Solving logistics on the basis of fuzzy package

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Abstract. The article discusses an approach to solving a logistic problem based on fuzzy set theory. The classic fuzzy control module is developed at the node of the transport network, as well as when solving the problem of modeling the traffic control strategy in the network. An ambiguous rule base was developed for defining traffic control parameters at a transport network node, and rules were proposed for mapping a control parameter to a specific class and fuzzy rule base.

1. Introduction

The term intelligent transport systems describes the means of integration of transport infrastructure management used to solve the problem of transport management based on modern information technologies, based on modern information technologies, organizes the flow of information about the operation of transport infrastructure in real time. Multi-level, complex organized intelligent transport systems embody a hybrid system consisting of a variety of interconnected systems in which management, classification, forecasting, experimentation, decision-making, or process support are used to achieve a common goal.

The priority of the development of intelligent transport systems is road safety. The functions of this type of intelligent transport systems include: forecasting dangerous situations, detecting congestion and road traffic accidents, developing an action plan in dangerous situations, informing road users about emergencies. The advantage of intelligent transport systems when operating in these conditions is the ability to integrate all data sources.

The issue of intelligent transport systems.

The classification of issues to be addressed in the framework of transport infrastructure activities allows to determine the strategy and tactics of synthesis of intelligent transport systems.

Monitoring issues

Traffic monitoring:
- monitoring of traffic flow characteristics;
- collection of information on the status of traffic using controlled vehicles;
- traffic management on highways;
- Monitoring of street network features:
- certification of road network, multi-level transport intersections and tunnels;
- certification of ground and underground pedestrian crossings;
- certification of railway crossings;
- assessment of the current state of the road network;
• monitoring of emergency repair works in the road network.

Monitoring of traffic control equipment:
• register of road signs;
• register of traffic lights;
• register of road drawings;
• trunk and network control of traffic lights;
• Automatic electronic toll and parking.

Monitoring of environmental pollution.

Management issue
Traffic management:
• coordinate traffic management;
• assessment of the quality of transport networks;
• emergency management;
• detection of a traffic accident;
• monitoring to assess the dynamics of traffic congestion development;
• development of traffic management strategy in congested conditions;
• Integration of traffic management systems.

Transportation process management:
• providing pre-transport information, informing customers about the network route, travel planning;
• booking of transport services;
• assessment of transport requirements;
• on-line tracking of the route;
• developing a management strategy in specific situations;
• operational management of traffic control schemes;
• priority traffic management;
• route navigation and priority of special individual vehicle flows;
• monitoring of dangerous and bulky cargo transportation;
• optimization of the route network;
• integration of traffic management systems;

The issue of providing information to the participants of the movement:
• data transmission through communication channels;
• segmentation of information flows.

Integrate traffic management database system.

At the node of the transport network, as well as the problem of modeling the traffic management strategy in the network, is to develop a classic non-trivial control module. Its components:

1. Phase blocking: the obscure logic control system works with obscure sets, as well as the specific value of the obscure control module input signal underlies the phasing operation, resulting in the obscure set being connected to it.

2. A rule base is a set of rules that are not clear to identify the ambiguous set to which the output signal of the system belongs.

3. Decision development block: direct determination of the set of relevance of the output signal for specific sets of input signals.

4. The defascification block represents the procedure of comparing the obscure set obtained at the output of the decision block to a certain value, which reflects the control.

2. Problem solving
As a rule, there are no statistics on the time $T_i$ distribution of the transport flow in real time of operation. But in these conditions it is necessary to choose the optimal route to establish the connection required to receive data with satisfactory quality.
In this regard, an a priori non-reflexive matrix of privileged routes is constructed at the node of each $B_{Mk}$ transport on the basis of a standard function corresponding to the condition of $c_k \in C_u$, the state stored in the database. The initial database is formed in the form of a logically ambiguous rule based on the opinions of experts in the transport network.

If we consider the manager in the network management system to be superior at the distributed management level, it is sufficient to form only the $F$-matrix of routing.

Thus, the route parameters at the expense of the agent’s address (code) $\pi_n = \Pi$ and, where possible $c_k \in C_u$, the optimal set of routes in the $M$ control system are expressed as follows $L^* \subset L = \{l_j\}$.

