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FUZZY AND NEURAL METHOD BASED ON AGENTS CLUSTERING USED FOR A LOGISTIC SYSTEM

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Abstract: Transport optimization is in the focus of many studies, which aim at cost minimization, maximization of transported cargos, minimization of delivery time. Although there are many internet-based systems, which facilitate transport service searching, very few of them are integrating transport optimization algorithms. Our study presents a part of the project's results, including some solutions regarding transport optimization based on clustering of transport service providers and clients, using fuzzy and neural methods. These algorithms are meant to be implemented in an internet-based system, which can be used by both clients and transporters in order to maximize their profits.

1. INTRODUCTION

Clustering aim is to reduce the data volume through classification and similar data grouping. Two clustering types can be defined [1], [4], [7], etc: ranking (grading) clustering and partitioning clustering. A lot of clustering algorithms were presented in literature, three of them being selected to be analyzed in this paper: Fuzzy C-means (FCM), Gaussian Mixture (GM) and Self-Organizing Maps (SOM) [5], [6].

University of Oradea is developing a project to create a collaborative logistics network throughout the European road E60. The project goal is to develop organizational models and software capable of providing access and logistical infrastructure to coordinate the use of some SMEs (Small and Medium Enterprises) appropriate structured groups (clusters). From the clustering point of view, two aspects can be considered regarding the collaborative logistic system:

- regarding the transported goods (client point of view);
- regarding the cargo carrier (logistic point of view);

In order to reduce the problem complexity, the goods transportation is considered to be the main aspect of the problem, considering that its optimization could indicate implicitly which transportation vehicle should be used. From a strategic point of view, (anyhow the problem needs to be considered as an inter-correlation between cargo and vehicle) the previously mentioned aspects are important only in the initial phase of the process.

The main logistic parameters, from the cargo point of view, can be structured in four categories:

A. Intrinsic parameters of the cargo.

1. Cargo (goods) type – specifies a certain category defined through properties as: fragility, outage, packing, risk factors, etc
2. Weight – cargo weight;
3. Volume – package volume;
4. Divisibility – specifies if the cargo may be divided into multiple parts so multiple vehicles can carry it.

B. Cargo parameters related to carrier vehicle.

1. Suitability degree of the carrier vehicle – represents the level of the carrier suitability for the cargo, so it could reach the destination in optimum condition;
2. Charging degree – specifies the cargo weight related to the loading capacity of the vehicle;

3. Loading degree – specifies the level of pre-existent loaded goods relative to the maximum load capacity (volume) of the vehicle;

C. Cargo parameters related to the pre-existent loaded cargo.

1. Compatibility degree – specifies the extent to which the previous loaded cargo is compatible with the one that is going to be loaded in the same vehicle.

D. Logistic parameters

1. The shipment costs – specifies the global shipment cost, including any other costs that may occur: distances, fuel, stationing costs, insurance cost, and so on;

2. Fulfillment degree of the planning – specifies the extent to which the transportation schedule is respected and if loading-unloading activities can be included in this schedule. Rescheduling may affect shipment costs.

A general scheme of these parameters correlation is presented in fig.1.

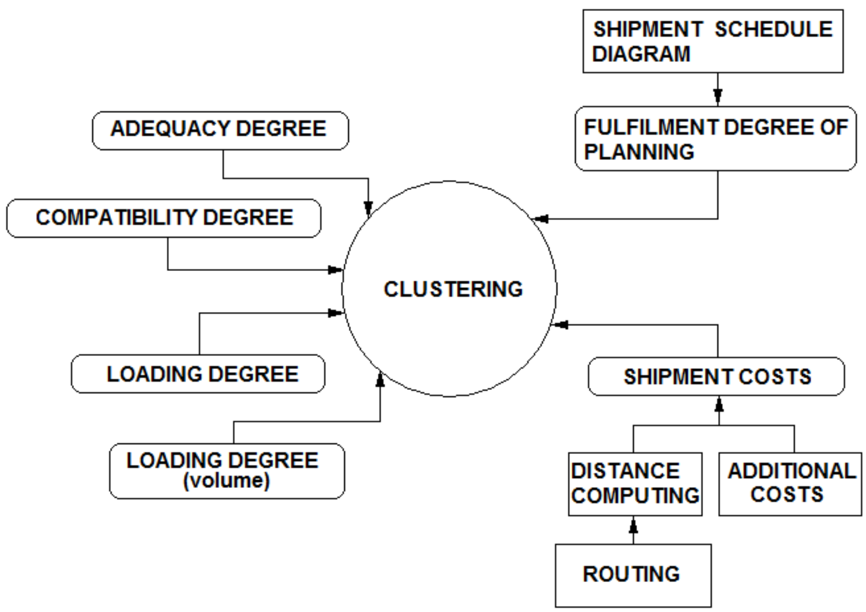

Figure 1. Relational schema of the clustering parameters

Figure 2 shows the spatial distribution of the logistic components specifying the suitability of the vehicle for a certain client (different nuances in color), indicating the multidimensional aspect of the problem. In this case, clustering based on two inputs is useful: suitability and shipment costs (computed considering the distances). Figure 3 presents the relation between pre-existent loaded cargo (transport no. 1) and the demanded transport (transport no.2). The diagram shows the time frames in which loading-unloading activities may take part, considering that between two consecutive loading-unloading activities enough time is provided for the trip. These diagrams are useful to establish the fulfillment degree of the planning.

