

Optimization of travel routes based on modified genetic and ant algorithms

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Abstract. In the article, propose to use modified mating operators and initialization genetic and ant algorithms to solve transport problems in tourism. The article analyzes modern methods of optimization of routes used to transport tourists between the settlements of view of efficient use of resources. By analyzing the behavior of ant colonies, such as finding the shortest route by providing mating pheromones and features two solutions genetic algorithm developed algorithms for finding the optimal route, costing resources search distance, time, route, storing executed routes. The paper present description created system for mobile phones operating system IOS, which performs all operations listed above.

Key words: ant algorithm, ant colony genetic algorithm, hiking trails.

INTRODUCTION

In recent years, for solving combinatorial optimization problems are increasingly used computational intelligence algorithms. These algorithms have several advantages: practical application flexibility and customization can get very effective results that help you find the optimal solution in a short period of time. Among these include ant algorithms and genetic algorithms.

The article is an association of ant and genetic algorithms in hybrid with its own modification to increase the efficiency of the new algorithm for solving transportation problems is for tourism industry [1–3].

Also, one area of research is to find optimal distribution stations, which will cluster tourists, so that resource consumption do not affect adversely the efficiency of finding the optimal way and both were rational. In the study of genetic algorithm was needed to use the tool to optimize the crossing of finding the optimal route for the tourism industry.

TOPICALITY

The needs of people in a traffic increase with the development of infrastructure as a whole. Following the urgency and travel. It is possible to find a logical explanation. First, settlements and infrastructure connections between them becomes increasingly wider

road constantly updated. Second, road transport carried out fairly quickly and there will always be a need to accelerate the process of transportation. So important is the need to constantly generate and create conditions for convenient and effective implementation of transport tasks using modern technologies, which significantly facilitate determining the route, and optimizes resource consumption and find the optimal path.

At present, the shortest route search has found, however, solving this is not always feasible, especially given the specificity of tourism. Therefore, finding the shortest path is not always an effective solution, especially in tourism. The main objective of the task is the automation of this type of routes, according to the needs of tourists as quickly and efficiently to places dispatch stops. At the same time minimize the cost of transport to carry out its tasks, including: roads, tourist spot, stop, landing and disembarkation of tourists. Also, it is necessary to take into account the types of transport and their capabilities, such as: seating capacity, speed of transport.

Road transport is the most common means of transportation. It is used as for the transport of persons by buses and rental cars mainly for personal travel and recreation. Especially popular bus tours to visit several cities, attractions, tourist camps.

Transportation, tourist resorts, information systems and technologies in tourism are closely related. Therefore, using all of the aspects of the system to create high-quality tourist services. Mobile technologies occupy considerable attention in these information systems that are used in the transport sector. There is a trend of using mobile devices while performing routes, which are widely used in society. Therefore, the development of mobile application that adapts the process of tourist services is relevant, affordable, necessary and what is important, easy tool to use.

The development of such a system could help travel companies and tourists make the trip or tour right and well and as efficiently allocate their time, cost and schedule their own tour or trip.

OBJECTS AND METHODS OF INVESTIGATION

In implementing these methods using simulation and design of limitation in time and expenses based on the modeling of collective intelligence which includes the method of ant colonies (Ant Colony Optimization, ACO), a method of crossing two solutions genetic algorithm (Crossbreeding solutions genetic algorithm, CSGA), modifications operators (modification operators, MO) and other methods. These methods are effectively use to solve different problems: ACO is use for solving the shortest route search, CSGA used for solving the transportation, MO used for clustering and data objects. Taken together, the above listed methods are used to create a hybrid algorithm.

