Stochastic Optimization Algorithms
Home Problems, Set 2

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Problem 2.1, The Travelling Salesman Problem (TSP)

This problem is a combination of the travelling salesman problem (TSP) and the ant colony optimization (ACO).

To create the route of the travelling salesman, given a list of points of specified dimensions, the algorithm is written to generate a closed path between these points under the following conditions. Firstly, each point must be visited only once, except for the first, as it coincides with the last. Secondly, the path is formed by initially choosing a random point from the given list and, then, by performing probabilistic selection to generate the sequence of following points.

However, the goal of the travelling salesman problem is not only to generate the possible paths that the travelling salesman may take, but also to find the optimum path, the path of the shortest possible length. This is achieved by implementing ant colony optimization into the travelling salesman algorithm. Each ant acts like the travelling salesman, with the addition of pheromones. Thus, all routes between points carry different pheromone values, which get updated in the algorithm so, that paths with larger pheromone values are respectively shorter. Then, the path sequences are generated using roulette-wheel selection, with fitness, p, which depends on pheromone levels,

tau, and the reverse length (visibility), eta, of each path over all the traversed paths, as presented below:

$$p(e_{ij}|S) = \frac{\tau_{ij}^{\alpha}\eta_{ij}^{\beta}}{\sum_{\nu_l \notin L_T(S)} \tau_{lj}^{\alpha}\eta_{lj}^{\beta}}$$

After running the algorithm, the overall shortest total path length was found on the 9th iteration by ant 39 and has value:

$$\text{path length} = 93.64993 \text{ length units}$$

The respective generated path is presented in the figure below.

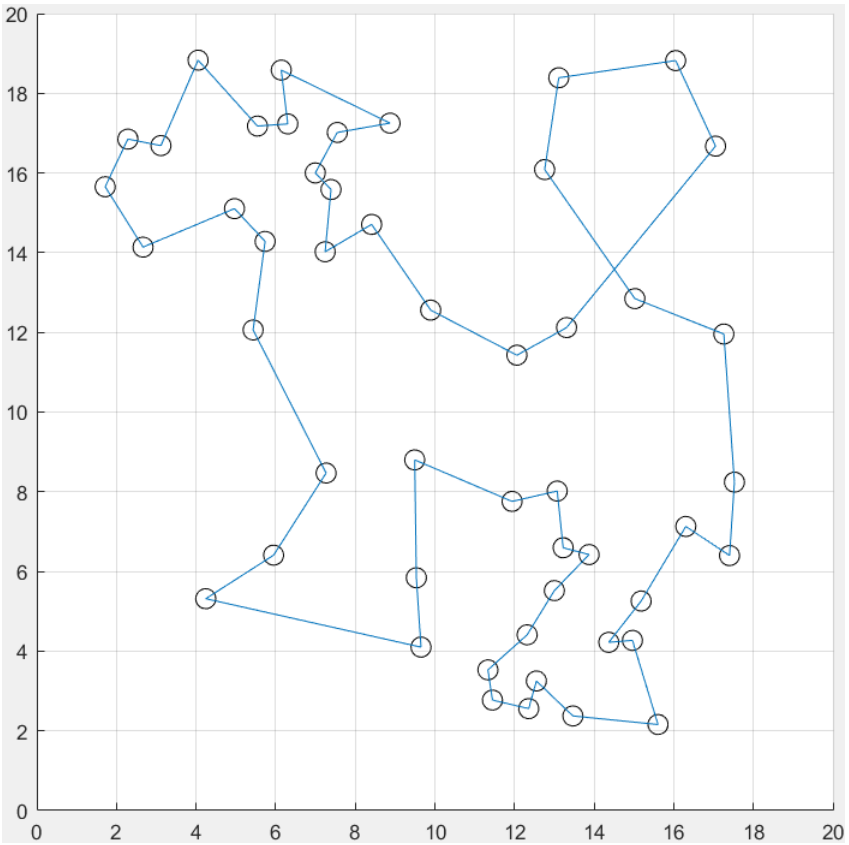

Figure 1: Best path found by the ACO for the TSP. Length = 93.64993

Problem 2.2, Particle Swarm Optimization (PSO)

In this problem, the goal is to find a given function's minima using the particle swarm optimization (PSO) with the inclusion of inertia weights.

The parameters used during the various steps of the algorithm are shown in the table below:

Parameter Name	Parameter Value
alpha	1
time step length	1
cognitive component	2
social component	2
initial weight	1.4
lower weight boundary	0.32
number of runs	10^3

After running the algorithm, four sets of coordinates were found to correspond to the function's global minimum. These coordinates along with respective function value are presented on the table below:

x	y	f(x,y)
2.99788	2.00037	$1.53\ 10^{-4}$
-3.8	-3.3	0.0277
-2.8	3.1	0.0397
3.6	-1.8	0.0512

The values of f(x,y) were calculated by inputting the respective (x,y) values in the Evaluation.m function. These four points can be seen in the contour graph of F(x,y) = log[0.001 + f(x,y)] below marked as black dots.

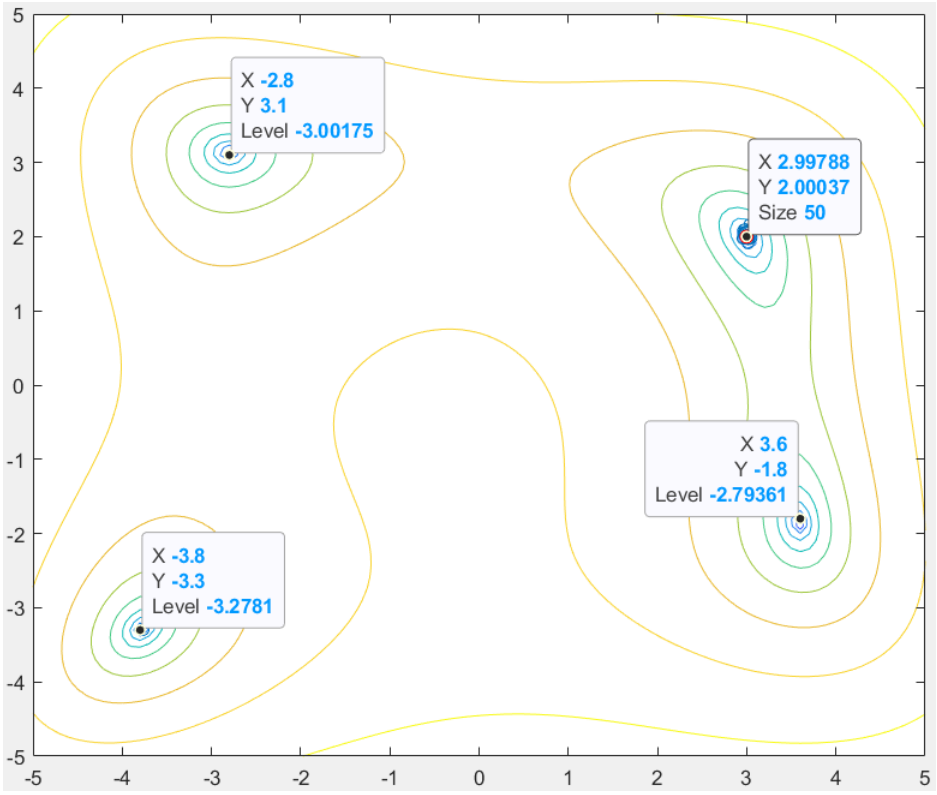

Figure 2: Plot of F(x,y) = log[0.001 + f(x,y)]