# IMPLEMENTATION OF GENETIC ALGORITHMS FOR TRANSIT POINTS ARRANGEMENT

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*Abstract: The problem of transit points arrangement is presented in the paper. This issue is connected with accuracy of tariff distance calculation and it is the urgent problem at present. Was showed that standard method of tariff distance discovering is not optimal. The Genetic Algorithms are used in optimization problem resolution. The UML application class diagram and class content are showed. In the end the example of transit points arrangement is represented.*

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## Introduction

At present days the freight service billing and tariff distance defining are actual issues for railroad monopoly. There about 13000 railroad stations, wayside stops, passing-tracks and another points are located in Russia. We can compose the formal definition the set of these points connected with railway lines as a triply connected flow diagram. Problem for shortest distance discovering is very actual problem. So for the barest necessity there is a special reference book for freight service billing calculation between two various points of Russian Railroads. But there some problems are connected with search: it takes a lot of time and persons can make mistakes. Thus development fast search method and this implementation are very urgent problems.

## Standard method for tariff distance calculation

For contraction of adjacency matrix volume (columns count more than 169 000 000) using model of transit points (TP). In the reference book for freight service billing for each transit point $P_i$, is defined $S_{ij}$ - shortest distance to nearest transit point $TP_j$, and distance between arbitrary points $S_{jk}$. This model allows to reduce information volume and complexity.

We should define distance between two arbitrary railroads points $P_i$ and $P_j$. Let there are some points $TP_k$ and $TP_m$ . are located in the neighbourhood of $P_i$. Let there are some points $TP_n$ and $TP_q$.. are located in the neighbourhood of $P_j$. Using tables of departure and arrival we can define distances $S_{ik}$, $S_{im}$, $S_{jn}$, $S_{jq}$. Using reference book for freight service billing we can define distances between TP: $S_{kn}$, $S_{kq}$, $S_{mn}$ и $S_{mq}$. Thus we get the set of tracks $L_i$, where $L_1 = S_{ik} + S_{kn} + S_{jn}$, $L_2 = + S_{ik} + S_{kq} + S_{jq}$, $L_3= S_{im} + S_{mn} + S_{jn}$, $L_4 = + S_{im} + S_{mq} + S_{jq}$. Moreover tariff distance is defined as [Tarrif guide 1, 2001, Tariff guide 3, 2001]

$$L = \min_i L_i$$

In this case tariff distance is not shortest distance.

## GA method for shortest distance discovering

Let look at singular case. Let railroad points are located as showed at the Figure 1. In this case tariff distance between $P_i$ and $P_j$ will define as $L_1 = S_{ik} + S_{kn} + S_{jn}$. Obviously that tariff distance include $S_{ik}$ two times. So optimal arrangement TP for new sectors of railroads is urgent problem, because it has an influence on inaccuracy in tariff distance calculation on the one hand and on the volume of reference book on the other hand.

Figure 1. Example of TP arrangement

For optimization problem solving we use the genetic algorithms (GA) [Batishev, 1995], because GA has a resistibility to hit into local minimum, and very effective on huge data set. Graph nodes which have two or more incoming connection are called main node. Generally transit points are located in the main nodes for optimal arrangement.

We define the chromosome as $H=\{h_1,h_2,\ldots,h_t\}$, where $t$ – main nodes count. At that

$$h_i = \begin{cases} 0, \text{ if } P_i \text{ is not } TP \\ 1, \; P_i \text{ is } TP \end{cases}$$

Term “pass” is set of nodes and connections in the graph between two main nodes. We define number of passes with out TP as $s_i$ , $r_{max}$ – highest possible number of TP in graph’s fragment is considered in the arrangement problem, $r_i$ – number of TP in the $i$ chromosome. In this case fitness function is calculates

$$f_i = \begin{cases} 0, & \text{if } r_i > r_{\max} \\ \dfrac{1}{s_i}, & \text{if } r_i \le r_{\max} \end{cases}$$

After the individual fitnesses of the offspring has been evaluating we can define offspring selection probability for crossing. Offspring selection probability is directly proportional the individual fitnesses of the offspring. After that the crossover and mutation are executed.

Genetic algorithms using for arrangement.

Choose 2 individuals A and B with highest fitness

After crossover obtain individuals C.

Make the mutation of offspring C with probability mutationPos.

Make the inversion of offspring C with probability inversionPos.

Sort the set of chromosomes in the order of fitness decrease.

Change the the worst chromosome on C.

Input parameters are graph of rairod stations, maximum allowable number of TP, mutation and inversion probabilities and point of chromosomes crosses.

## Implementation

For implementation of Genetic Algorithms was realized software application. We use Microsoft Visual Studio Express Edition as a IDE and C# as a programming language and Test-Driven Development as a software development technology. UML application class diagram (without links) of the main classes is represented on the Figure 2. Class «Khromosome» includes necessary fields and methods (as the Inversion, Mutation, Crossover methods) for implement of individuals and offspring. Class «Generation» uses list of «Khromosome» class’ objects and contains methods for create and change of chromosomes list. The class «GeneticAlgorithm» uses object of «Generation» class and has initializing methods.

Bellow example of TP arrangement using software application is represented. The initial states map is showed at the Figure 3.

In this case after GA implementation for arrangement 2 transit points were added into the graph. They are showed at the Figure 4 and marked yellow points.

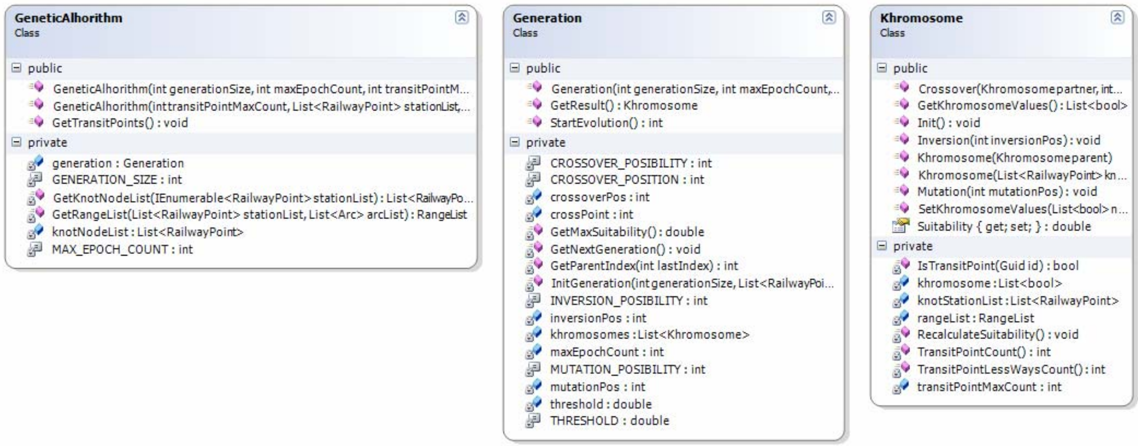


Figure 2. Class diagram for GA implementation.


Figure 3. Initial railroad points map


Figure 4. Added transit points

## Conclusion

Offered method allows find optimal arrangement of transit points and as a result decrease inaccuracy in tariff distance calculation. Software application was tested on 15 various graphs with definite results for effectiveness and adequacy defining. We obtained the same results of methods implementation and the test samples with permissible error.

## Bibliography

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