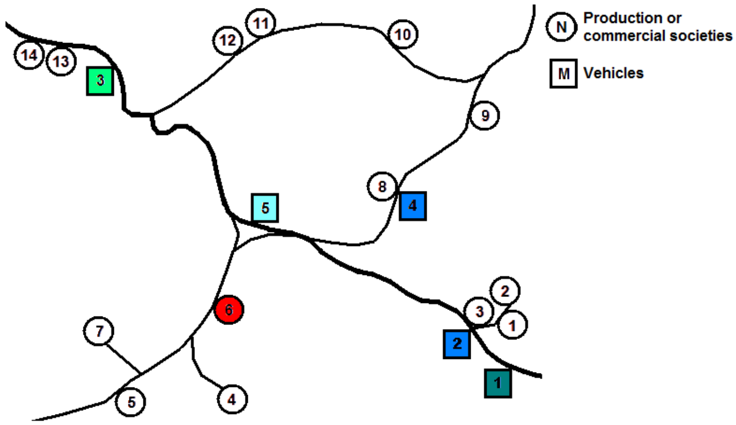

Figure 2. Spatial distribution of the logistic system elements and the suitability degree of the vehicles for client no.6

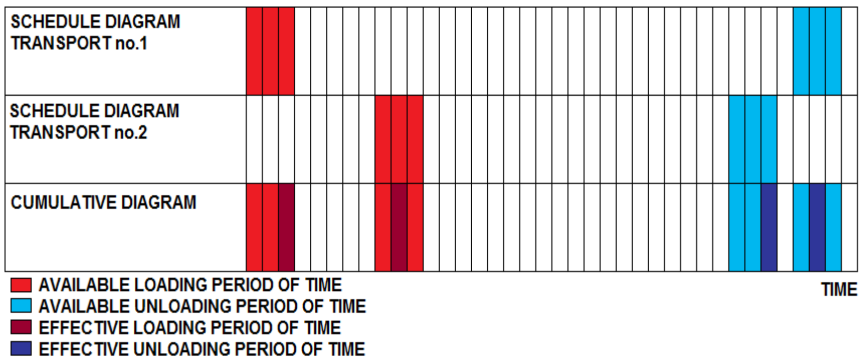

Figure 3. Transport scheduling diagram

2. CLUSTERNG SELECTION METHOD

The following aspects need to be taken into account in the activity of clustering method selection:

- multidimensional analysis – considering the fact that simultaneous parameter evaluation is needed;
- possibility of relationships between object creation including com-posed objects like cargo – vehicle – pre-loaded cargo;
- dynamic creation of cluster number without previous definitions;

For the creation of the program modules, the following elements are needed:

- a simple way of clustering algorithms defining, using the IDE functions;
- the establishment of the parameter needs to be as short as possible (useful for the ease of soft changing);
- the IDE needs to offer quick result visualization capabilities;
- after testing and validating, the algorithms need to be easily translated in programming language used to create the logistic system modules.

Analyzing some programming media, MATLAB was selected to develop the clustering algorithms, due to its programming facilities and libraries.

Considering this, the methods selected to solve the collaborative logistic system are:

a. FCM (Fuzzy C-Means) method;
b. GM (Gaussian Mixture Model) method;
c. SOM (Self Organizing Maps) method.

3. EXPERIMENTAL INFORMATIONAL SYSTEM

An experimental information system (EIS) whose general scheme is shown in figure 4, was made to validate the information component of collaborative logistics system.

