**ЛАБОРАТОРНА РОБОТА № 7**

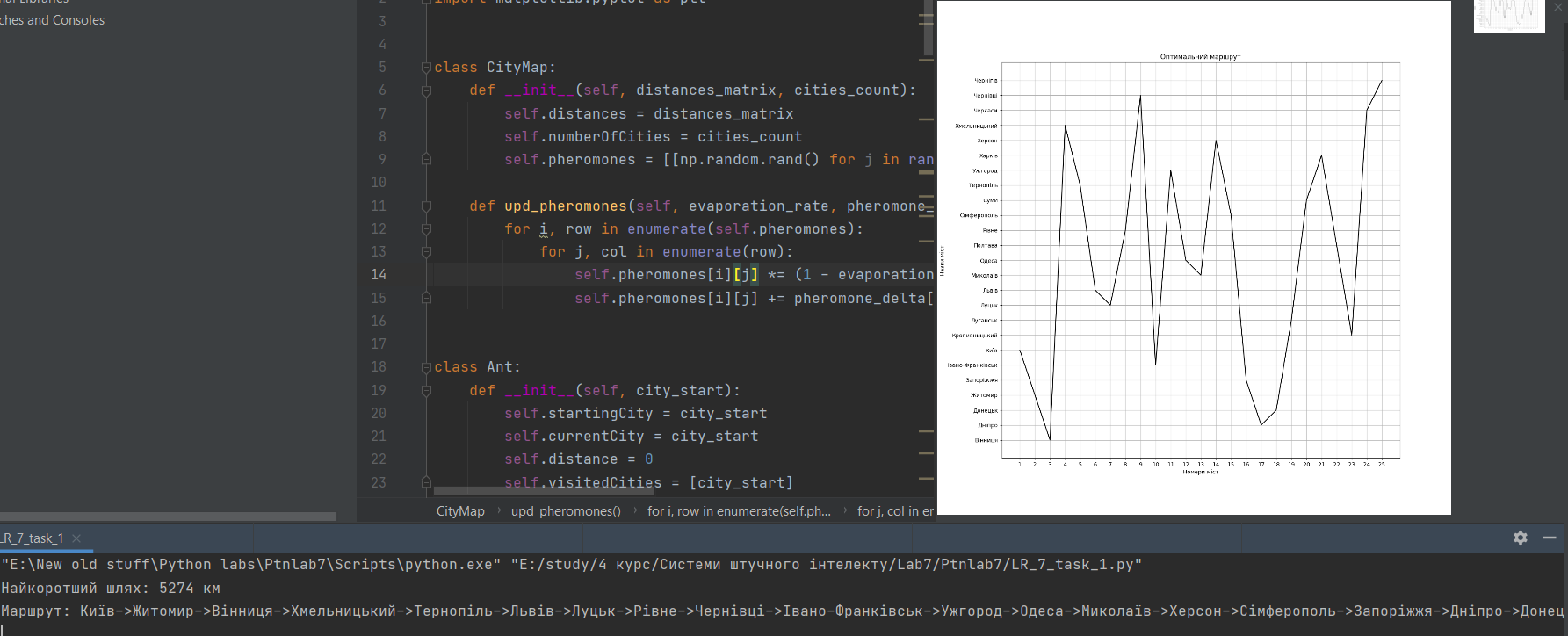
**Тема**: ДОСЛІДЖЕННЯ МУРАШИНИХ АЛГОРИТМІВ

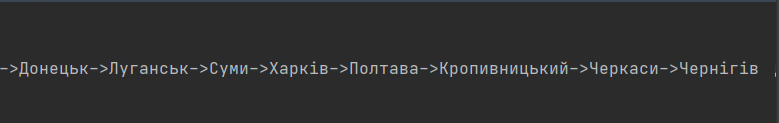
**Мета**: використовуючи спеціалізовані бібліотеки та мову програмування Python навчитися дослідити метод мурашиних колоній.

