ADVANCED DECISION MAKING FUNCTIONS AND SOME METHODS OF INFORMATION PROCESSING FOR SOCIO ECONOMIC CLUSTERS

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Abstract*: New organizational and algorithmic instruments in the area of municipal (and regional) management are described. There is a brief overview of such tools as effective methods of quantitative decision support and the territorial cluster creation. Also some ideas are presented on how the information exchange between territorial clusters' participants might look like.*

Keywords*: goals of city development, decision grounding, dependent features, territorial cluster.*

ACM Classification Keywords*: H.1 Models and Principles – H.1.1 – Systems and Information Theory – General Systems Theory, I.1.4 Development Simulation.*

Introduction

Problem of large city formation, in its entering the path of rational and harmonious development is, as always, quite important. City, as a very complicate system needs authorities, functions of which are no less complicate than the managed system itself. This take place not only for the municipality, but also for major, for the city council, council of trade unions and for other managing and supervisory bodies.

Let us consider the difficulties that appear in the management of a large city with population of over a million inhabitants, and each of them has own requests and needs.

The work of city authorities involves, as usually, a number of challenges:

• budget planning; legislative aspects;
• distribution of resources (human, financial, material, etc.);
• support the state of operability of urban technical (and other) infrastructure systems;
• planning further optimal development of the city;
• monitoring of the municipality' activity as a complex system;
• creation of the optimal decision making system in urban governance in general;
• political, environmental aspects, social affairs, and much more.

Strictly saying just due to our objects are very complicate, we have to use the system representations, the methodological approach to system analysis, etc. Among these tools and the problems of certain structural-and-functional mechanisms creation, the main stages are: goal-setting, self-determination, primary structurization, etc.

Work with the municipality's goals and some new mechanisms

Almost all directions of municipality's activity can be reflected as the structure with a lot of vectors or directions of work. The main problem here is the great numbers of these vectors are opposite and compete with each other. Such competition is not always useful for the city. Talking about the tree of the aims in the work of the city municipality and the city mayor it is necessary to define two groups of aims:

1) the improvement of the city and people prosperity;

2) the development of the social production, and the increasing of its effectiveness.

Partly these purposes supplement each other, but there are some "tight" places, where they compete with each other, e.g. in getting financial resources, official personnel's attention, human resources, area etc.

For this reason the third aim appears:

3) balances solving of previous two aims: creating of circumstances, strategies and plans. The realization of them could provide the harmonious advancement of society to their aims.

The municipality has to elaborate its own organizational instrument to control the balance of all these divisional parts and for resources distribution between them. All these things have to be done for the reducing of the negative return influence in this system. So, the first step must be to transform the conflict mechanism (confrontation) into the cooperation mechanism, using this type of mediator. And the next stage will be the straight collaboration. The working out of this type of mechanisms has to become one of the first mayor's and municipalities' assignment.

The next key factors can be related to them:

- economical (facilities, bonuses, fines etc.);
- organizational (new structures, agencies, bureaus, associations etc.);
- administrative (orders, regulations, instructions etc.);
- informational (announcements, popularization, clarifications, TV programs etc.);

So, summarizing the main aim of the cooperation between the mayor and municipality in city we must tell that the good and equal collocation of all important structures has to be the result of "the top manager's" work.

Decision making rules for situations both with independent and dependent features

Preliminary Notes

A lot of tasks, due to automatization and algorithmization different kinds of activity, deep computing and so on, – need now the effective decision rules application. There are dozens of works devoted to this problem, among them, particularly, [Banerji, 1978], [Schlaifer, 1979], [Gladun, 2000], [Zagoruiko, 1976], many oth.

There are certain works describing data processing by means special spaces, e. g. [Krissilov V., 1998], [Krissilov, 2005]. It may be seen, that using geometrical explanation and imagination is very fruitful approach in various AI tasks and in complicated data processing.

Various decision functions and rules, that are applied in tasks of pattern recognition and support of the administrative decisions, are constructed in the assumption of independence of attributes (features) being used for description of analyzed and/or recognized objects. Desire to take into account dependence between parameters leads to the very large expenses of time and memory, or, at the best, comes to final fixing, for example, only of pair dependences. Besides it happens seldom when users or developers have the information on real values of dependences features' presence or absence from each other in various processes, classes etc.

At the same time it is difficult to imagine a task, in which the description of analyzed objects is made by means of parameters independent in aggregate. Especially it looks clear by putting medical diagnosis [Popov, 1971], in solving the environmental monitoring tasks, etc. In these last cases, e. g., analyzing a natural situation or estimating anthropogenous influence, the expert operates with such characteristics, as moisture of ground, water table level etc., are dependent from each other certainly.

Then if we have the problem to build full-scale monitoring system (and while another tasks solving) alongside with other means of processing of the information, it is necessary to use decision functions, which are able to take into consideration relations and dependencies between the features without using a big system resources.

