Partial Selection Method and Algorithm for Determining Graph-Based Traffic Routes in a Real-Time Environment

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Abstract: In this paper discussed how to determine traffic-dependent traffic-oriented traffic in real-time. The partial selection method is presented in the algorithm. The main aspect of partial selection is that the focus is on selecting the graph widths on an informal basis. The developed algorithm is presented as pseudo code.

Keywords: Real time environment, partial selection, the shortest path problem

I. INTRODUCTION

In developed countries a special attention is paid to the solution of the problem of dataflow full control in telecommunication networks in real time, implementation of automated information systems in particular spheres and the expansion of their existing capabilities. Development of dataflow control system due to the increasing number of users in the network and emergence of various types of traffics has become one of the most important problems today.

The solution of problems refers to traffic control, i.e. traffic map, the determination of spare nodes by results of determination of the optimal traffic routing in the network.

The problem of constructing of a traffic network map of geo-location and determining of the spare traffic network nodes, intellectual analysis of information, doing researches using automated systems are carried out in developed countries in this sphere, such as the USA, South Korea, Russia, Denmark, Japan, Spain, Germany, Great Britain, France and Uzbekistan.

Traffic control system is similar to the control system of transport facilities of a big city. Problems for both of them are considered to be the same. Firstly, it is distribution of the flow; secondly it is the violations of traffic rules.

Emergence of terms of traffic control in networks is explained as following:

- Discontinuity of the traffic;
- the diversity of the quality requirements of information transfer of different types;
- Nonstationary of traffic network, i.e. randomness.
- Emergence of reload and lockout in network as the result of non stationary of traffic network.

Mentioned above conditions in computer networks cause the appearance of problem of discontinuity traffic control and lead to necessity of solution the following problems:

1. insurance of reliability of information transfer, i.e., deliver information to subscribers without loss;
2. effective use of expensive technical equipment in the network, i.e., regular distribution of information flow in the network while adaptive routing process;
3. Reduction of transmission time in the network, especially while transmitting multimedia;
4. To avoid the reload and to prevent lockout in traffic networks.

Algorithm of finding traffic routes with dynamic parameters in real time environment and elaboration of partial selection method based on graph in solution of traffic route problems in limited life is one of the most important problems of traffic engineering in communication networks.

II. PARTIAL SELECTION METHOD OF CHOOSING OF INFORMATIVE EDGES OF THE GRAPHFOR DETERMINING L NUMBER TRAFFIC ROUTES

Let us assume that multiparameter G=(V,E) graph is given andenter Boolean vector,which means existing of all completed routes $\lambda_p = (\lambda_p[1]\ \lambda_p[2] \ldots \lambda_p[m])$, if the value ofi-component of Booleanvector λ_p is equalto one,then it means that presence of e_i edgeof graph in P route compound, but if noti.e. the value ofi-componentis equalto zero ,then it means absence of e_i edge in P route compound.

Let us assume, the assessmentcriteria of P route quality which is related toBoolean vector is defined as following:

$$I(\lambda_p) = \frac{\sum_{i=1}^{m} a_i \cdot \lambda_p[i]}{\sum_{i=1}^{m} b_i \cdot \lambda_p[i]}$$

the value of edge $I(\lambda_p)$ is explained as quality criteria ofP-routing.The greater the value of the function, the better the selected route is.The optimistic view of this is expressed in the following way, it is necessary to find $\exists\lambda_p$ solution,

$$I(\lambda_p) = \frac{\sum_{i=1}^{m} a_i \cdot \lambda_p[i]}{\sum_{i=1}^{m} b_i \cdot \lambda_p[i]} \to \max_{\lambda_p} \quad (1).$$

Let Optimization problem have a solution.

Here, each *i* edge corresponds to a_i and b_i , $\overline{1 \le i \le m}$ components of a and b vectors, the

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following $a_i \geq 0$ and $b_i > 0$, $\overline{1 \leq i \leq m}$ is required for the values of these components.