**Хід роботи:**

**Task1**

Дослідження мурашиного алгоритму на прикладі рішення задачі комівояжера





import numpy as np  
import matplotlib.pyplot as plt  
  
  
class CityMap:  
 def \_\_init\_\_(self, distances\_matrix, cities\_count):  
 self.distances = distances\_matrix  
 self.numberOfCities = cities\_count  
 self.pheromones = [[np.random.rand() for j in range(cities\_count)] for i in range(cities\_count)]  
  
 def upd\_pheromones(self, evaporation\_rate, pheromone\_delta):  
 for i, row in enumerate(self.pheromones):  
 for j, col in enumerate(row):  
 self.pheromones[i][j] \*= (1 - evaporation\_rate)  
 self.pheromones[i][j] += pheromone\_delta[i][j]  
  
  
class Ant:  
 def \_\_init\_\_(self, city\_start):  
 self.startingCity = city\_start  
 self.currentCity = city\_start  
 self.distance = 0  
 self.visitedCities = [city\_start]  
  
 def move(self, city\_new, distance):  
 self.currentCity = city\_new  
 self.visitedCities.append(city\_new)  
 self.distance += distance  
  
  
class Colony:  
 maxColonyCycles = 50  
 pheromoneAddition = 0.0005  
 pheromoneEvaporationRate = 0.2  
 pheromoneImportance = 0.01  
 distanceImportance = 9.5  
 antCanVisitPreviousCities = False  
  
 def \_\_init\_\_(self, ants\_num):  
 self.numberOfAnts = ants\_num  
  
 def find\_route(self, city\_map, city\_num):  
 min\_dist = float('inf')  
 route = []  
 for cycle in range(self.maxColonyCycles):  
 pheromones\_delta = [[0.0 for i in range(city\_map.numberOfCities)] for j in range(city\_map.numberOfCities)]  
 for antNumber in range(self.numberOfAnts):  
 ant = Ant(city\_num)  
 while len(ant.visitedCities) < city\_map.numberOfCities:  
 next\_city = self.get\_next\_city(ant, city\_map)  
 ant.move(next\_city, city\_map.distances[ant.currentCity][next\_city])  
 ant\_dist = ant.distance + city\_map.distances[ant.currentCity][ant.startingCity]  
 if ant\_dist < min\_dist:  
 min\_dist = ant\_dist  
 route = ant.visitedCities  
 for city in range(len(ant.visitedCities) - 1):  
 pheromones\_delta[ant.visitedCities[city]][  
 ant.visitedCities[city + 1]] += self.pheromoneAddition / ant\_dist  
 city\_map.upd\_pheromones(self.pheromoneEvaporationRate, pheromones\_delta)  
  
 return min\_dist, route  
  
  
 def get\_probabilities(self, ant, city\_map):  
 result = [0 for i in range(city\_map.numberOfCities)]  
 total\_probability = 0  
 for newCity in range(city\_map.numberOfCities):  
 if (newCity != ant.currentCity) and (self.antCanVisitPreviousCities or newCity not in ant.visitedCities):  
 probability = pow(city\_map.pheromones[ant.currentCity][newCity], self.pheromoneImportance) \* pow(  
 1 / city\_map.distances[ant.currentCity][newCity], self.distanceImportance)  
 result[newCity] = probability  
 total\_probability += probability  
 result = [result[i] / total\_probability for i in range(city\_map.numberOfCities)]  
 return result  
  
  
 def get\_next\_city(self, ant, city\_map):  
 probabilities = self.get\_probabilities(ant, city\_map)  
 random\_value = np.random.rand()  
 for i in range(city\_map.numberOfCities):  
 if probabilities[i] > random\_value:  
 return i  
 else:  
 random\_value -= probabilities[i]  
 return -1  
  