Decision Functions working with independent features (1st learning stage)

Let some *k*'s object, having evaluated or recognized, is described by *n*-dimensional vector [Krissilov, 1962, 1984]

$$f_k = \{\nu_1,...,\nu_i,...,\nu_n\},$$

where - $i = \overline{1,n}$ is number of feature;

- ν_i is the measured value of ***i'***s feature in the ***k'***s object.

Dealing with classification problem we can obtain (as result of learning stage) the matrix

$$C_n = \left\| p_{ji} \right\|,$$

where - *j* is number of class;

- p_{ji} is probability of *i*'s feature in *j*'s class.

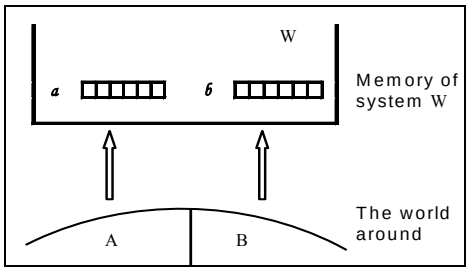

Figure 1. Creation of the memory (1st stage)

So, we see, that objects recognizing have statistical nature. 1st step in learning is shown on Fig. 1.

The pattern recognition stage is provided by means of some decision rules. One of them, namely the rule maximizing a right classification probability [Krissilov, 1984, 2000] can be proposed for our problem solving. This decision function is as follows:

$$f_k \in M_j / R_f = \max_j P(M_j / f_k) = \max_j \prod_i^n p_{ji}^{(\nu_i)}, \quad (1)$$

where - f_k is *k*'s unknown object which must be classified;

- M_j is class with number *j*;
- $P(M_j / f_k)$ is probability of M_j when this concrete set of features f_k is presented;
- $p_{ji}^{(\nu_i)}$ equals to p_{ji} if $\nu_i = 1$, and to $1 - p_{ji}$ if $\nu_i = 0$. And it is probability of measured value ν_i, if the feature isn't binary.

In expression (1) the value R_f, being found as the maximum of the value $\prod p_{ji}^{(\nu_i)}$ for various classes (*j* changes from 0 (unknown class!) up to *S*), – shows the class that can generate the present vector f_k with the most probability, – in a case the features are independent each from another.

But there are a lot of tasks, as it was told, where depending features describe the objects. So we have to construct corresponding decision rule. For these purposes the second learning stage must be introduced.

Decision Function Strengthening (2nd learning stage)

The curves of probability distribution of concrete characteristics of examined objects are applied to this task solution. These curves are obtained as results of the additional training stage by means of the representative choosing of objects/classes should be recognized.

Showing known objects from class M_j to recognizing system, we can find for each f_k the value $x_{kj} = \prod_i^n p_{ji}^{(\nu_i)}$ and fix the probabilities $P(x_{kj}/M_j)$ and organize its memory consequently (see Fig. 2).

Then the following decision rule may be proposed:

$$f_k \in M_j / R_\Sigma = \max_j P(x_{kj} / M_j), \quad (2)$$

-- accordingly this function of decision is made on the ground of a maximum probability of belonging the present input gamma of features (given f_k) to definite class, and comparing these probabilities for all classes.

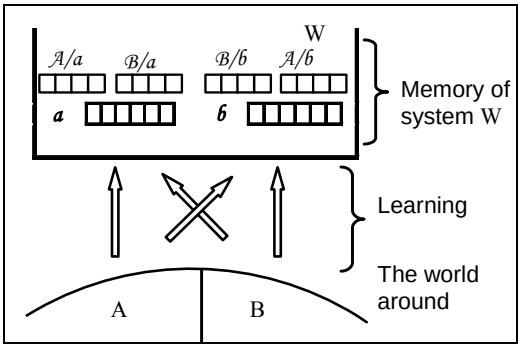

Figure 2. Second learning stage.

It needs to be noted, that we measure in this case the values of probability obtained by using only one line from matrix C_n, – for each class, i. e. using the sample of one class only.

The next our step can be generalizing this approach by means of extending the number of samples, of lines our matrix, being included in process, using for these purposes similar samples of classes and, lastly, all lines from matrix C_n entirely.

Then final version of decision rule looks as follows (in this expression $r = \overline{1,S}$):

$$f_k \in M_j / R = \max_j \prod_{r=1}^{s} \left[P(x_{kr} / M_j) \right]_r \tag{3}$$

Thus we obtained the multidimensional decision function (MDDF) that allows using deeper data in comparison with previous rules of decision, as it is shown at Fig. 3.

