LOGISTIC EXPERT SYSTEMS AND ARTIFICIAL INTELLIGENT IN ELECTRIC POWER

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ABSTRACT

The paper considers artificial intelligent application for the solution of the tasks of electric power supply. It analyses logistics systems, decision making, expert systems, and types of multi-agents applications in electric power supply systems.
This paper reviews some questions, witch are connected with electric power supply company expert group decision making in logistic processes field, using artificial intelligent methods and tools. It this paper is paling special attention for the expert group consultant activities in the client serving.
The expert group consultant functions in the serving of database.
The expert group consultant activities and functions in the capsule the information by technical condition of processes and example – of the cooperation of expert group in global network environment with technical processes in company. There is an analysis of the results of mentioned system by dispersion analysis data.
The main part of given project is use of dispersion analysis in the organization of power supply process optimization.

INTRODUCTION

This paper is devoted to the observation of the methods, it analyses a complex structure of the models for electric power supply in the global network. The expert group interaction between themselves and complex of power supply process for the staff models software agents characteristics are considered. The formalized target setting of the model investigation is demonstrated. It is demonstrated in the work that for the solving of the task of software agent modeling the models of management goals, management process and multicriterial evaluation are necessary to be elaborated. For the development and investigation of the software agents models of electric power supply a complex of nine mutually co-ordinated models is investigated in the paper:
- A functional model of feedstock supply system is shown - Sum;
- Functional model of the transport system for resources delivery to the electrical power producers - Stm;
- Model of electrical power supply to the consumers - Sem;
- Model of electrical energy consumers behavior in the conditions of liberal electrical power market - Spm;
- Model of software agents which interaction with the model of feedstock supply systems solves the task of optimal feedstock supply to power systems - Au;
- Model of software agents which interaction the model of transport system solves the task of optimal feedstock supply to power systems - At ;
- The model of software agents which solves the task of electric power supply to the consumers - Ae;
- The model of consumers software agents which takes into account priority of the consumers, reaching the goals of the real expert groups - Ap.

The model of Supra software agent which provides the reaching of the goal nominated by the expert group with the help of software agents in the processes of electric power supply is analyzed in the work.

TARGET SETTING

Expert group making decision, about the task of optimal feedstock supply to power systems.
In the evaluation of the given project efectivity a group of three experts takes part. The experts evaluate feedstock supply routes according to the following criteria:
- Price og the route
- Maximum speed of the vehicle
- Technical safety of the transportations

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METHODOLOGY AND TECHNIQUE

Optimal feedstock supply for power station in the Baltic region (fig.1) software for the agent models development and investigation are analysed in the interrelation of nine models, power systems, software agent models, which together with transport solve the problem of optimal raw materials delivery to the power systems, reaching the goals of real expert groups, Supra expert groups

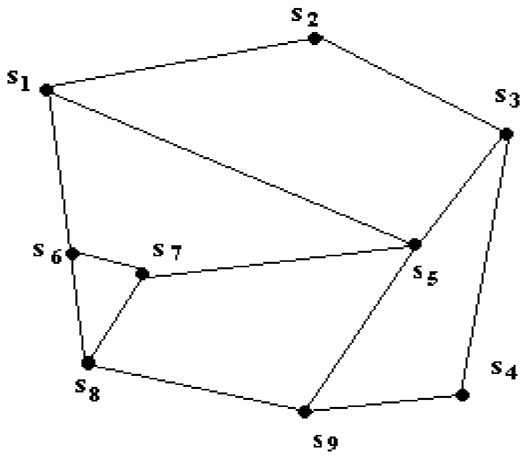

Figure 1. att. Elektroenerģijas lielākie ražotāji Baltijā.

Which take into account the goals of the expert group, providing the realization of consumers aims in an uninterrupted regime. The interrelation of the expert group is in Fig.2.

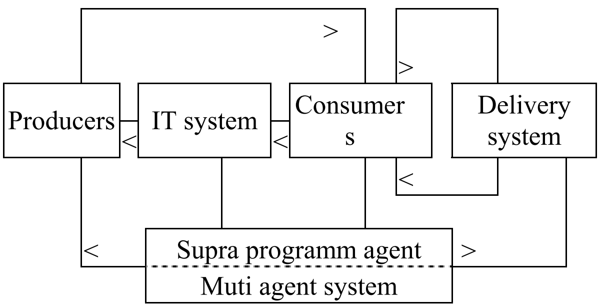

Figure 2 Interrelation of the sytem.