THE ANALYSIS OF RECENT RESEARCHES, PUBLICATIONS AND PROBLEM DEFINITION

In developing the new algorithm was necessary to understand the work of ant algorithm, namely a colony of ants while providing themselves with food seeking the shortest path between the nest and the food source without apparent active coordination mechanisms. The study revealed a chaotic ant activity, but once the food source was found, more and more organized ants moving along the shortest path [17–20]. Most species of ants use indirect contact form through Pheromone trails. To increase the efficiency of the algorithm, namely the process of finding the shortest route between local points we used Pheromone trails. The desired result is optimal routes and storing a quick calculation paths with greater concentration of pheromones [4–6].

The second algorithm to study and design a modified algorithm was selected genetic algorithm that included the adaptive search, which today are often used to solve transportation problems of functional optimization. They are based on the genetic processes of biological organisms [6–9].

Genetic algorithm is a set of “persons” – populations, each of which is solving a problem. Each person is assessed degree of ‘adaptation’ performance and effectiveness of its work. The paper used feature mating agents. This approach enables better serve tourists directly and automates the process, so that each agent will contain in itself all the previous results of the routes will not seek a new solution of again, and have already found use solving. This will improve the speed of the programs.

The object of the study is to create a hybrid algorithm and system that significantly improve the efficiency of the transportation problems in tourism.

SETTING GOALS AND OBJECTIVES

Based on a systematic analysis of the subject area and modern technologies used for solving transportation problems and algorithms and methods to implement such problems was established objective article.

The purpose of the article is the goal to increase the efficiency of transportation between cities and rational distribution of collection points with regard to tourists rational use of resources such as fuel consumption,

choose the type of transport seating and standing places in vehicles, the time spent on transportation. Also develop a mobile application with intuitively simple and intuitive interface.

To achieve the objectives of the article was delivered the following tasks:

- analyze the modern technologies used for solving transportation problems and formulate basic formulation of the problem in transportation of tourists between the settlements of view of efficient use of resources;
- develop algorithms for solving finding the optimal route between cities, placement of collection points and busy tourist transport tourists regarding the number of seats in transport;
- develop a mobile application developed algorithms based on solving the transportation problem in the tourism sector with regard to placement of collection points and transport tourists;
- to investigate the effectiveness of the algorithm as a numerical experiment, and test the effectiveness of the mobile application by “first test”.

RESEARCH METHODS OF ALGORITHMS

The study primary issue raised learning the basic functions of ant algorithm. The movement of ants is a complete undirected graph. Each edge has a weight that is designated as the distance between two nodes that are interconnected. Graf has two directions as ant (agent) is able to move on the edge in any direction (Fig. 1).

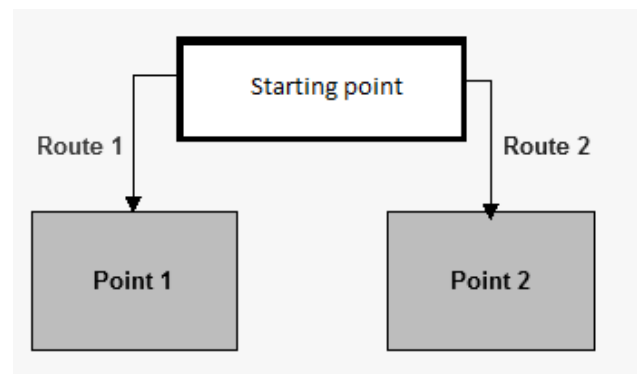


Fig. 1. Directions agents

The probability of inclusion agent route selected proportional pheromone on edge, and the amount of pheromone proportional to the length of the selected route. Therefore, we can conclude that the shorter the route the more pheromone p will be highlighted on the edge and the increasing number of ants will include it in its own synthesis route. Modeling this approach, which uses only positive inverse relationship leads to premature convergence x – the majority of agents moving on the locally preferred route, the edge w_{ij} and exudes

pheromones that affect $\frac{Q}{L_x(t)}$ where: variable Q is constant, which is given a number (concentration) isolating pheromone to record the route traversed ant;