  
  
distance = [  
 [0, 645, 868, 125, 748, 366, 256, 316, 1057, 382, 360, 471, 428, 593, 311, 844, 602, 232, 575, 734, 521, 120,  
 343, 312, 396],  
 [645, 0, 252, 664, 81, 901, 533, 294, 394, 805, 975, 343, 468, 196, 957, 446, 430, 877, 1130, 213, 376, 765,  
 324, 891, 672],  
 [868, 252, 0, 858, 217, 1171, 727, 520, 148, 1111, 1221, 611, 731, 390, 1045, 591, 706, 1100, 1391, 335, 560,  
 988, 547, 1141, 867],  
 [125, 664, 858, 0, 738, 431, 131, 407, 1182, 257, 423, 677, 557, 468, 187, 803, 477, 298, 671, 690, 624, 185,  
 321, 389, 271],  
 [748, 81, 217, 738, 0, 1119, 607, 303, 365, 681, 833, 377, 497, 270, 925, 365, 477, 977, 1488, 287, 297, 875,  
 405, 957, 747],  
 [366, 901, 1171, 431, 1119, 0, 561, 618, 1402, 328, 135, 747, 627, 898, 296, 1070, 908, 134, 280, 1040, 798,  
 246, 709, 143, 701],  
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 190, 538, 149],  
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 126, 637, 363],  
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 1177, 706, 1292, 951],  
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 578, 336, 949],  
 [360, 975, 1221, 423, 833, 135, 550, 710, 1379, 152, 0, 850, 970, 891, 232, 1173, 896, 128, 261, 1028, 1141,  
 240, 740, 278, 690],  
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 642, 640],  
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 420, 515, 529],  
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 279, 892, 477],  
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 508, 331, 458],  
 [844, 446, 591, 803, 365, 1070, 972, 570, 739, 1052, 1173, 282, 392, 635, 1157, 0, 896, 1097, 1363, 652, 221,  
 964, 696, 981, 1112],  
 [602, 430, 706, 477, 477, 908, 346, 506, 253, 734, 896, 681, 800, 261, 664, 896, 0, 774, 1138, 190, 732, 662,  
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 420, 1036, 608],  
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 351, 713, 691],  
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 463, 190, 455],  
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 0, 660, 330],  
 [312, 891, 1141, 389, 957, 143, 538, 637, 1292, 336, 278, 642, 515, 892, 331, 981, 883, 176, 444, 1036, 713,  
 190, 660, 0, 695],  
 [396, 672, 867, 271, 747, 701, 149, 363, 951, 949, 690, 640, 529, 477, 458, 1112, 350, 568, 951, 608, 691, 455,  
 330, 695, 0]  
]  
  
  
cities = [  
 'Вінниця', 'Дніпро', 'Донецьк', 'Житомир', 'Запоріжжя', 'Івано-Франківськ', 'Київ', 'Кропивницький',  
 'Луганськ', 'Луцьк', 'Львів', 'Миколаїв', 'Одеса', 'Полтава', 'Рівне', 'Сімферополь', 'Суми', 'Тернопіль',  
 'Ужгород', 'Харків', 'Херсон', 'Хмельницький', 'Черкаси', 'Чернівці', 'Чернігів'  
]  
  
if \_\_name\_\_ == '\_\_main\_\_':  
 cityMap = CityMap(distance, len(distance[0]))  
 colony = Colony(len(distance[0]))  
 result = colony.find\_route(cityMap, 6)  
 print(f"Найкоротший шлях: {result[0]} км")  
  
  
 cityRoutes = "Маршрут: "  
 for i in result[1]:  
 cityRoutes += cities[i]  
 if i != result[1][-1]:  
 cityRoutes += "->"  
 print(cityRoutes)  
  
  
 fig = plt.figure(figsize=(13, 13))  
 plt.xticks([i + 1 for i in range(25)])  
 plt.yticks([i for i in range(25)], cities)  
 plt.xlabel("Номери міст")  
 plt.ylabel("Назви міст")  
 plt.title("Оптимальний маршрут")  
 plt.plot([i + 1 for i in range(25)], result[1], ms=12, mfc='r',  
 mec='black', mew=2, color='black')  
 plt.grid()  
 plt.show()

**Висновок:** використовуючи спеціалізовані бібліотеки та мову програмування Python навчивя досліджувати метод мурашиних колоній.