بنام خدا

حل مسئله فروشنده دوره گرد با الگوریتم ژنتیک در محیط پایتون با استفاده از کتابخانه deap

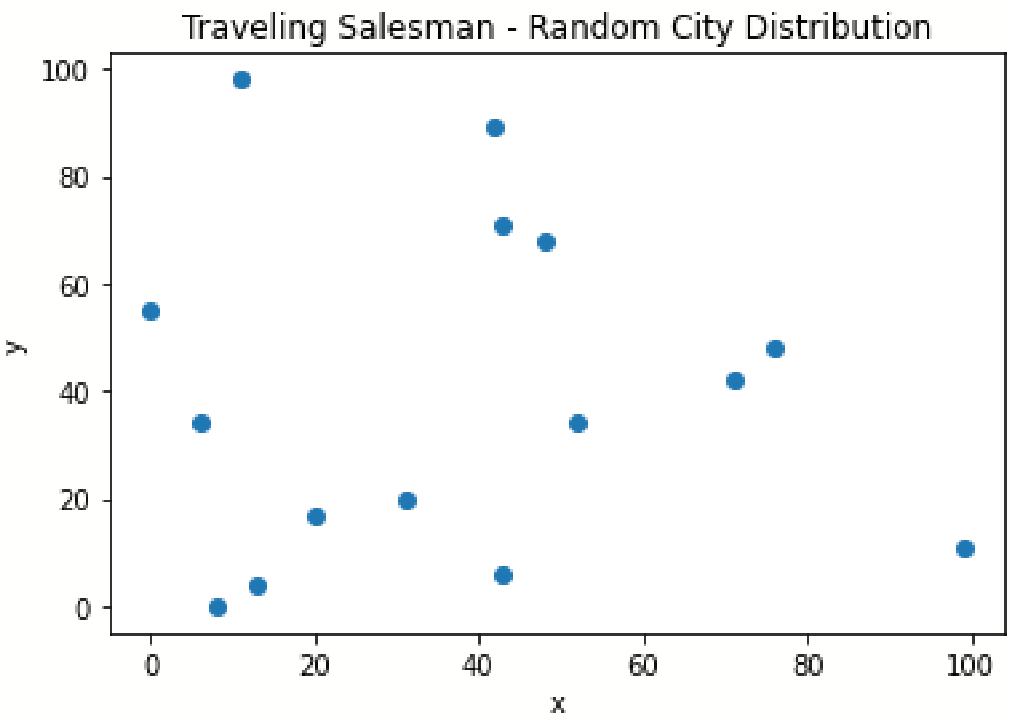
نصب deap

pip install deap

فراخوانی کتابخانه ها

```
from matplotlib import pyplot as plt
import random
from deap import creator, base, tools, algorithms
import numpy as np
import time
from shapely.geometry import Point

random.seed(123)

# City Options
NUM_CITIES = 15
MAX_X = 100
MAX_Y = 100

# Algorithm Options
POPULATION_SIZE = 300
MUTATION_RATIO = 0.1
CROSSOVER_RATIO = 0.5
NGEN = 40


# Generate Random Cities
cities = []
for i in range(NUM_CITIES):
    cities.append(Point(random.randint(0, 100), random.randint(0, 100)))


# Visualize Cities
plt.scatter([c.x for c in cities], [c.y for c in cities])

plt.xlabel("x")
```

```python
plt.ylabel("y")

plt.title("Traveling Salesman - Random City Distribution")
plt.savefig("salesman.png")
```




```python
# Chromosome initialization: Random order of town indices
def ini_salesman(container, num_cities):
    basic_plan = list(range(num_cities))
    random.shuffle(basic_plan)
    return container(basic_plan)

test = ini_salesman(list, 10)
# Fitness Function: Total path length
def calc_distance(travel_plan, cities):
    dist = 0
    for i, e in enumerate(travel_plan):
        if i!= len(cities)-1:
            origin = cities[e]
            destination = cities[travel_plan[i+1]]
        else:
            # Return home
            origin = cities[e]
            destination = cities[travel_plan[0]]
        dist += origin.distance(destination)
```

```
    return dist,



# Mutation: Switch two random positions of the travel plan
def mutate_travel_plan(travel_plan):

    # Determine indices to be switched
    idx_1 = random.choice(list(range(len(travel_plan))))
    idx_2 = random.choice(list(range(len(travel_plan))))

    # Switch indices
    travel_plan[idx_1], travel_plan[idx_2] = travel_plan[idx_2], travel_pl
an[idx_1]

    return travel_plan,



# Mating two travel plans to generate one child: Retain x consecutive city
 ids of tp_1 and fill with tp_2 order
# Example:
# tp_1: [0,1,2,3,4,5]
# tp_2: [3,2,1,5,0,4]
# Retain: [1,2,3]
# Child: [5,1,2,3,0,4]
def mate_travel_plans_single(tp_1, tp_2):