PROCEDURE OF EXPERT GROUP MANAGEMENT GOALS

1.part. The expert group management goal definition; 1.step. Asking for management goal Z_i definition; 2.step. Input goal Z_i definition (text not longer than gs symbols); 2.part. Objects set *B* representation; 3.step. Asking for set *B*; 4.step. Input $Z_i \in Z$; 5.step. Test $Z_i \in Z_0$; If yes go to 8.step; If no go to 6.steo; 6.step. Inform Z_i in not accepted; 7.step. Define $i=i-1$. 8.step. If set *B* is input, then go to 9. step; If no then define $i=i+1$ and go to 4.step; 3.part Representation of set *W*; 9.step. Asking for set *W*; 10.step. Input $w_i \in W$; 11.step. Test $w_i \in W_0$; If yes goto 14.step; If no go to 12.step;12.step. Inform w_i is not found; 13.step. Define $j=j-1$; 14.step. If *W* is input, go to 15.step; If no, define $j=j+1$ and go to 10.step; 15.step. The end of the algorithm operation.

TASK SOLVING

There are seven variants of routs suggested F1-F7 (1.tab). Evaluating each route variant an expert makes a decision, the results of the decision making could be demonstrated in the type of the following tables, where horizontals are the routes variants and verticals are the each expert's evaluation of each variant, sign "-" means that this expert did not evaluate this variant. E` means an average result.

1.tab. seven feedstock supply routes variants

	F1	F2	F3	F4	F5	F6	F7
E1	1,0	-	-	-	-	0,125	0,5
E2	0,125	-	0,5	0,5	1,0	-	-
E3	-	0,25	-	-	0,125	1,0	0,5
E`	0,563	0,25	0,5	0,5	0,563	0,563	0,5

Presentative of the expert group defines by Pseido Grandi function for how many points this route is worse than an ideal one with all the carriages and loading technologies, the ideal transporting conditions could be shown in the following way:

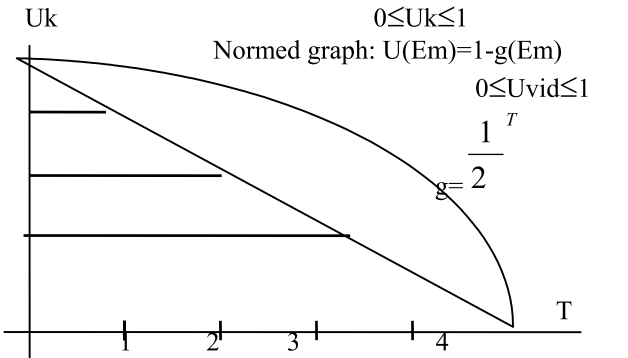

Figure 3. Evaluation of alternative by Pseido Grandi function

At the beginning of the coordinates there is an ideal route and point 1 means that the given alternative is one grade worse than the ideal one, according to this technology a numerical evaluation of each alternative is done. The given data of the expert evaluation (verticals of the graph) have been obtained for the best variants 1,0 and then for the next best station variant 1,00/2, etc. The graph of the solution is the following:

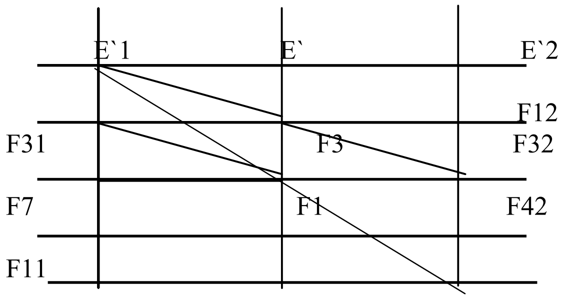

Figure 2 task decision

The given variants of the evaluation follow the evaluation of the route effectivity according to the to the conventional blocks of mehods. At the moment of the decision making experts or responsible persons for the organization of the transportation process take part.
Tādejādi piemērotākais risinājums būs maršruta F3 variants.
The group of experts can give a recommendation to use route F3. the given analysis is needed for evaluation of the route, if the decision of the experts is not univalent. The methodology can be used for the analysis of the other questions.

APPLICATION OF THE DISPERSION ANALYSIS

Let's analyse factor A k at the levels of A_1, A_2, …, A_k. for simplification we will assume the number of the observations at all the levels of factor A is n.

