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Genetic algorithm for distribution of delivery routes

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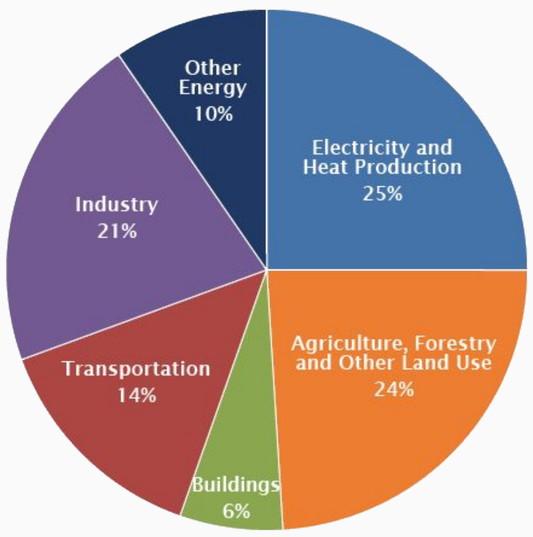
Introduction

This work focuses on development of a genetic algorithm for solving a generalized case of multi-depot vehicle routing problem (MDVRP). In our version of the problem we assume that vehicles starting points can be anywhere, and moreover, optimization process focuses not only on the overall distance, but on the average delivery time as well.

Who needs it and why?

Such algorithm has many obvious applications in industry. In fact, the use of computer optimization can give huge savings to a company as transportation is usually a significant component of the cost of a product (10-15%). Indeed, the transportation sector makes up 10% of the EU's GDP. The quality of transport services has a major impact on people's quality of life. On average 13.2% of every household's budget is spent on transport goods and services. Transport also depends heavily on oil resources and represents an important source of CO_2 emissions.

Global greenhouse gas emissions by economic sector:

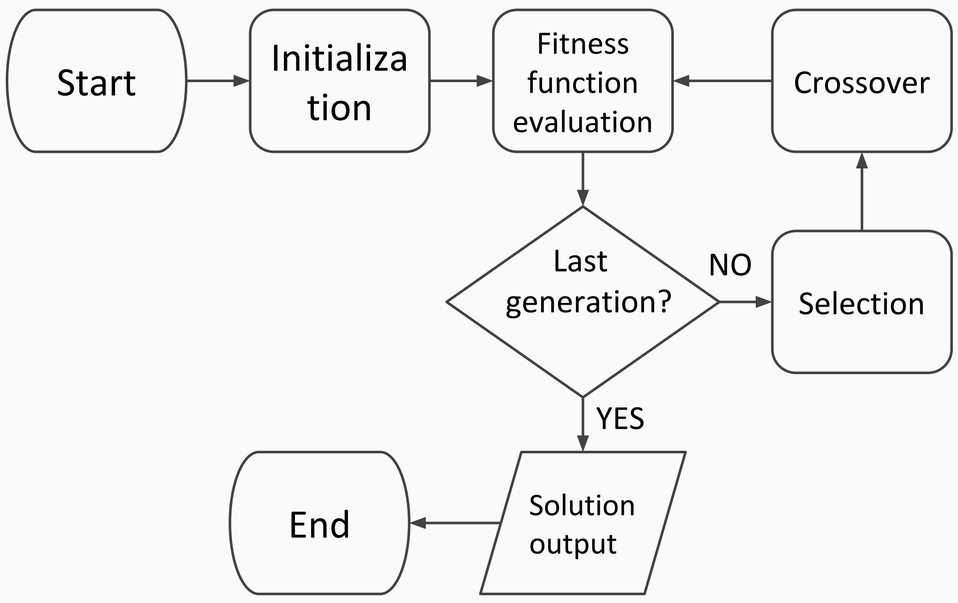


Approach

The research was divided into three parts. The first part involved the development of the genetic algorithm itself. In the second part, a visualization app was developed for examining the work results. The aim of the third part was to evaluate the efficiency of the proposed algorithm. For that, two other algorithms have been developed. Those are the Ant colony optimization algorithm (ACO) and an algorithm on the basis of dynamic programming (DP).

The algorithm

An abstract genetic algorithm consists of five main parts. These are initialization, where the starting population is generated, and then several generations, which comprise of fitness function evaluation, selection, crossover and mutation. Due to the specificity of our problem, we don't have mutation in our algorithm.



Chromosomes in our algorithm are delivery plans and consist of a number of routes. The initial chromosome pool is generated with a greedy algorithm. We add all orders one by one in locally optimal positions.

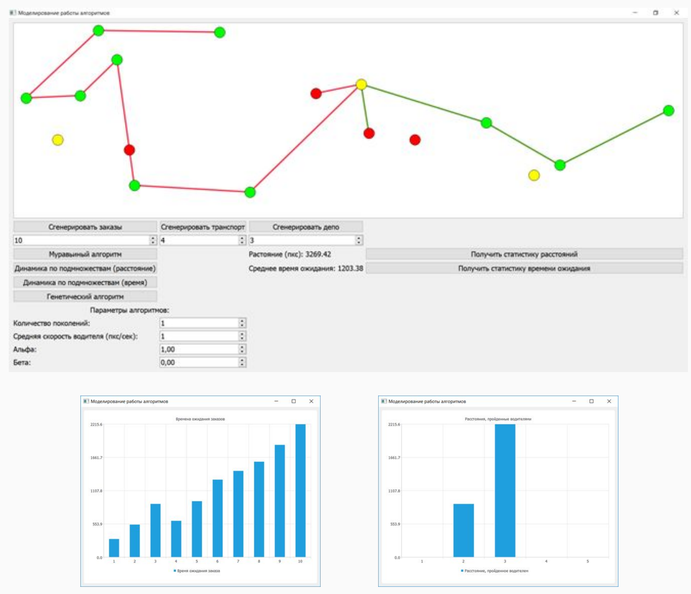
As stated earlier, our optimization focuses not only on the distance, but on the average delivery time as well. Consequently, the fitness function is a linear combination of the latter.

The selection is being done with the "tournament" scheme.

During the crossover, two routes exchange some consecutive destination points.

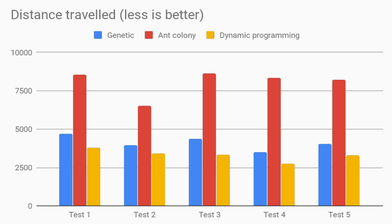
The visualization app

To estimate the efficiency and understand different aspects of the proposed algorithm, a visualization and testing environment was crucial. For that, an application was developed using C++ and Qt.



Conclusion

During testing we found out that the developed algorithm shows a significant improvement over a known in this field ant colony algorithm, and shows almost optimal results as compared to a precise solution with dynamic programming (which is, though an exponential time algorithm and doesn't have practical use).



In the future it is planned to incorporate the developed algorithm in the work of a real enterprise. We hope that with it we could make an improvement in transportation and ecology.