    N = len(tp_1)

    idx_1 = random.choice(list(range(N)))
    idx_2 = random.choice(list(range(N)))

    idx_start = min(idx_1, idx_2)
    idx_stop = max(idx_1, idx_2)

    if idx_start==idx_stop:
        if idx_start > 0:
            idx_start = idx_start-1
        else:
            idx_stop = idx_stop+1

    retain_sequence = tp_1[idx_start:idx_stop+1]
    substitute_values = [i for i in tp_2 if i not in retain_sequence]
    substitute_places = [i for i in list(range(N)) if i<idx_start or i>idx
_stop]
```

```
    for i in substitute_places:
        tp_1[i] = substitute_values.pop(0)

    return tp_1
```

```
# Test function
mate_travel_plans_single([0,1,2,3,4,5], [3,2,1,5,0,4])
```

```
[2, 1, 5, 3, 4, 0]
```

```
def mate_travel_plans(tp_1, tp_2):
    ind1 = mate_travel_plans_single(tp_1, tp_2)
    ind2 = mate_travel_plans_single(tp_1, tp_2)
    return ind1, ind2
```

```
# Define classes
# Create a class "total_distance". Define it as a fitness. Fitness shall b
e minimized (-1)
creator.create("total_distance", base.Fitness, weights=(-1.0,))

# Create a class "Individual" containing a list and assign a fitness of ty
pe "travel_distance"
creator.create("Individual", list, fitness=creator.total_distance)

# Open a new toolbox
toolbox = base.Toolbox()

# Register an "individual" to be of class "Individual". Initialize it with
 the ini_salesman function. Pass necessary values
toolbox.register("individual", ini_salesman, creator.Individual, num_citie
s=NUM_CITIES)

# Register a "population" and initialize it with a list of "individual" ob
jects
toolbox.register("population", tools.initRepeat, list, toolbox.individual)

# Register a fitness function called "travel_distance" and assign an evalu
ation function (calc_distance) to it
toolbox.register("travel_distance", calc_distance, cities=cities)
```

```
# Register functions for mating, mutating and selecting
toolbox.register("mate", mate_travel_plans)
toolbox.register("mutate", mutate_travel_plan)
#toolbox.register("mutate", tools.mutShuffleIndexes, indpb=0.01)
toolbox.register("select", tools.selTournament, tournsize=10)
```

```
# Generate intial population
population = toolbox.population(n=POPULATION_SIZE)
```

