Task 4: Delivery route optimization using a genetic algorithm

In our project for the BOAI lab, Mehmet, İbrahim, and I worked on optimizing delivery routes for a courier company using a genetic algorithm (GA). The core objective was to minimize the total cost or time of deliveries by finding the most efficient route to deliver packages to ten specific customers, labeled K1 through K10. Each customer had a geographic location defined by latitude and longitude, and we had a cost matrix representing the travel cost or time between each pair of customers.

We started by defining a genotype encoding that would represent each delivery route as a sequence of customers. We chose permutation coding since each customer must be visited exactly once, making this representation both intuitive and efficient for our needs.

To kick off the genetic algorithm, we generated an initial population of chromosomes. Each chromosome was a random permutation of the ten customers, representing a possible delivery route. For our experiments, we created a population of 100 chromosomes to ensure sufficient diversity in potential solutions.

Next, we developed an objective function to evaluate each chromosome's fitness. This function summed the costs or travel times from the cost matrix along the route represented by the chromosome. The lower the total cost or time, the fitter the chromosome.

We implemented several genetic operators to evolve the population over successive generations. For selection, we used tournament selection, where multiple chromosomes competed based on their fitness, and the best ones were chosen to reproduce. For crossover, we experimented with both single-point and multi-point methods to combine genetic material from parent chromosomes. Mutation was applied by randomly swapping two customers in a chromosome to maintain diversity and prevent premature convergence on suboptimal solutions.

The evolution process involved creating new generations by applying these genetic operators, evaluating each generation's fitness, and using elitism to retain the best-performing chromosomes. We set stopping conditions for the algorithm, including a maximum number of generations and a threshold for improvement, to ensure we did not run indefinitely.

After running the genetic algorithm, we presented the optimal route that minimized the delivery cost or time. For better visualization, we used the Google Maps API to display the route on a map, making it easier for stakeholders to understand the improvements.

Throughout the project, we experimented with various parameters, such as population size and crossover/mutation rates, to find the most effective settings for our problem. We documented our entire process, including the optimization approach, the genetic operators used, the experimental results, and an assessment of the route quality. This documentation provided a comprehensive view of our project and the effectiveness of the genetic algorithm in optimizing delivery routes.

Burçin Işık

Mehmet Özyürek

Ibrahim Ercoşman

Here is the github codes: link

And deployment (the server side doesn't work, if I don't open the flask that is deployed in my computer): link