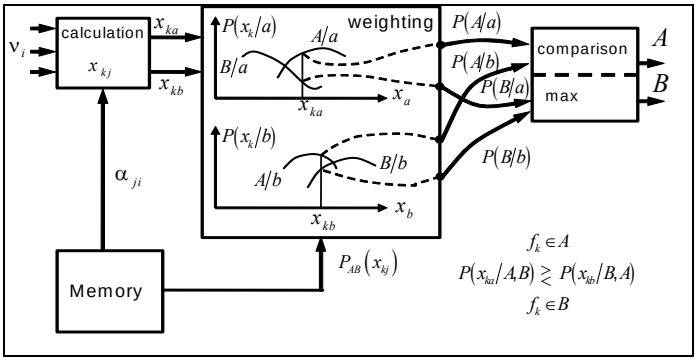

Figure 3. Using the probability distribution curves for advanced decision.

MDDF Interpretation

Multidimensional Decision Function' using and applying corresponding procedures form/build the memory of recognizing system in manner of holographical one, distributed and developed.

Indeed, in cases when decision rule in expression (1) is realized, then each class' sample in memory unit consists information regarding that class. This information is represented by features' probabilities for objects belonging to given class.

When decision function expressed by (2) is realized, then the information which forms each sample becomes more complicated. It includes now the curve of probability' distribution of appearance certain values x_{kj} (results of evaluation) being measured/ weighed on definite line of matrix (with number j) by showing objects from corresponding class. These curves of probability distribution (for all our classes), as it was told, are obtained as results of the additional training stage showing the representative sets of objects/classes should be recognized. And we have for each class one curve only. Decision by (2) is made by means of the finding maximum of evaluation among classes compared, – it is maximum probability of belonging just that combination of features (in this concrete recognizing object f_k) to given class.

And, finally, when rule (3) is used, the sample of each class includes (in form of certain curves of probability distribution) the indices of estimates/assessments x_{kj}, which shows the results of weighing various objects from *given* class *on samples all other* classes. Just this result we obtain in 2nd stage of training.

It looks as if just one object or situation is observed by means of several perception inputs, from different points of view, or is passed in parallel through various filters or prisms (see Fig. 2 and Fig. 3).

It was found some years ago, in certain neurobionic studies that information from *each* mouse' vibrissa on its nose reflects (is sent) not only *in one* corresponding pull of neurons in mouse' brain, but it is in *all of them*; very close to the way being realized in holographic system (see Fig. 4).

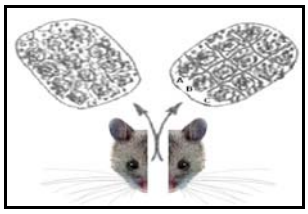

Figure 4. Structure of mouse memory

We may say that increasing of grounding and quality of decision making is got in this case in our decision or assessment system as result of more entire extraction of information about classes should be recognized, about interrelations between classes and latent links between its features. Besides it must be pointed out that such results are obtained due to some fuller and better disposing the knowledge mentioned above when MD Decision Functions in various managerial and control problems are used, due to better use the "context information".

Some Concluding Remarks

Decision functions mentioned above was successfully used by solving various tasks:

- evaluation of the socio-economic level for some administrative territories (life quality);
- comparison of development level for south regions of Ukraine;
- risk assessment and estimation of various protective devices' effectiveness;
- recognition of printed and handwritten letters, either some voice commands;
- data interpretation in geophysical exploration (known task "Oil – Water Recognition");
- medical diagnostics, staff management, and so on.

Interesting and hopeful results were obtained in all tasks listed above ([Krissilov, 1984, 2000, 2007] and other).

The system could recognize the different situations and objects, to make grounded decisions, is able to simulate monitored situations. Some important properties of outworked system were displayed:

- ability of work with qualitative and quantitative features;
- obtaining of aggregated, generalized evaluations for monitored processes, objects or situations in a case of action of various local or depending factors;
- ability of classification of the objects and situations, forecast variants evaluation, to provide support and quantitative decision making.

The territorial cluster

Now let us discuss level of some city objects and social organizations. The increasing of the competitiveness of some factories, municipal structures, and the city as a whole is lying on the way of improvement of the level of their work. The quality of production, service and information has to become the source of the added tax.

How is it possible to achieve it? The answer is the creation of equal competitive possibilities will lead to the searching of the optimal development ways by the city organizations. They will look for the minimization of the consumption, for increasing of labor quality, for attracting of some new clients, their products and service.

The next step is the subsequent development of the competitive enterprises into the harmonious cooperation in the city. The territorial cluster is one of the kinds of the cooperation. It has shown itself as the effective structure.

Making of cooperation will bring the opportunity to increase the reliability and firmness of the functioning of some field. It will also help to continue the innovating activity on the new level, when the enterprises make the combined elaborations to improve the effectiveness of work.

The results of the transformation of the socio-economic situation in the city will be harmonious city development. It will be seen in the evolution of the small business. The city will pass the complicated stages of the development, such as “Confrontation – Competitiveness – Cooperation”. There will be the increasing of the investment and innovation activity level and, the important point? - the socialization of the actions.

