Modification of the initialization and crossing methods of ant and genetic algorithms for solving the transport problem in the tourism

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Abstract – The article proposes to analyze the behavior of ant colonies, namely the search for the shortest route by means of the allocation of pheromones and the function of crossing the two solutions of the genetic algorithm, to develop a method and algorithm for the following operations: search of the optimal route, calculation of resource costs, search of the distance, route time, routes.

Keywords – ant algorithm, genetic algorithm, an initialization method, crossing method, transport problem, transport task, ant colony, hiking trails.

I. Introduction

In recent years, algorithms of computational intelligence have been increasingly used to solve combinatorial optimization problems. Such algorithms have some advantages: practical application, flexibility in configuration and allow you to get beneficial results that help to find the best solution for a short period. Among these algorithms are ants and genetic algorithms.

So far, to fulfill the reference transport task, an ant algorithm was used. Such an algorithm relates to a class of routing algorithms. The article suggests using an ant algorithm to solve transport problems because, for the sake of finding the shortest path, ants distinguish pheromone traces in the search for a source of food. As a result of such actions on the path with the highest concentration of pheromones, more and more ants will move, considering this path to be the shortest. This approach allows you to find the optimal solution for most transport tasks.

However, having set the task to accomplish the transport task, taking into account the use of resources, the calculation of their costs, one ant algorithm will not be enough. There was a need to use the genetic algorithm, namely its functions of crossing two solutions. The genetic algorithm allows to pass a few solutions of the ant algorithm by creating a descendant that contains a single solution with specified properties such as fuel consumption, time consumption, distance traveled, etc.

In practice, such transport solutions, taking into account the cost of resources, are already being used. Combining two or more algorithms for creating a hybrid algorithm will allow accomplishing the objectives set. However, the application of such a solution requires a technical basis, following current trends in the world[3].

Every day technology development is increasing. New roads create, new tourist resorts creates, communication channels of tourist centers creates, that is, the transport network, as a rule, is growing. As a result, optimizing new routes is a topical issue. Therefore, intensive study of this sphere and development of new solutions is a promising direction.

II. Analysis of literary sources and formulation of the problem

In the process of developing a new algorithm, it was necessary to understand the work of the ant algorithm, namely, as colonies of the ants in providing themselves with food, looking for the shortest path between the nest and the source of food without visible, active coordination mechanisms. Studies have revealed the chaotic activity of ants, but as soon as the source of food found, more and more ants were moving along the shortest path. Most varieties of ants use an indirect form of contact, through pheromone traces. To increase the efficiency of the algorithm, namely the process of finding the shortest route between local points, we used pheromone traces. The desirable result is remembering the best routes and a quick calculation of paths with a higher concentration of pheromones [1].

Another algorithm in the study and design of a modified algorithm was the selection of a genetic algorithm that contained adaptive search methods, which today are often used to solve transport tasks of functional optimization. They base on the genetic processes of biological organisms.

In the work of the genetic algorithm, the agent interbreeding function use. This approach makes it possible to serve tourists more efficiently and automates this process in a way that each agent contains all the previous results of the performed routes, and this will allow not to look for a new solution again, but to use the solution already found.

The research methods use: Ant Colony Optimization (ACO) method, crossbreeding solutions genetic algorithm (CSGA), modifications of operators (modification operators, MO) and other methods. These methods are already efficiently used to solve various tasks: ACO is used to solve shortcut route search tasks, CSGA is used to solve transport tasks, MO used for clustering data and objects. Together, the above methods are used to create a hybrid algorithm[4].

The research objective is to create a hybrid algorithm that will significantly improve the efficiency of transport tasks in the field of tourism.

Based on the system analysis of the subject area and the modern technologies used to solve transport problems, as well as algorithms and methods for the realization of such tasks, the purpose of the article form.

The purpose of the article is to increase the efficiency of transportation between cities and manage the accommodation of tourist points in a rational manner, such as fuel consumption, choice of transport type, number of seats and standing in transport, time spent on transportation [2,5].

To achieve the purpose of the article, the following tasks were set:

1. To analyze modern technologies used for solving transport problems;
2. To formulate the necessary statement of the task for transportation of tourists between settlements taking into account rational use of resources;
3. To develop algorithms for solving the search of the optimal route between cities, the arrangement of tourist destination points and the traffic volume of tourists about the number of seats in transport;
4. To investigate the effectiveness of the algorithm in the form of a numerical experiment.

III. Development and modification of initialization and crossing of genetic and ant algorithms for solution of transport problem

The primary task of the modified operator of initialization is to generate routes in such a way that they are correct while retaining the functions of minimizing the path to be transported.

To find the optimal solution for the transportation of tourists from the m points of the route $A_1, A_2, \mathbf{K}, A_m$ to the n points of the final stops on route $B_1, B_2, \mathbf{K} B_n$ minimize the cost of resources for the transportation of tourists.

We define through $c_{i,j}$ – the cost of resources for transportation from i point of the route to j point of the final stop, through a_i – the number of tourists at i point of the beginning of traffic. Also, though b_j we will define the needs of tourists in the transport at j point of the final stop, through x_{ij} – the number of tourists that need to transport from point i from the start of the route to j point of the final stop.

The mathematical model for solving a search using the interrupt and initialization operators will look like this:

$$F(x) = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij} \quad (1)$$

under the following three conditions:

$$\sum_{j=1}^{n} x_{ij} = a_i, i = \overline{1,m} \quad (2)$$

$$\sum_{i=1}^{m} x_{ij} = b_j, j = \overline{1,n} \quad (3)$$

$$x_{ij} \geq 0, i = \overline{1,m}; \quad j = \overline{1,n} \quad (4)$$

A modified operator of initialization has a memory, that is, a database of saved routes, local points, and calculations, which allows the system not to spend resources to search for a new path.

The operator of crossing ant and genetic algorithms work in such a way as to receive not only new routes but reduce their number, which allows reducing the number of vehicles.

Conclusion

In the article an analysis of modern methods of optimization of routes used for solving transport problems with which the solution for the transportation of tourists between settlements is designed taking into account the rational use of resources. These methods include genetic and ant roid algorithms, which search for the optimal route and the allocation of collection points.

From the created modifications of the operators of initialization and crossing, a system develops that solves the transport problem in the field of tourism, taking into account the location of the collection points. The article analyzes modern methods of route optimization, which are used to solve transport problems, with the help, which they have planned the solution for the transportation of tourists between settlements taking into account the rational use of resources. These methods include genetic and ant algorithms, which search for the optimal route and the allocation of collection points.

By the established modifications of the operators of initialization and crossing, develops a system that solves the transport problem in the field of tourism, taking into account the collection point points, as well as tourists in transport.

When investigating the effectiveness of the algorithm in the form of a numerical experiment and checking the effectiveness of the mobile application by the "first test" method, it discovers that the system builds a route from one settlement to another with the least error and distance.

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