L_x – the distance was an ant; variable t – this pheromone evaporation. In fact, if the pheromone disappears quickly, it leads to memory loss colony and optimal solutions, but on the other hand, long-term pheromone evaporation allows to receive stable optimal solution, which will look like:

$$w_{ij}(t+1) = (1-p)w_{ij} + \sum_{x \in w_{ij}} \frac{Q}{L_x}. \quad (1)$$

Once completed the path of the ants, and the edges of compliance with the updated path length and held evaporation of pheromones on all edges, then the algorithm again, an example is shown in Fig. 2. However, to address one of the tasks you need to use a double burden on the graph. Additional burden on local terms are tourists. Therefore there is a dependence on vehicle loading (agent) to tourists. If the agent is unable to meet the needs of all travelers, the program is next agent until tourists need not comply.

The work functions ant algorithm can be described as follows:

- a initialization, input source data (the amount of transportation of tourists);

- select the route and location of local points on the map;
- if the optimal route already exists, the program will notify the user and immediately gives the result – if not, then skip to the next step;
- elected the first agent;
- the agent looks for way from one point to another;
- moving the map identifies the agent pheromone trails;
- if the route comply then calculated and applied pheromone publication of results;
- if the route is not satisfactory, the agent prior to joining another agent.

Classical genetic algorithm was proposed by John. Holland as an algorithm that mimics the adaptation of populations to the desired function devices. In the process of designing a hybrid algorithm problem arose determine the best structure or values of objects (tracks, agents). This problem is called optimization. When combined with optimization calculation of optimal parameter values for a given object structure, it called parametric optimization. The task of choosing the optimal structure is a structural optimization.

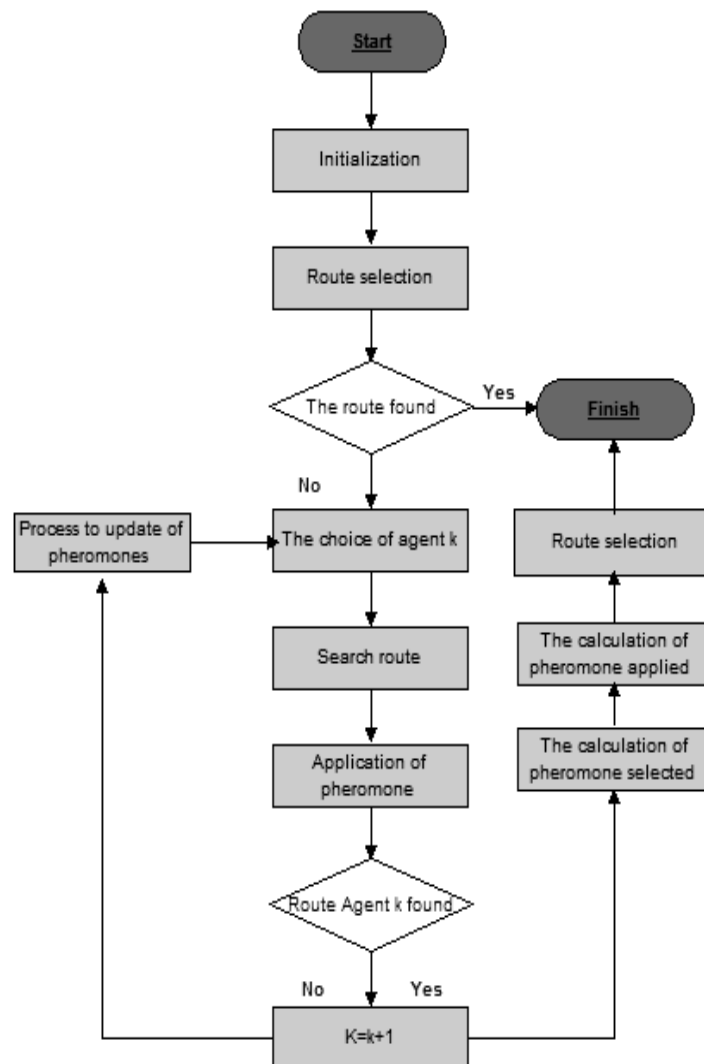


Fig. 2. Block diagram of ant algorithm

The main element of the genetic algorithm was chosen heuristic search algorithm used for solving optimization and simulation by random selection, combination and variation of parameters using certain mechanisms that resemble biological evolution.

