notebook1

November 7, 2022

[1]:
```python
import pygad
import numpy as np
import math
import matplotlib.pyplot as plt
from scipy.signal import argrelextrema
```

[2]:
```python
matriz = [
    [5,2,4,8,9,0,3,3,8,7],
    [5,5,3,4,4,6,4,1,9,1],
    [4,1,2,1,3,8,7,8,9,1],
    [1,7,1,6,9,3,1,9,6,9],
    [4,7,4,9,9,8,6,5,4,2],
    [7,5,8,2,5,2,3,9,8,2],
    [1,4,0,6,8,4,0,1,2,1],
    [1,5,2,1,2,8,3,3,6,2],
    [4,5,9,6,3,9,7,6,5,10],
    [0,6,2,8,7,1,2,1,5,3]
]
```

[3]:
```python
#Funcion de
def binatodeci(binary):
    return sum(val*(2**idx) for idx, val in enumerate(reversed(binary)))
```

[4]:
```python
def fitness_func(solution, solution_idx):
    # output = numpy.sum(solution*function_inputs)
    # fitness = 1.0 / (numpy.abs(output - desired_output) + 0.000001)
    # return fitness
    fitness = 0
    num = binatodeci(solution)
    xfs = ((num/16)/16)*10  #256 -> 12 % 10 -> 2
    yfs = ((num%16)/16)*10
    for i in range(0,10):
        for j in range(0,10):

            fitness+= math.sqrt((i-xfs)**2  + (j-yfs)**2)*matriz[i][j]

    return 100/np.sqrt(fitness)
```

[5]:
```
#Parametros del modelo
num_generations = 20    # Number of generations.
num_parents_mating = 2  # Number of solutions to be selected as parents in the␣
 ↪mating pool.
sol_per_pop = 4         # Number of solutions in the population.
num_genes = 8
last_fitness = 0
mutation_probability=0.40
```

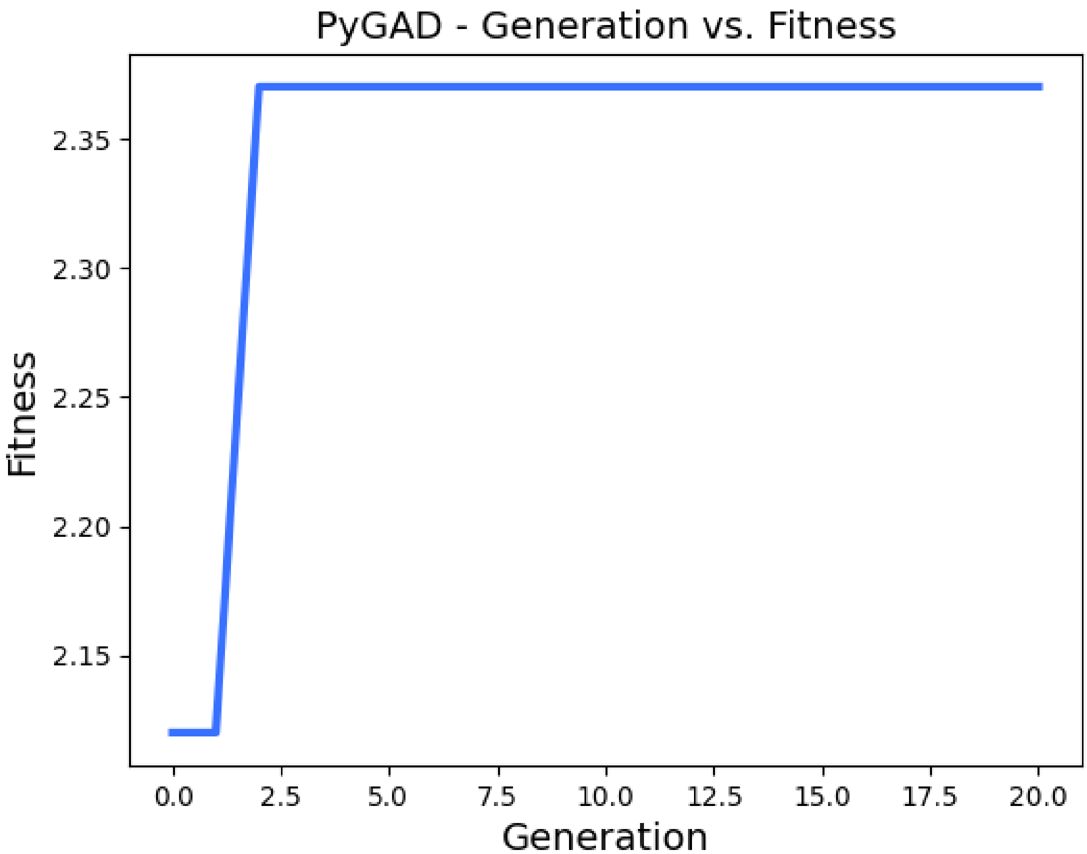
[6]:
```
#Print en cada generacion
def on_generation(ga_instance):
    global last_fitness
    print("Generation = {generation}".format(generation=ga_instance.
 ↪generations_completed),end=" ")
    print("Fitness = {fitness}".format(fitness=ga_instance.
 ↪best_solution(pop_fitness=ga_instance.last_generation_fitness)[1]),end=" ")
    print("Change = {change}".format(change=ga_instance.
 ↪best_solution(pop_fitness=ga_instance.last_generation_fitness)[1] -␣
 ↪last_fitness),end=" ")
    print("x Best Solution: " +str(binatodeci(ga_instance.
 ↪best_solution(pop_fitness=ga_instance.last_generation_fitness)[0])),end=" ")
    print("Population:",end=" ")
    for x in ga_instance.population:
        print(binatodeci(x),end=" ")
    print("")
    last_fitness = ga_instance.best_solution(pop_fitness=ga_instance.
 ↪last_generation_fitness)[1]
```

