Міністерство освіти і науки України

Національний університет біоресурсів і природокористування України
Механіко-технологічний факультет
НДІ техніки і технологій
Кафедра транспортних технологій та засобів у АПК

Представництво Польської академії наук в Києві
Польська академія наук відділення в Любліні
Академія інженерних наук України
Українська асоціація аграрних інженерів

ЗБІРНИК ТЕЗ
доповідей
III Міжнародної
науково-практичної конференції
«Автомобільний транспорт та інфраструктура»

AutoTransport and Infrastructure

23-25 квітня 2020 року
м. Київ

УДК 631.6

DIGITALIZATION IN LOGISTICS

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This area is extremely relevant and necessary in the conditions of scientific progress and the constant growth of the needs of transportation, especially automotive. Since the car is the only type of transport that can provide door-to-door transport.

From the point of view of economic theory, the concept of transport logistics is considered as the planning of optimal routes of freight transportation with minimization of costs, which is especially relevant for trading companies, delivering products to customers every day. Due to the increasing traffic of motorways, business drivers are often late in the established time intervals of delivery, which leads to product returns, increased customer dissatisfaction, and, ultimately, loss of revenue and losses.

The importance of low transportation costs and their subsequent impact on the cost of delivering goods multiplies the productivity and savings of the company when integrating the VRP solution, thus eliminating all doubts about the relevance of the VRP study, regardless of the length of the existence of this problem.

- the presence of only one warehouse from which vehicles begin to move;
- all vehicles are homogeneous, that is, they have the same characteristics;
- vehicles return to the starting point of the route;

• routes are one day.

We propose the introduction of parameters that will complement the classical model and simplify the calculations by adding only a few new algorithms:

• vehicles have limitations on carrying capacity;

• Each vehicle is assigned a time frame within which it can carry out its work;

• Each order also assigns a time frame within which it can be delivered.

Local Search Algorithms algorithms consist of random initialization of the initial solution and the gradual transformation of this solution into more and more optimal. In each cycle of the algorithm, the current solution is taken and a set of neighboring solutions (neighborhood solutions, in which case the current solution can be translated using one elementary change (motion, move) is considered). The motions are chosen by the most optimal (which gives the maximum value of the evaluation function that corresponds to the chosen optimization criterion - the minimum time of delivery of orders, the minimum number of involved vehicles, the minimum covered distance). If it meets the criteria (acceptable, acceptable), which is inherent in a specific local optimization algorithm, then the current solution is replaced by the optimal outfit from the outfit (step, step) and the cycle of execution of the algorithm is restarted for a new solution.

Hill Climbing Algorithm (Local Local Search Algorithm) is a local optimization algorithm for maximizing the estimated function. This algorithm takes all steps from the current neighborhood, chooses from them the optimal variant.

Tabu Search, like the Hill Climbing Algorithm, looks for the optimal value of the evaluation function in all solutions from the neighborhood of the current one, but excludes those whose movements are affected by the objects contained in the tab-list. A tab-list is a set of objects that are not eligible for a certain time after being hit in a taboo list to participate in the move. In the list objects fall after selecting the appropriate step that affects them, in the current run of the algorithm.

Unlike the two previous algorithms**, *Simulated Annealing*** does not consider all movements in the neighborhood, which greatly increases the speed of execution of this algorithm. Viewing movements is interrupted when the first suitable movement is found, which becomes the optimal step in this cycle. Motion is considered suitable if it leads to a solution that does not reduce the value of the estimation function for the current solution, or reduces it, but passes a random check.

The Late Acceptance Hill Climbing Algorithm, just like Simulated Annealing, considers only part of the movement in the neighborhood. Motion can be chosen as a step if it leads to a solution that does not reduce the value of the estimation function for the current optimal solution, or to solve with a less than the value of the account than the optimal solution of a certain number of cycles back.

Step Counting Hill Climbing Algorithm differs from the Late Acceptance Hill Climbing Algorithm so that instead of comparing possible movements with the optimal solution account, a certain number of cycles back this algorithm retains one threshold for several cycles, choosing the following movements only if they do not reduce the given threshold. 3) Genetic Algorithm

The results of the application of the genetic algorithm for optimization were worse than all other algorithms, with the exception of the Hill Climbing Algorithm.

This was reflected in the longer time finding a solution, which is explained by the need to evaluate and verify a large number of solutions at each cycle of population changes.

To write the program, PHP, JavaScript and HTML markup language were used. The choice is based on the specifics of language data, aimed at creating web-applications, which was the main requirement for creating the interface of the application. The implementation of the APIs of external systems, with which applications need to work, namely GoogleMaps and Google Geocoder, have an important role to play, just for the above-mentioned languages.

For writing the program, the php-libraries "curl" and "SimpleXML" were used, which provide work with HTTP-requests and xml-format data, respectively. HTTP requests were used to work with methods known APIs, and xml-format was used to work with Excel documents. The genetic algorithm develops the generation (set) of individuals represented in the form of chromosomes, creating new generations of descendants by making changes to the data, as long as certain criteria for completion parameters of the algorithm are not achieved. To such criteria in the described implementation of the algorithm is the value of the maximum number of generations. Upon completion of the algorithm, the best-developed chromosome in the decode is deciphered and selected as a sought-after solution.

To solve the VRP problem with the help of the genetic optimization algorithm, the model of representation of each individual in a generation (which means one solution) of one chromosome, where each chromosome looks like a chain of orders and vehicles, was chosen. Vehicles are delimiters between route sheets, and orders placed after such dividers show their affiliation to a particular route.

Creating a new generation includes three stages:

Selection of a part of individuals from the current generation with the best indicators of the evaluation function; random selection of a set of pairs of individuals from the current generation and the recombination of genes in chromosomes (operation

cross-headers) of the elected parents inside the couple to receive two descendants; mutation of genes of descendants to increase diversification of individuals (decisions).

The described stages create new from the old generation, on the one hand preserving quality in the form of a set of the best chromosomes, and on the other - adding to the operation of cross-over and mutation diversification into a set of solutions of the new generation.

The first generation turns out to be similar to the starting solution for the local search algorithms described earlier, using the First Fit heuristics, which runs a certain number of times for order lists in different. sequences. The pseudo code for the algorithm is given in Appendix 3.

As a result of the research, the company solved the following issues:

a) Formation of the sequence of customer service;

b) Reduction of product losses, as in the investigated application, and in a number of others;

c) Optimal distribution of driver occupancy.

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