A distinctive feature of the genetic algorithm – focus on the operator “crossing”, which deals recombination decisions, in this case the specified objects whose role is similar to the role of wildlife crossing [12–17].

Design features of genetic algorithm that were used in the hybrid algorithm consists of several stages:

- Preparatory part – forming initial population (the initial set of solutions). The algorithm for the formation may be different, but used a random process with the aim to cover a larger area for searching solutions;
- selection – an important step in the algorithm, is responsible for selecting areas of all possible routes (population). That is, the selection rejects solving low-value device that improves the average fitness of the entire population;
- crossing – the stage at which the creation of new solutions in the population that went through the selection process. The peculiarity of it is that when using crossbreeding taken two or more possible solving of the population, and among them – parts and connected to the new solution, which remains in the population;
- evaluation and stop making algorithm. For solving to apply genetic algorithm based on solving themselves. Therefore, the approach with a number of established populations. Also stop can take place beforehand, if it is ready solving.

JUSTIFICATION APPLICATIONS FOR MOBILE OPERATING SYSTEM IOS

In developing the software was chosen method of extreme programming “first test”. Thus, if the code passes all tests, it is effective, which increases the performance of the product and reduces the load on the device, which launched the product. In course of the following problems arise:

- large memory capacity of mobile application – 400 MB;
- remaining debris large amount of information after the cycles of the mobile application;
- a large load on backend;
- map of the world and its load;
- a complex hierarchical system class mobile application;
- construct a way to impassable areas (rivers, lakes, oceans).

In order to solve these problems, the development team were taken for solving partly improved the efficiency of the mobile application.

Large memory mobile application for the type of service and service leads to many problems, such as reducing the speed of application errors, early termination of the application, etc. Most of the annex occupied memory card. Therefore, using the opportunity to work with a map server through the Internet connection – was completely resolved the problem.

Remaining large amount of debris in the mobile app after cycles of consequently reduced the speed of application and hindered Internet connection. To solve

this problem the program was added to the code, the purpose of which was to periodically clean the “rubbish” and cache to free memory that is needed for the normal operation of the software.

World map and its load associated with the problem of a large load on the server side. In order for mobile application was easy and fast, it was necessary to release the load on the system itself. On the other hand, this load we translated into backend. Therefore, further development and the development of the software will try to solve the problem of load on the server.

The most important stage of development of the mobile application – is the development of algorithms and modified operators crossing initialization, and the range of applications. Thus, writing an algorithm in the code had to create a hierarchical class system. Such systems are severely tested and the process is lengthy because the error in this case may lead to errors in the application when performing secondary operations.

DESCRIPTION OF CLASSES AND TEST SOFTWARE

Classes and testing mobile application can be described as follows:

1. Class TravellingSalesmanAlgorithm logical structure contains built-in program that mark out population, mating and offspring of parents algorithm f . Entering data in this class defines a list of points x identified previously at the stage of initialization. The work of this class is the class work Location and gives the optimal solution for these points. This fitness function F to optimize the use of the problem:

$$F(x_{i,j}) = \frac{1}{f(x)}. \quad (2)$$

If the fitness function takes the value 1, then the way from city i to city j is defined otherwise function acquires the previous value. This class interacts with class Location, namely transmits the result of the data processing on the optimal path.