So, while a_i component increasesthe quality of e_i graphic edge, the b_i component reduces its quality, which means that, the values of e_i graph determine the overall traffic quality.

Let's defineset λ_p of all available traffic routes through Λ^p on the given graph. Then $\lambda_p \in \Lambda^p$ expression will be appropriate.

Task. It is required to find Lnumber of the most perfect traffic routes for optional nodes (three) of the graph among all $\lambda_p \in \Lambda^p$ traffic routes.

In order to solve the problem, $I(\lambda_p)$ functional values are calculated using all the elements of the set and they are sorted by reduction and the first L numbers are taken and serve as a solution to the task with λ_p s representing the route.

This is a complete selection method and it is a functional value for all λ_p s. As the number of edges increases, the number of elements in the set λ_p increases as the geometric progression. Using of this method is appropriate and a perfect solution to the problem is found in the presence of a small amount of graph edges in traffic route.

The most important part of the optimization problem in determining the above mentioned traffic routes is to complete Λ^p set. This set creates a base of traffic routes. That is why our main task is to complete this set.

Let us make the following definition : $c^j = \frac{aj}{bj}$.

1) As $c^j \in R, j = \overline{1,N}$ (R is a setof concretenumbers) $c = \left(c^1, c^2, c^3, \ldots , c^N\right)$vector componentscan be arranged in ascending order (because R is asequential set).

2) Thus, $(c^1, c^2, \ldots, c^N) \rightarrow (c_1, c_2, \ldots, c_N)$ is, $\forall_i \left(i = 1, \overline{N-1}\right)$ is for $c_i \leq c_{i+1}$.

3) $c = (c_1, c_2, \ldots, c_N)$ Using vector components, we create the following sequences::

$$f_1 = \sum_{i=1}^{l} c_1, f_2 = \sum_{i=2}^{l+1} c_i, \ldots, f_k = \sum_{i=k}^{l+k-1} c_i$$

$l + k - 1 = N \Rightarrow k = N - l + 1$.Is.

Thus ifz≥2 is $f_z = f_1 + \sum_{i=1}^{z-1}(c_{l+1} - c_i)$.

If we consider f as function of k , that is, if we consider as $f_k = f\ (k)$, the following confirmation will be appropriate.

Confirmation 1. $f\ (k)$growth function.

Proof:

Ink≥3that is enough to show that$f(k-1) \leq f(k)$

$f(k-1) \leq f(k) \Leftrightarrow f(k) - f(k-1) \geq 0,$

$$f(k) - f(k-1) = f_1 + \sum_{i=1}^{k-1}(c_{l+1} - c_i) - \left[f_1 + \sum_{i=1}^{k-1}(c_{l+i} - c_i)\right] = c_{l+k-1} - c_{k-1}$$

As it is known, that$\forall_i$for$c_{i+1} \geq c_i \Rightarrow c_{l+k-1} - c_{k-1} \geq 0 \Rightarrow f(k-1) \leq f(k)$

Confirmation 1 has been proven.

Property 1. $\forall\, \lambda \in \Lambda^l$is for$f_1 = \min(c, \lambda)$.

Confirmation 2. $\Lambda^l(c) \neq \emptyset$ifonly if$f_1 \leq c_0$is.

Proof:

$\Rightarrow \Lambda^l(c) \neq \emptyset \Rightarrow \exists \lambda \in \Lambda^l(c)$ isavailable $(c, \lambda) \leq c_0$. According to the above property $\forall\, \lambda \in \Lambda^l$ for $f_1 = \min(c, \lambda)$.and$\Lambda^l(c) \subset \Lambda^lasf_1 \leq (c, \lambda) \leq c_0$.

