
   return int(binary_str, 2)

def AdjustValue(binary_str, MinVal, MaxVal):
   return MinVal + (MaxVal - MinVal) * DecodeBinary(binary_str) /
(2**len(binary_str) - 1)

def CrossOver(p1, p2):
   c1 = p1[0] + p2[1:4] + p1[4]
   c2 = p2[0] + p1[1:4] + p2[4]
   return c1, c2

#given data
Population = ['11010', '00111', '10110', '00101']
randNumbers = [0.4, 0.15, 0.7, 0.9]

# decode
DecodePopulation = [DecodeBinary(individual) for individual in Population]
AdjustedPopulation = [AdjustValue(individual, 0, 2) for individual in Population]
```

```
# Fitness
FitnessValues = [FitnessFunction(adjusted) for adjusted in AdjustedPopulation]
print("\n")
print("1st Generation Indiviuals:")
for j , (individual , decoded , adjusted, fitness) in enumerate(zip(Population,
DecodePopulation, AdjustedPopulation, FitnessValues) ,1):
    print(f"String {j}: Binary: {individual}, Decoded: {decoded}, Adjusted:
{adjusted:.10f}, Fitness: {fitness:.10f}")

# PDF & CDF
TotalFitness = sum(FitnessValues)
prob = [fitness / TotalFitness for fitness in FitnessValues]
CDF = np.cumsum(prob)

# select string
SelectedIndiviuals = []
for rNum in randNumbers:
    SelectedIndiviual = next(j for j , cdfVal in enumerate(CDF) if cdfVal >= rNum)
    SelectedIndiviuals.append(SelectedIndiviual)

print("\nSelected Strings for Random Numbers:")
for i, rNum, SelectedIndiviual in zip(range(1, 5), randNumbers,
SelectedIndiviuals):
    print(f"Randon Num {rNum}, String: {SelectedIndiviual + 1}")

# crossover
c1, c2 = CrossOver(Population[SelectedIndiviuals[0]],
Population[SelectedIndiviuals[1]])
c3, c4 = CrossOver(Population[SelectedIndiviuals[2]],
Population[SelectedIndiviuals[3]])
newPopulatoion = [c1,c2,c3,c4]

#calculations for new generation
DecodeNewPopulation = [DecodeBinary(individual) for individual in
newPopulatoion]
```

```
AdjustedNewPopulation = [AdjustValue(individual, 0, 2) for individual in newPopulatoion]
NewFitnessValues = [FitnessFunction(adjusted) for adjusted in AdjustedNewPopulation]


print("\nNew Population - After Crossover:")
for j, (individual, decoded, adjusted, fitness) in enumerate(zip(newPopulatoion, DecodeNewPopulation, AdjustedNewPopulation, NewFitnessValues), 1):
   print(f"String {j}: Binary: {individual}, Decoded: {decoded}, Adjusted: {adjusted:.10f}, Fitness: {fitness:.10f}")
print("\n")

#Plot
MaxFitnessInitial = np.max(FitnessValues)
MaxFitnessNew = np.max(NewFitnessValues)

Generations = np.arange(1.0, 2.01, 0.2)

yAxis = np.arange(round(MaxFitnessInitial, 2), round(MaxFitnessNew, 2), 0.02 )
plt.plot([1.0,2.0] , [MaxFitnessInitial, MaxFitnessNew], '-ro', color="purple" )

plt.xticks(Generations)
plt.xlabel("Generations")

plt.yticks(yAxis)
plt.ylabel("Maximum Fitness")

plt.title("Fitness Per Generation")
plt.grid(True)
plt.show
```

Output:





```
In [93]: runfile('C:/Users/Laiba Binta Tahir/.spyder-py3/temp.py', wdir='C:/Users/Laiba Binta Tahir
py3')


1st Generation Indiviuals:
String 1: Binary: 11010, Decoded: 26, Adjusted: 1.6774193548, Fitness: 0.5411030177
String 2: Binary: 00111, Decoded: 7, Adjusted: 0.4516129032, Fitness: 0.6992715921
String 3: Binary: 10110, Decoded: 22, Adjusted: 1.4193548387, Fitness: 0.8241415193
String 4: Binary: 00101, Decoded: 5, Adjusted: 0.3225806452, Fitness: 0.5411030177

Selected Strings for Random Numbers:
Randon Num 0.4, String: 2
Randon Num 0.15, String: 1
Randon Num 0.7, String: 3
Randon Num 0.9, String: 4

New Population - After Crossover:
String 1: Binary: 01011, Decoded: 11, Adjusted: 0.7096774194, Fitness: 0.9157127992
String 2: Binary: 10110, Decoded: 22, Adjusted: 1.4193548387, Fitness: 0.8241415193
String 3: Binary: 10100, Decoded: 20, Adjusted: 1.2903225806, Fitness: 0.9157127992
String 4: Binary: 00111, Decoded: 7, Adjusted: 0.4516129032, Fitness: 0.6992715921
```