[7]:
```
#Definicion del modelo:
ga_instance = pygad.GA(num_generations=num_generations,
                       num_parents_mating=num_parents_mating,
                       sol_per_pop=sol_per_pop,
                       num_genes=num_genes,
                       fitness_func=fitness_func,
                       on_generation=on_generation,
                       mutation_by_replacement=True,
                       init_range_low=0,
                       init_range_high=2,
                       gene_type=int,
                       mutation_probability=mutation_probability
)
```

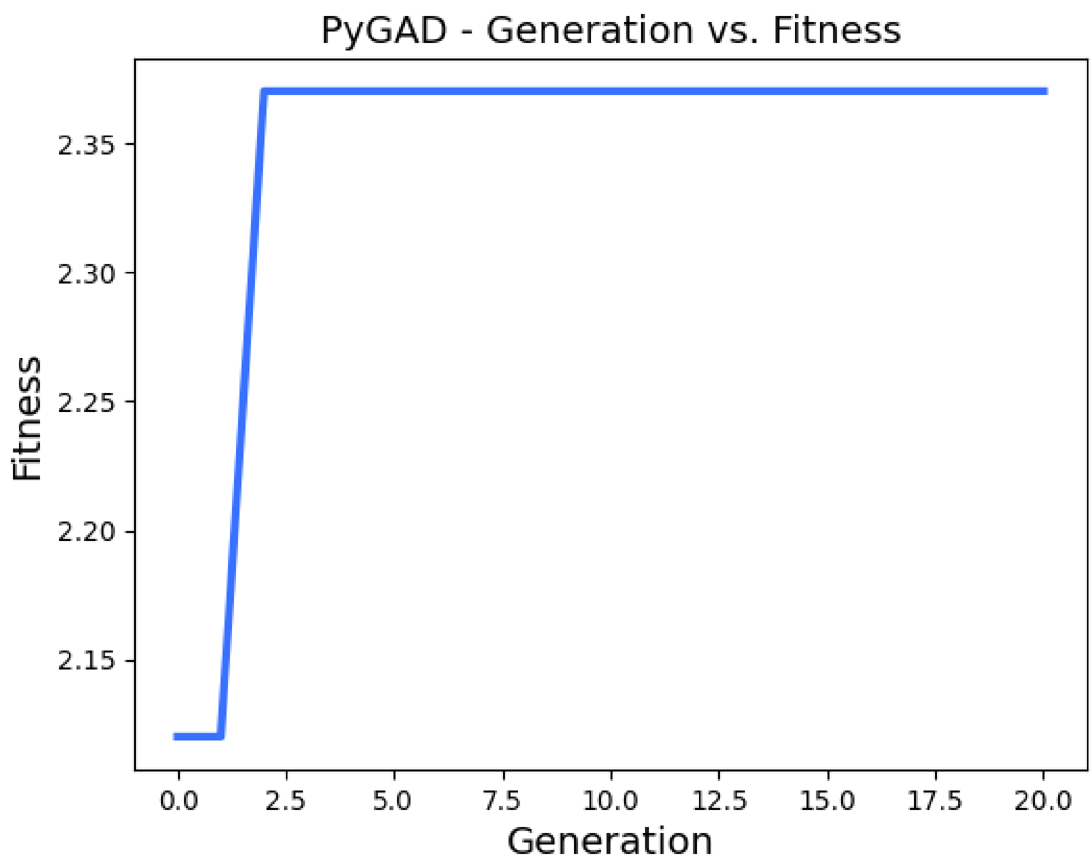
[8]:
```
ga_instance.run()
ga_instance.plot_fitness()
```

```
Generation = 1 Fitness = 2.1201160956294944 Change = 2.1201160956294944 x Best
Solution: 77 Population: 77 64 0 8
```

```
Generation = 2 Fitness = 2.370304932982659 Change = 0.25018883735316466 x Best
Solution: 72 Population: 77 72 12 0
Generation = 3 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 77 72 64
Generation = 4 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 8 8 8
Generation = 5 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 64 8 8
Generation = 6 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 64 8 72
Generation = 7 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 64 72 8
Generation = 8 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 64 8 64
Generation = 9 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 8 0 72
Generation = 10 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 8 0 72
Generation = 11 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 64 0 64
Generation = 12 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 64 64 0
Generation = 13 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 64 64 0
Generation = 14 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 72 72 72
Generation = 15 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 0 64 8
Generation = 16 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 72 0 72
Generation = 17 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 0 0 0
Generation = 18 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 64 0 64
Generation = 19 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 0 8 72
Generation = 20 Fitness = 2.370304932982659 Change = 0.0 x Best Solution: 72
Population: 72 64 72 72
```