From the set $L^*$ is constructed a privileged obscure matrix with the following appearance:

$$
\begin{pmatrix}
 l_1 & l_2 & l_3 & \ldots & l_j \\
 l_1 & 1 & a_{i2} & a_{i3} & \ldots & a_{ij} \\
 l_2 & a_{21} & 1 & a_{23} & \ldots & a_{2j} \\
 M_n^l = l_3 & a_{31} & a_{32} & 1 & \ldots & a_{3j} \\
 \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\
 l_q & a_{ql} & a_{q2} & a_{q3} & \ldots & 1 \\
\end{pmatrix}
$$

(1)

Here is the $M_n^l$ correlation matrix of the routes; $\pi - \pi$ parameter index $l_j \in L$, the degree of connection of preferential routes, determined by an expert in the network; $a_{ij}$ – the numerical value of the belonging function.

$$
\mu_R(l_q,l_j) = \text{not worse } l_j,l_q,l_j \in L, a_{ij} \in [0,1].
$$

(2)

In addition, a preferential $B_{lk}$ reflex matrix for conditional $c_k \in C_u$ route parameters is constructed on the basis of $\pi_n = \Pi$ the defined a priori database:

$$
\begin{pmatrix}
 \pi_1 & \pi_2 & \pi_3 & \ldots & \pi_j \\
 \pi_1 & 1 & b_{i2} & b_{i3} & \ldots & b_{ij} \\
 \pi_2 & b_{21} & 1 & b_{23} & \ldots & b_{2j} \\
 M_k^\pi = \pi_3 & b_{31} & b_{32} & 1 & \ldots & b_{3j} \\
 \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\
 \pi_q & b_{q1} & b_{q2} & b_{q3} & \ldots & 1 \\
\end{pmatrix}
$$

(3)

Here is $\pi_n$ - the current parameter $c_k$ of the route; $b_{ij}$ - digital value of the belonging function

$$
\mu_R(\pi_i,\pi_j) = \text{not worse } \pi_j, i, j = 1, n, b_{ij} \in [0,1].
$$

(4)

It is then necessary to link the matrices (1) and (3) and decide on the most optimal route to deliver the information to the recipient, i.e. to create the following matrix

...
\[
l_1 \quad l_2 \quad l_3 \quad \ldots \quad l_j \\
\pi_1 \quad \alpha_{11} \quad \alpha_{12} \quad \alpha_{13} \quad \ldots \quad \alpha_{1j} \\
\pi_2 \quad \alpha_{21} \quad \alpha_{22} \quad \alpha_{23} \quad \ldots \quad \alpha_{2j} \\
M_k^j = \pi_3 \quad \alpha_{31} \quad \alpha_{32} \quad \alpha_{33} \quad \ldots \quad \alpha_{3j} \\
\ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \\
\pi_q \quad \alpha_{q1} \quad \alpha_{q2} \quad \alpha_{q3} \quad \ldots \quad \alpha_{nj} \\
\]

(4) Each row of the matrix is \( \mu(l_j) \in [0,1], \alpha_{nj} \in [0,1] \) - an improper set with the \( \cdot \) - relationship function \( L_{kn} = \langle \pi \rangle \) set of possible routes under the condition of the parameter \( > \), where \( j \) is the current index, \( k \) is the index of the \( c_k \) state.

(4) Each row of the matrix \([82]\) is a compression of a matrix of type (4) according to the algorithm.

Step 1. A matrix that is strictly acceptable on the basis of a matrix of type (1) is constructed by the following expression

\[
R^S = R^p - (R^p)^{-1} \\
\mu_R(x,y) = \max_{x,y \in L} (0, \mu_R(x,y) - \mu_R(y,x)).
\]  

(5)

Here \( R^p \) - the indefinite relation is the \( R^p = M^d \) indefinite relation of privilege; \( \cdot (R^p)^{-1} \) - feedback; \( R^S \) - inexplicable connection of strict privilege; \( x,y \)-values are the same variables of \( l(\text{route}), l_j \in L \).