If it is$\Leftarrow$ $f_1 \leq c_0$,i.e$f_1 = s\ \sum_{i=1}^{l} c_i = c_1 + c_2 + \cdots c_l \leq c_0$, then$\lambda = (\lambda_1, \lambda_2, \ldots, \lambda_l, \lambda_{l+1}, \ldots, \lambda_N)$The initial$\lambda$number components of the vector ($\lambda_1 = \lambda_2 = \ldots = \lambda_l = 1$) is one, let supposethe restof them $(\lambda_{l+1} = \lambda_{l+2} = \ldots = \lambda_N = 0)$are equal tozero, $\lambda \in \Lambda^l$and$(c, \lambda) = f_1 \leq c_0$. From that we get$\Lambda^l(c) \neq \emptyset$.

Confirmation2 has been proven.

3) now we will findk which will be$c_0 - f_k \geq 0$.

Note. If$c_0 - f_k \geq 0$ is, then it will be $\Lambda^l(c) \equiv \Lambda^l$.

Property 2. If $c_0 - f_1 \geq 0$ and $c_0 - f_{N-l+1} < 0$ is, $\exists p \in \overline{1, N-l+1}$ will be found as

$$.\begin{cases} c_0 - f_p \geq 0 \\ c_0 - f_{p+1} < 0 \end{cases}$$

Proof:

Let's imagine the opposite, then for the optional $p \in \overline{1, N - \lambda + 1}$ will be

$$\begin{cases} c_0 - f_p \geq 0 \\ c_0 - f_{p+1} < 0 \end{cases} \text{or} \begin{cases} c_0 - f_p \geq 0 \\ c_0 - f_{p+1} \geq 0 \end{cases}$$

Consequently, when p=1 or p=N-*l*+1this indicates that the property condition is corrupted. We come across with a conflict.

It means that our assumption is not right. From this, we come to the conclusion that, there is p where the property above is appropriate.

Now, let's see how to find this p. To do this, we use({1, 2, ... , N-λ+1}) the bisection scaling method , i.e. $, p1 = \left[\frac{N-l+1+1}{2}\right]$that is where [*] is the integer.Then$c_0 - f_{p_1}$value is checked, if $c_0 - f_{p1} < 0$is$p_2 = \left[\frac{p1+1}{2}\right]$otherwise we take it as$p_2 = \left[\frac{N-l+1+p1}{2}\right]$.$\exists \rho m$is produced after doing this work several times repeatedly, and there will be$\begin{cases} c_0 - f_m \geq 0 \\ c_0 - f_{m+1} < 0 \end{cases}$ .We proof property completely, if we take it as$p_m = p$.

Property 2 has been proven.

If we take$S = \{c_1, c_2, \ldots, c_l, \ldots, c_{l+p-1}\}$as a set,the sum of the optional λ number elements of this set is smaller than c_0, according to the proven property.

4) At this $(c_1, c_2, \ldots, c_l, \ldots, c_{l+p-1})$ stage, we define the largest component of the vector that can be involved in the problem.

To do this, we'll consider the following system:

$$\begin{cases} f_0 + c_j \leq c_0 \\ f_0 + c_{j+1} > c_0 \end{cases}, j = \overline{l, N-1}$$

here $f_0 = \sum_{i=1}^{l-1} c_i$.

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If c_q (q<N) is a solution of the system, then we deny $c_{q+1}, c_{q+2}, \dots, c_N$ values corresponding to the quantities and decrease the starting point spacemeasuring to q, i.e. we go to the space $R^N \to R^q$.

$c \in R^q, a \in R^q, b \in R^q (q \geq l)and\Lambda^l = \{\lambda \in R^q : \lambda^i \in$
0;1i=1qλi=l

5) Now, we divide Λ^l set in such a section so that the resulting optional part is $\lambda \in \Lambda_i^l(C) \subseteq \Lambda^l$ for$(c,\lambda) \leq c_0$vector derived from the set. Such partitions are generated as follows.