Class Location is the data model that contains a function for finding the distance L between two pairs m_1 , m_2 and n_1 , n_2 of local outlets and, using that formula 1:

$$L = \sqrt{(m_1 - m_2)^2 + (n_1 - n_2)^2} = \sqrt{(n_2 - n_1)^2 + (m_2 - m_1)^2}. \quad (3)$$

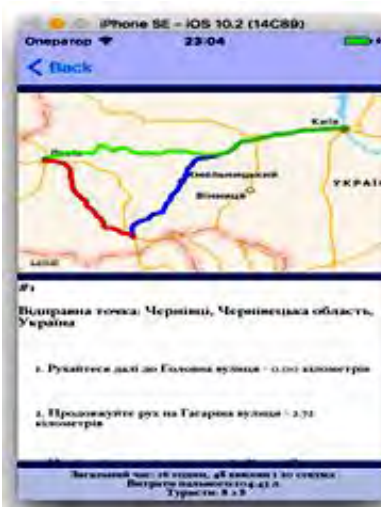
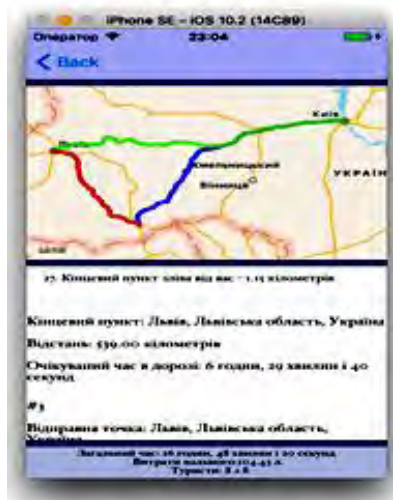
Class calculates the total distance through all the terms and indexes changes between points for the correct operation of the algorithm. Testing search route Chernivtsi-Kyiv showed that this class builds the way until the distance traveled and the error will not take the slightest importance. Sample tests shown in Table.

Illustration designed system using tourism route optimization shown in Figs. 3–5.

Class ViewController provides the system display all of the data visually, that is responsible for the visualization software in general. It works with the result of the two previous classes of the algorithm to display on the map. All the burden on the graph are calculated on the priority of each component of the load, namely calculation of transport capacity, serving tourists to its capabilities. Also, this class is counting fuel and looking for optimum distance.

Table. Results of testing for finding the optimal route

Chernivtsi-Kyiv	Distance, km	Uncertainty km
Iteration №1	524.86125	-1.890507
Iteration №2	514.60852	-2.588139
Iteration №3	515.12161	-0.116215
Iteration №4	538.03895	-1.549931
Iteration №5	534.78239	-2.258549
Iteration №6	534.09532	-3.000126
Iteration №7	537.51959	-0.335941
Iteration №8	549.80766	-1.615849
Iteration №9	548.92406	-2.923222
Iteration №10	559.58426	-3.186893
Iteration №11	558.62982	-4.263554
Iteration №12	514.88224	-3.186893
Iteration №13	514.60852	-0.116215

**Fig. 3.** The choice locality**Fig. 4.** Route planning**Fig. 5.** Cost resources

From the main menu you can choose a local point of visits and the number of tourists in these areas that the city built between which the shortest route. Pressing the left button at the tape entering the city, you can enter the number of tourists and clicking on "Select" page opens selecting the city where we can confirm our choice. After local terms will be introduced, we can build the route, which will be indicated road from one city to another in different colors. Also these cards will be described in the way tips, distance, travel time, the number of tourists as well as fuel consumption.

CONCLUSION

The article analyzes the current route optimization techniques used to solve transportation problems in which solving designed to transport tourists between the settlements of view of efficient use of resources. These methods include genetic and ant algorithms by which performed the optimal route search and placement of collection points.

Based on established operators modifications initialization and the crossing was built a system that solves the transportation problem in the tourism sector with regard to placement of collection points and transport tourists.

In the study of the effectiveness of the algorithm as a numerical experiment and test the effectiveness of mobile application by "first test" was found that the system builds a route from one town to another in which error and the smallest distance..