Step 2. Fillers are obtained from (5)

\[
\overline{R} = 1 - R^S \\
\mu_{\overline{R}}(x,y) = 1 - \mu_R(x,y).
\]  

(6)

Step 3. A non-dominant alternative non-dominant subset is defined, (1) \( M_k^j \), multiplication of the matrix is performed in the form of the following line

\[
\mu_R^{\ell\ell}(y) = \min_{y \in L} \left[ 1 - \mu_R(x,y) \right], \ y \in L, \\
\]

(7)

or

\[
\mu_R^{\ell\ell}(y) = 1 - \max_{x \in L} \mu_R(x,y), \ y \in L, \ i = 1, n.
\]  

(8)

As a result of operations (5) - (8), an ambiguous relationship matrix (2) is formed.

Then, according to the algorithm, an indefinite relationship matrix is formed on the basis of matrices (2) and (4).

Step 4. The max-min composition of the matrices (4) and (3) is obtained

\[
R_k = M_k^j \circ M_k^S \\
\mu_R(l_i,l_j) = \max_{x,y \in L} \left[ \mu_{M^j}(l_i, \pi_j), \mu_{M^S}(\pi_i, \pi_j) \right].
\]  

(9)

(10)

Step 5. \( R_k \) is represented from the matrix (9) as an obscure subset of non-dominant alternatives (7) or (8). Thus, \( L_k \subseteq L \) the possible routes of the system in the \( k \)-network mode with the subset set belonging function are found

\[
\mu_{L_k}(l_j / \pi_1, \pi_2, \ldots, \pi_n),
\]  

(11)

according to the parameter condition \( \pi_j, i = 1, \ldots, n \).
Step 6. According to expression (3), the most optimal route in the management network is determined. Then (4) is compressed in the row-matrix according to the algorithm obtained from the matrix \( \mu \) and is represented by the most optimal route according to the rule

\[
I_k^* = \arg \max_{l \in L} \mu(l_j / \pi_1, \pi_2, ..., \pi_i).
\] (12)

Here \( \mu(l_j / \pi_1, \pi_2, ..., \pi_i) \) - relationship function \(< \pi_1, \pi_2, ..., \pi_i>\) area of possible routes \( L \) under parameter condition \( >\); \( I_k^* \) - the most optimal routes on the \( k \)-position in the network.

3. Conclusion

The main features of the traffic flow were identified and the concept of the basic diagram was introduced. This allows you to control and manage traffic flows.

The mechanism of congestion was studied. At the intersection with heavy traffic, the issue of minimizing the total duration of vehicle delays was formed. This will allow to classify the problems to be solved in the framework of transport infrastructure activities, to determine the strategy and tactics of synthesis of intelligent transport systems.

At the node of the transport network, as well as the problem of modeling traffic management strategy in the network, a classic obscure control module has been developed.

In order to determine the parameters of traffic flow control at the node of transport networks, a vague rule base was developed, and a rule of conformity of the control parameter to a particular class and a vague rule base were proposed. This allows congestion forecasting and prevention.

4. References

[1] Sai V M, Brusyanin D A 2014 Estimation by the method of linear reconciliation of particular criteria of options for the route network of passenger traffic. V 10 p 63–72
[2] Fosgerau, M. 2015 The Valuation of Travel Time Variability, Quantifying the Socio-Economic Benefits of Transport
[3] Venables A J 2016 Incorporating Wider Economic Impacts within Cost-Benefit Appraisal, Quantifying the Socio-Economic Benefits of Transport
[4] Yakimov M V 2013 Transport planning creation of transport models of cities p188
[5] Ortuzar J D, Willumsen L G 2011 Modeling Transport p 594
[6] Zyryanov V, Feofilova A 2014 Evaluation parameters of re-routing
[7] Zyryanov V, Feofilova A Simulation of evacuation route choice p 740–745
[8] Trofimenko, Yu. V. 2013 Transport planning: the formation of efficient transport systems in large cities p 447
[9] Sizy S V, Vikharev S V, Brusyanin D A, Nizovtseva I G 2013 The method of forming the optimal route network of regular passenger transport V 3 p 73–79
[10] Muhammediyeva D T and Sayfiyev J 2019 Approaches to the construction of nonlinear models in fuzzy environment 1206
[11] Sotvoldiev D, Muhammediyeva D T, Juraev Z 2020 Deep learning neural networks in fuzzy modeling 1441
[12] Muhammediyeva D K 2020 Study parabolic type diffusion equations with double nonlinearity 1441