Through f_k^jfunction we define that onlythe last member j (j≤λ-1) of f_k is not present.

$$\begin{cases} f_{p-1}^j + \sum_{z=1}^{j} c_{t_z} \leq c_0 \\ f_{p-1}^j + \sum_{z=1}^{j-1} c_{t_z} + c_{t_{j+1}} > c_0 \end{cases} i = \overline{0, p-1}; j =$$

$\overline{1, ; -1}$, here$t_z \geq p - i + l - j - 1; t_z < t_{z+1} \leq k$.

Note: If $t_z = k$ in the above system, then we will stop increasing the value of i for the fixed j.

Let's consider all C_is that can be involved in solving the problem as an elements of the S * set.

In this case if we solve the system above separately for each pair of i and j, then S * will be divided into such partitions(the number of elements is not less than λ), where the sum of any λoptional from these sections will be smaller than s0.

In line with these partitions we create$\Lambda_h^l(c)(\cup_h \Lambda_h^l(c) = \Lambda^l(c))$and we form R^q dimensional character space as a new sectional space corresponding to each $\Lambda_i^l(c)$of the character space.

The equivalent of the task(1) given above will be produced from it. .

$$\begin{cases} J_i(\lambda) = \frac{(a,\lambda)}{(b+c,\lambda)} \to max \\ \lambda \in \Lambda_h^l(c) \end{cases} \quad (2)$$

Here(*,*) is scalar multiplication of of the vectors, if we find perfect solution of(2) $\lambda_i$for each h, then the solution of the task(2)will be defined as$J(\lambda) = \max J_h(\lambda)$and graphs edges corresponding to components of λvector which differ from zero form the most informative graph edges.

III. SEPARATION ALGORITHM FOR THE AMOUNT USED INSOLUTION OFPROBLEMS

Step I.Given values: λ - number of required characters; N – number of allcharacters; s - N dimensional vector; c_0 – s0 is the quantity of the amount with limited resource.

Step II.$\sum_{i=1}^{l} c_i$the value is calculated and compared to s0.If$\sum_{i=1}^{l} c_i \geq c_0$ the case is not solved, the process will be completed.

Step III. Let's take it as *q=l.*

Step IV. Checking of the term$\sum_{i=1}^{l-1} c_i + c_q \leq c_0$

Step V. If the above term is performed, *q=q+1* will be retrieved and return to step IV.

Step VI. $S = \{c_1, c_2, \dots, c_l, \dots, c_q\}$set of all funds, which will participate. We go to $R^N \to R^q$.

Step VII.

$$\begin{cases} f_{p-1}^j + \sum_{z=1}^{j} c_{t_z} \leq c_0 \\ f_{p-1}^j + \sum_{z=1}^{j-1} c_{t_z} + c_{t_{j+1}} \leq c_0 \end{cases}$$

$i = \overline{0, p-1}$; $j = \overline{1, l-1}, t_z \geq p - i + l - j - 1$;
$t_z < t_{z+1} \leq k$

.System above will be solved for each *i* and *j* and defined sections of S *.

Step VIII$\Lambda_h^l(c)(\cup_h \Lambda_h^l(c) = \Lambda^l(c))$is produced.

The problem solving algorithm

Step I. Given values : λisrequired traffic routes; N is a number of all traffic routes; a, b, c are m dimensional vectors; c_0 is the amount of allocated resources; $\Lambda_h^l(c)$isa set of vectors.

Step II.

$$\begin{cases} I_i(\lambda) = \frac{(a,\lambda)}{(b,\lambda)} \to \max \\ \lambda \in \Lambda_i^l(c) \end{cases}$$

is calculated.

Step III. taken as $I(\lambda) = I_1(\lambda)$.

Step IV. we take it as *i=i+1*.

Step IV . $I(\lambda)$is compared to$I_i(\lambda)$. If$I(\lambda) \leq I_i(\lambda)$,it is considered as$I(\lambda) = I_i(\lambda)$and return toStep IV .

StepV . $I(\lambda)$exit parameter.

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