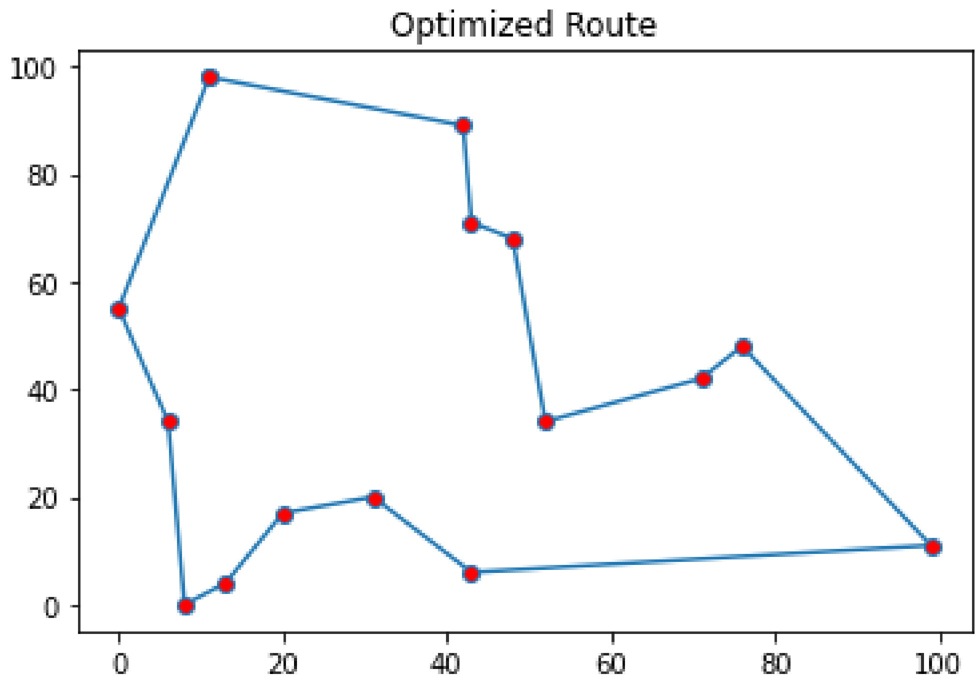
```
for gen in range(NGEN):
    print("Calculating generation {} of {}".format(gen+1,NGEN))

    # Retrieve all new offsprings generated by mutation and crossover (mat
ing)
    offspring = algorithms.varAnd(population, toolbox, cxpb=0.5, mutpb=MUT
ATION_RATIO)

    # For each individual in the toolbox that has not been evaluated befor
e, evaluate the fitness
    fits = toolbox.map(toolbox.travel_distance, offspring)

    # Assign fitness values to individuals
    for fit, ind in zip(fits, offspring):
        ind.fitness.values = fit

    # Create new population
    population = toolbox.select(offspring, k=len(population))
```

```
Calculating generation 1 of 40
Calculating generation 2 of 40
Calculating generation 3 of 40
Calculating generation 4 of 40
Calculating generation 5 of 40
Calculating generation 6 of 40
Calculating generation 7 of 40
Calculating generation 8 of 40
Calculating generation 9 of 40
Calculating generation 10 of 40
Calculating generation 11 of 40
```

```
Calculating generation 12 of 40
Calculating generation 13 of 40
Calculating generation 14 of 40
Calculating generation 15 of 40
Calculating generation 16 of 40
Calculating generation 17 of 40
Calculating generation 18 of 40
Calculating generation 19 of 40
Calculating generation 20 of 40
Calculating generation 21 of 40
Calculating generation 22 of 40
Calculating generation 23 of 40
Calculating generation 24 of 40
Calculating generation 25 of 40
Calculating generation 26 of 40
Calculating generation 27 of 40
Calculating generation 28 of 40
Calculating generation 29 of 40
Calculating generation 30 of 40
Calculating generation 31 of 40
Calculating generation 32 of 40
Calculating generation 33 of 40
Calculating generation 34 of 40
Calculating generation 35 of 40
Calculating generation 36 of 40
Calculating generation 37 of 40
Calculating generation 38 of 40
Calculating generation 39 of 40
Calculating generation 40 of 40
```

```
winner = tools.selBest(population, k=1)
[[1, 9, 8, 4, 2, 5, 13, 12, 6, 10, 7, 3, 14, 0, 11]]
```

```
# Visualize Result
cities_ordered = [cities[e] for e in winner[0]]
X = [c.x for c in cities_ordered]+[cities_ordered[0].x]
Y = [c.y for c in cities_ordered]+[cities_ordered[0].y]
plt.plot(X,Y, marker = "o", markerfacecolor='red')
plt.title("Optimized Route")
plt.savefig("salesman_solution.png")
```



Optimized Route
100
80
60
40
20
0
0
20
40
60
80
100