The result of the observations at the j level is marked with x_{1j}, x_{2j}, ,x_{nj}.

The results of all the observations we will sum up in table 2.

Table 2

Number of the observation Nr	Level of factor A						
	A_1	A_2	…	A_j	…	A_k	Σ
	x_{11}	x_{12}	…	x_{1j}	…	x_{1k}	X'_1
2	x_{21}	x_{22}	…	x_{2j}	…	x_{2k}	X'_2
…	…	…	…	…	…	…	…
i	x_{i1}	x_{i2}	…	x_{ij}	…	x_{ik}	X'_i
…	…	…	…	…	…	…	…
n	x_{n1}	x_{n2}	…	x_{nj}	…	x_{nk}	X'_n
Σ	X_1	X_2	…	X_j	…	X_k	

In this table

$$X_j=\sum_{i=1}^{n}x_{ij}\ ,\quad X'_i=\sum_{j=1}^{k}x_{ij} \tag{1.}$$

$$x_{ij}=x_0+\Delta A_j+\Delta X \tag{2.}$$

where x_0 – the real value of the X , ΔA_j - amendment, defined by influence of factor A at the j - level, ΔX – error defined by uncontrolled factor influence. Then we will consider that ΔX distribution is normal and is not depend on ΔA_j.

We will mark j – that level observation average value $\overline{x_j}$, but all the observation with $\bar{\bar{x}}$.

Now we can define all the observed statistical dispersion

$$S^2 = \frac{1}{kn-1}\sum_{i=1}^{n}\sum_{j=1}^{k}(x_{ij}-\bar{\bar{x}})^2 = \frac{1}{kn-1}[\sum_{i=1}^{n}\sum_{j=1}^{k}x_{ij}^{\ 2} - \frac{1}{kn}(\sum_{i=1}^{n}\sum_{j=1}^{k}x_{ij})^2] \tag{3.}$$

Thies dispersion cdefines uncontrolled variable factors and factor A.

As at the level A_j (j=1,2,…,k) of each factor A there are n observations or parallel observations, it is not difficult to evaluate the influence of the factors on the observation results, as verable value X statistic dispersion S^2_j of the factor A at the j level defines only uncontrolled variables (dispersion of factor A is constant). Statistic dispersion S^2_j canbe calculated with formula

$$S^2_j=\frac{1}{n-1}\sum_{i=1}^{n}(x_{ij}-\overline{x_j})^2 \tag{4.}$$

where $\overline{x_j}=\frac{X_j}{n}$

Let's assume that between the dispersions S^2_j(j=1,2,…,k) there is no important difference. In this case we can use dispersion S^2_j to obtain more precise general dispersion $D_0(X)=\sigma^2_0$ evaluation S^2_0, defined with folmula

$$S_0^2=\frac{1}{k}\sum_{j=1}^{k}S_j^2\ \frac{1}{k(n-1)}\left[\sum_{i=1}^{n}\sum_{j=1}^{k}x_{ij}^2-\frac{1}{n}\sum_{j=1}^{k}\left(\sum_{i=1}^{n}x_{ij}\right)^2\right] \tag{5}$$

Knowing the statistic dispersions S^2 un S^2_0, factor A could approximately define A dispersion $D_A(X)=\sigma^2_A$. Taking into account that dispersion S^2_0 defines the uncontrolled variable factors, but S^2 defines the uncontrolled variable factors and factor A we can write an approximate expression

$$\sigma^2_A\approx S^2-S^2_0. \tag{6.}$$

Evaluation (6.) is very approximate. Factor A could more precisely defined taking into account that separate observation x_{ij} dispersion is n times more than dispersion of the average value $\overline{x_i}$. In other words average value of the separate level $\overline{x_j}$, which dispersion is n times less that separate observation dispersion, ia more sensible to the influence of factor A. Taking into account all mentioned above:

$$\sigma_A^2\approx\frac{1}{k-1}\sum_{j=1}^{k}(\overline{x_j}-\bar{\bar{x}})^2-\frac{S_0^2}{n} \tag{7.}$$

Both parts of (5.9.) we will equate to n then we can obtain

$$S_A^2\approx n\sigma_A^2+S_0^2 \tag{8.}$$

For the statistic dispersion S^2_A is k-1 range of discretion. Influence of factor A is considerable only if statistic dispersion S^2_A differs from S^2_0.