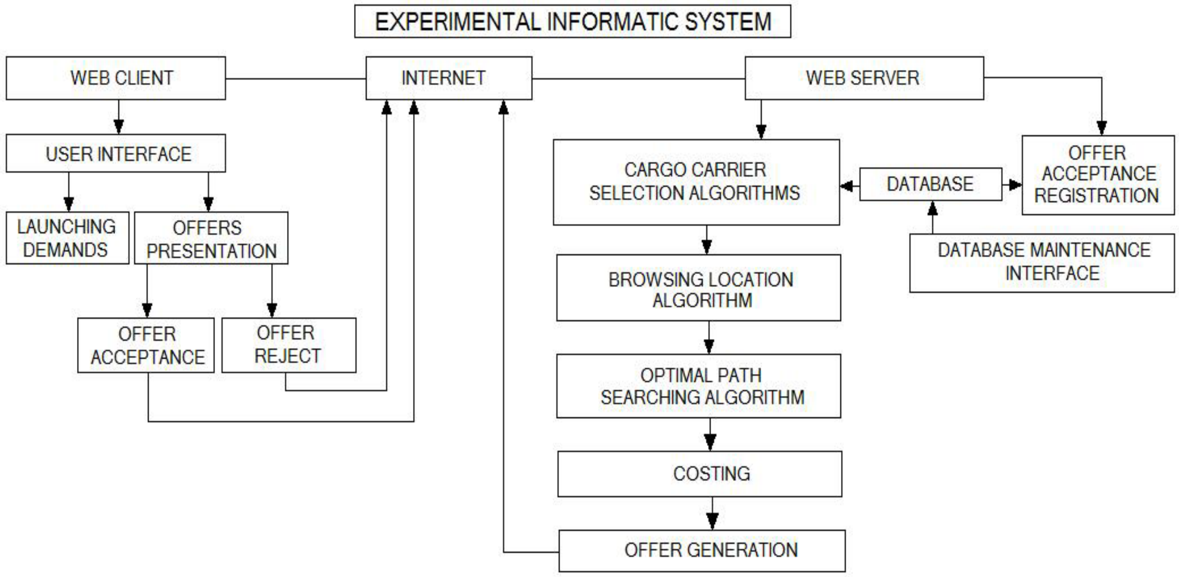

Figure 4. The principle scheme of the experimental information system

On the client branch, the WEB APPLICATION CLIENT manages the operation user interface that allows launching of applications and submission of tenders. In the user interface, the customer enters the system transport parameters:

- type, volume and the weight of the cargo;
- the sender and receiver locations;
- time of shipment;

After necessary data are introduced, the client launches online the request through which the transport parameters are being delivered to the server. When the query is done, the client has the possibility of either accept or not the offer.

On the server branch, the WEB APPLICATION SERVER, at the same time with the client's query, analyzes the transport parameters with the help of the CARGO CARRIER SELECTION ALGORITHMS module. This module searches the carrier database and selects the available carriers suitable for the cargo (volume, weight, time of shipment, route, vehicle, capacity and so on). If sufficient space is available on a partly loaded carrier and the goods characteristics fit those of the carrier specificity, that carrier is selected and its route is being recomputed.

After this step the route is calculated inside the BROWSING LOCATION ALGORITHM module. This module offers as the result a matrix which consists of the locations that needs to be reached. Algorithm selects routes that match orders for loading and unloading (including shipping and destination locations) of all possible routes (obtained as a matrix of permutations of the number of locations).

Once set correct paths using the minimum path are calculated using search algorithms (OPTIMAL PATH SEARCH ALGORITHM MODULE). For the case of this experimental information system a variant of A* algorithm (and the Dijkstra algorithm) are used.

After finding the optimal path, costing algorithm is achieved by a linear sequence (COSTING), then generates details of supply: cost, route, time of shipment - delivery (OFFER GENERATION), which is sent to customer, using the two web applications user interface. If the user accepts the offer it is recorded (OFFER ACCEPTANCE

REGISTRATION) in the database. The database is dynamic, being updated every time an offer is accepted. This structure is managed by the DATABASE MAINTENANCE INTERFACE module.

4. CONCLUSION

Considering both the advantages and disadvantages of the clustering methods described in the paper and the nature of logistic system parameters, there are three-candidate methods possible to use:

- FCM (Fuzzy C-Means) method;
- GM (Gaussian Mixture) statistic method;
- SOM (Self-Organizing Maps) method.

Each of them can solve, theoretically speaking, the clustering problem for the objects defined in the collaborative logistic system.

The FCM method needs time resources to accomplish. Because of this, a single step primary subtractive clustering is applied, in order to achieve initial clusters and centers. In this case, the objective-function is the distance from an object to the centre of the cluster and needs to be minimized. The GM method, similar to K-mean method uses an iterative algorithm, which converges to a local minimum, and is suitable for applications in which the clusters have different sizes and inter-correlations. SOM is widely used in data analysis and engineering problems solving. Its main advantage consists in the fact that it uses a learning process to create a nonlinear regression of a structured set of referential vectors. Maps are suitable to display objects grouped in clusters and, consequently, the cluster density in certain regions of data space.

As a conclusion, the steps needed to achieve the final clustering algorithms are:

1. Logistic input datasets and data packages used for algorithms learning, testing and validation finishing;
2. Learning, testing and validating stages for the algorithms. Result analysis;
3. Dataset redefining, to avoid algorithm specialization for data input narrow domains; insurance of solutions convergence;
4. Clustering program creation, in its final version and the integration in the logistic informational system;
5. Results evaluation and clustering program improvement.

Regarding the transport optimization (routing process), the A* and Dijkstra algorithms were used, due to the fact that they offer better results for the relative limited area situated in the neighborhood of the E60 road.

In this paper is presented the aspects related to the PN II 71-075/2007 grant. In side of SIRLC

Project is proposed conceiving and realizing of an informational system for a cooperative logistic network which is worshiped for SME`s located among the Romanian driveway of E60 European Highway.

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