REFERENCES

1. **Kazharov A. 2010.** Ant algorithms to solve transport problems // Russian Academy of Sciences. Theory and management systems, pp. 32–45
2. **Yemelyanova S. 2008** Solving transportation problems with a cluster clients using genetic algorithms // Fuzzy Systems and Computing, pp. 195–199.
3. **Gladkov L. 2006.** Genetic algorithms: Tutorial // Physics and mathematics, 320 p.
4. **Goryachev Y. 2001.** Genetic algorithms optimize multi conflict, 102 p.
5. **Kureychyk V. 2012.** Application of genetic algorithm for solving the problem of three-dimensional packaging // PFC. Engineering, pp. 8–14.
6. **Bova V. 2010.** The integrated subsystem hybrid and combined search and management problems of designing // PFC. Engineering, pp. 37–42.

7. **Yermeyev A. 2000.** Development and analysis of genetic and hybrid algorithm for solving discrete optimization, p. 22.
8. **Kureychyk, V. 2006** Search adaptation: Theory and Practice / M.: Physics and mathematics, 272 p.
9. **V. Pasichnyk, V. Savchuk 2015.** Mobile Information Technologies for Tourism Domain. ECONTECHMOD: an international quarterly journal on economics of technology and modelling processes, Vol. 4, No. 2, pp. 25–32, 2015.
10. **Lytvyn V., Medykovskyj M., Shakhovska N., Dosyn D. (2012).** “Intelligent Agent on the Basis of Adaptive Ontologies,” Journal of Applied Computer Science, Vol. 20, No. 2, pp. 71–77.
11. **Shakhovska N., Veres O., Hirnyak M. 2016.** Generalized formal model of Big Data. ECONTECHMOD: an international quarterly journal on economics of technology and modelling processes, Vol. 5, No. 2, pp. 33–38, 2016 (in Polish).
12. **Pasichnyk V., Lozytskyy O., Savchuk V. 2016.** Personified information technology to support the tourist with excursion content in DAISY format ECONTECHMOD: an international quarterly journal on economics of technology and modelling processes. Vol. 5, No. 2, pp. 77–86, 2016.
13. **Jannach D.,** Recommender Systems: An Introduction / D. Jannach, M. Zanker, A. Felfernig, G. Friedrich – Cambridge University Press, New York, 2010,– 352 p.
14. **Kask S.,** Modeling tourist and community decision making. The SAVE Market / S. Kask, C. Kline, K. Lamoureux, Annals of Tourism Research, 2011, Vol. 38, No. 4, pp. 1387–1409.
15. **Artemenko O.,** Dynamic characteristics of perspective touristic information technologies / Olga Artemenko, Natalya Kunanec, Volodymyr Pasichnyk, Valeriya Savchuk // Econtechmod an international quarterly journal, 2015, No. 4, Vol. 4, pp. 107–118.
16. **Bin R.,** Research on Tourism Service Intelligent Recommendation System Based on Apriori-MD Algorithm / Rao Bin // Applied Mechanics and Materials, 2014, Vol. 651–653, pp. 1642–1646. © (2014) Trans Tech Publications, Switzerland doi: 10.4028/www.scientific.net/AMM.651-653. 1642 p.
17. **Borras J.,** Intelligent tourism recommender systems: A survey / J. Borras, A. Moreno, A. Valls // Expert Systems with Applications, 2014, Vol. 41, pp. 7370–7389.
18. **Fedushko S., Syerov Yu., and Korzh R.,** “Validation of the user accounts personal data of online academic community” IEEE XIIIth Intern. Conf. “Modern Problems of Radio Engineering, Telecommunications and Computer Science”, Lviv-Slavske, February 23–26, 2016, pp. 863–866.
19. **Fedushko S.** “Development of verification system of socio-demographic data of virtual community member” Radio Electronics Computer Science Control, Article No. 3, pp. 87–92, 2016.
20. **Dosyn D., Lytvyn V., Yatsenko A. (2012)** DP-optimization of steel corrosion protection techniques in the intelligent diagnostic system // Physicochemical Mechanics of Materials, No. 9. – Lviv, 2012, pp. 329–333.