The question of the considerable or non-considerable dispersion difference S^2_A, S^2_0 can be clear with Fisher criterion. According to the criterion dispersions S^2_A, S^2_0 differ considerably if

$$\frac{S_A^2}{S_0^2} \rangle F_{1-\alpha}(f_A, f_0), \qquad (9.)$$

NUMERICAL EXAMPLE

Efectivity of transport application can be evaluated with dispersion analysis. Types of the transport are inaccordance with four cargo types. We will consider whether the type of the cargo considerably influences the using factor of the transport.

Table 3. Using factors of the transport types

Type of the trans port veids	Type of the cargo K1	K2	K3	K4
T1		0.35	0.80	0.80
T2	0.65	0.40	0.76	0.95
T3	0.72	0.55	0.79	0.84
T4	0.68	0.47	0.81	0.89
T5	0.69	0.53	0.75	0.93
T6	0.70	0.45	0.80	0.90

Solution: factors A – K1., K2, K3, K4i, - at the levels of factor A. x_{ij} using factor of the transport types.

For calculation of all observations square sum Q_1 Q_2 Q_3 first of all we will consider the necessary data for the these calculations in table 4.

Table 4. Level of factor A levels, valuation of the experts.

i	x_{i1}	x_{i1}^2	x_{i2}	x_{i2}^2	x_{i3}	x_{i3}^2	x_{i4}	x_{i4}^2
1	0.70	0.490	0.35	0.123	0.80	0.640	0.80	0.640
2	065	0.426	0.40	0.160	0.76	0.578	0.95	0.903
3	0.72	0.518	0.55	0.303	0.79	0.624	0.84	0.706
4	0.68	0.462	0.47	0.221	0.81	0.656	0.89	0.792
5	0.69	0.476	0.53	0.281	0.75	0.563	0.93	0.865
6	0.70	0.490	0.45	0.205	0.80	0.640	0.90	0.810
Σ	4.14	2.859	2.75	1.289	4.71	3.700	5.31	4.715

The following calculation are the next: we will apply the following symbols: n - is i maximum value (i =6), k - is j maximum value (k = 4).

$Q_1 = \sum_{i=1}^{6}\sum_{j=1}^{4} x_{ij}^2$ =2.8594+1.2893+3.7003+4.7151=12.56

$Q_2 = \frac{1}{6}\sum_{j=1}^{4} x_j^2$ =12.51

$Q_3 = \frac{1}{24}[\sum_{i=1}^{6}\sum_{j=1}^{4} x_{ij}]^2$ =

$= \frac{1}{24}$ (4.14+2.75+4.71+5.31)^2=11.91

Statistic dispersion :

$$S_0^2 = \frac{Q_1 - Q_2}{k(n-1)} = \frac{12.56 - 12.51}{4(6-1)} = 0.0025$$

$$S_A^2 = \frac{Q_2 - Q_3}{k-1} = \frac{12.51 - 11.91}{4-1} = 0.2$$

The level of importance α=0.05. An expected probability is β=1-α=-0.5=0.95. Ratio $\frac{S_A^2}{S_0^2} = \frac{0.2}{0.0025} = 80$. In the given case Fisher distribution $F_{1-\alpha}$ (3;20)=3.10. As $\frac{S_A^2}{S_0^2} \rangle F_{1-\alpha}$ (3;20), it can be concluded that type of the cargo considerably influence the using factor of the transport types.

Calculation of the dispersion evaluation of factor A:

$$\sigma_A^2 \approx \frac{S_A^2 - S_0^2}{n} = \frac{0.2 - 0.0025}{6} = 0.033$$

We can say that with probability 0.95 the cargo considerably influence the infill factor of the transport types.

According to the results of the experiment we can say that there is a considerable influence of the cargo type as well as difference of the given means of transport.

CONCLUSIONS AND FURTHER RESEARCH AND RECOMMENDATIONS.

Scientific novelty of the research covers the following aspects of the work: The task of the development of the software agents modelling methods for the logistic systems of electric power supply in the situation of global networks has been formulated. Operation methods and procedures of multicriterial software agents in risky conditions have been developed. Procedures of evaluation for Supra agents formalized goals models are developed: for consumers profile choice; for making of feedstock supplying schedules; for the expert commissions forming and their interaction with Supra agents for logistic expert systems and artificial intelligent in electric power.

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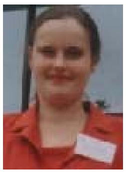

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