PyGAD - Generation vs. Fitness
Fitness
2.35
2.30
2.25
2.20
2.15
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Generation

[8]:



[9]:
```
# Returning the details of the best solution.
solution, solution_fitness, solution_idx = ga_instance.
 ↪best_solution(ga_instance.last_generation_fitness)
print("Parameters of the best solution : {solution}".format(solution=solution))
print("x Best Solution: " +str(binatodeci(solution)))
num = binatodeci(solution)
xfs = ((num/16)/16)*10  #256 -> 12 % 10 -> 2
yfs = ((num%16)/16)*10
print("x Best Solution: " +str(xfs)+" y Best Solution: "+str(yfs))
print("Fitness value of the best solution = {solution_fitness}".
 ↪format(solution_fitness=solution_fitness))
print("Index of the best solution : {solution_idx}".
 ↪format(solution_idx=solution_idx))
if ga_instance.best_solution_generation != -1:
    print("Best fitness value reached after {best_solution_generation}␣
 ↪generations.".format(best_solution_generation=ga_instance.
 ↪best_solution_generation))
```

```
Parameters of the best solution : [0 1 0 0 1 0 0 0]
x Best Solution: 72
```

```
x Best Solution: 2.8125 y Best Solution: 5.0
Fitness value of the best solution = 2.370304932982659
Index of the best solution : 0
Best fitness value reached after 2 generations.
```

[10]:
```
def fitness2(num):
    fitness=0
    xfs = ((num/16)/16)*10  #256 -> 12 % 10 -> 2
    yfs = ((num%16)/16)*10
    for i in range(0,10):
        for j in range(0,10):
            fitness+= math.sqrt((i-xfs)**2  + (j-yfs)**2)*matriz[i][j]

    return 100/np.sqrt(fitness)
```

[11]:
```
valoresx = range(0,256)
y = [fitness2(x) for x in valoresx]
maxL = argrelextrema(np.array(y), np.greater)
for num in maxL[0]:
    xfs = ((num/16)/16)*10  #256 -> 12 % 10 -> 2
    yfs = ((num%16)/16)*10
    print("Maximo local = "+str(num),end= " ")
    print("x= "+str(xfs),end= " ")
    print("y= "+str(yfs))
num = y.index(max(y))
xfs = ((num/16)/16)*10  #256 -> 12 % 10 -> 2
yfs = ((num%16)/16)*10
print("Maximo Global: "+str(y.index(max(y))))
print("Fitness: "+str(max(y)))
print("x: "+str(xfs)+" y:"+ str(yfs))
fig, ax = plt.subplots(2)
ax[0].plot(valoresx, y, color="red")
a = np.reshape(y,(16,16))
ax[1].imshow(a,cmap='hot', interpolation='nearest')
plt.show()
```

```
Maximo local = 8 x= 0.3125 y= 5.0
Maximo local = 24 x= 0.9375 y= 5.0
Maximo local = 40 x= 1.5625 y= 5.0
Maximo local = 56 x= 2.1875 y= 5.0
Maximo local = 72 x= 2.8125 y= 5.0
Maximo local = 88 x= 3.4375 y= 5.0
Maximo local = 104 x= 4.0625 y= 5.0
Maximo local = 119 x= 4.6484375 y= 4.375
Maximo local = 135 x= 5.2734375 y= 4.375
Maximo local = 151 x= 5.8984375 y= 4.375
Maximo local = 167 x= 6.5234375 y= 4.375
Maximo local = 183 x= 7.1484375 y= 4.375
```

```
Maximo local = 199 x= 7.7734375 y= 4.375
Maximo local = 215 x= 8.3984375 y= 4.375
Maximo local = 231 x= 9.0234375 y= 4.375
Maximo local = 247 x= 9.6484375 y= 4.375
Maximo Global: 104
Fitness: 2.436224680150709
x: 4.0625 y:5.0
```