Our comprehension of this cluster is it`s the entente cordiale for the territorial feature of the producers with the suppliers. Such collaboration’s aim is to increase the individual and combined economic profit after the satisfaction of their production needs and customer’s inquiries. So, the creating of the territorial cluster means the combining of the manufactures from the different fields and the objects of social sphere.

The municipality in the necessary component of this cluster, which has the important role in the development of the branch on the territorial-administrative level and has certain influence on the working out of the normative – lawful base, which directly regulates the development of the city infrastructure.

The suggested model allows to include not only technical side but to show how active it interacts with the sphere of finances, jurisprudence, social sphere and the local administration [Chumachenko V., 2008].

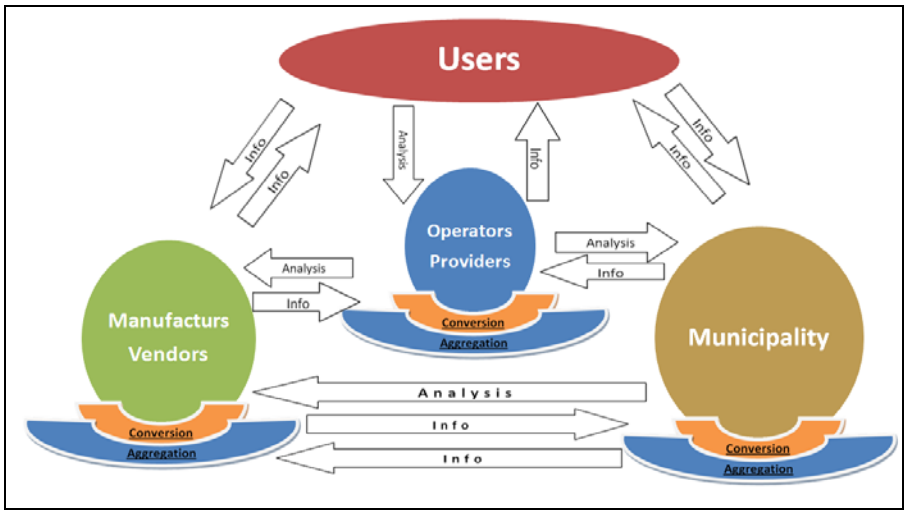

Figure 5. Example of data and documents changing (relatively the model of the territorial cluster)

It is necessary to work in practice the Internet, to implement the liberalization of the telecommunication market, to develop the Internet trade, to make the access to the Global Web for the society, and to increase their level of computer knowledge, especially for young people. All these things are very important for the providing of the city competitiveness in the informational – telecommunication sphere. The information technologies have to favour the local and regional development, the environmental protection and saving of the cultural treasures preservation. These technologies have to provide the access to the information about the working of the body of local executive power and body of local self-government.

Cluster system advantages

Clusters, unlike business systems, connect much bigger number of participants e.g. assistance institutes, producing and commercial structures. So one can see here the producers, suppliers, distributors and regional and national governments.

The level of these advantages increases a lot, combining with new information technologies. The development of clusters is the tool for the rising competitiveness strategy, which is consisted from the standard approaches.

The social part of the economical transformations plays the very important role in the conversion to the new economy. It is necessary to define the aims which are true for the interests of the people. It is also important to get the data for the necessary basis for the mobilization of the social potential in order to get the certain aim.

It is expedient to divide the created cluster for some subclusters, to consider the cluster structure in detail. Such division allows working out the different cluster parts more effective as different subclusters and their members will have different demands and possibilities. The question about the social importance of some objects (administrations, law enforcement, emergency service, ecological organizations and some civil defense sectors) is also very actual. The subsequent improvement of the scheme foresees the participation of the managing stuff to exposure of some particular features in the interaction of definite areas in the territorial cluster.

The elaborated scheme will allow to forecast the social changes more effective, to build the connections between some organizations etc. The cluster approach connected with the economy development is able to rise from the solitary and isolated activity which is fixated only on one project in some period of time, to the stable and integrative process.

The creation of the same information system and its effective exploitation make the cluster advantages much bigger. Except the above-listed advantages we should mention the new forms with the new relationships and structures which lead to the regulation improvement which are the feature of the well-developed system of the market members' interaction. It has the maximum influence on the socio–economic territory development, the increasing of its importance in the city and opening of some new investing ways.

We should mention also that the creation the territorial cluster, not brunch cluster, will become one of the confident steps to the preparation for the self-government territory, authority decentralization. Economic indexes become the stimulus for getting of the economic effect (looking for, elaboration, and saving of information, reducing of the transport cost etc.) stability growth due to the reservation.

The possibility of the creating the territorial clusters in Odessa or Odessa region is confirmed by the effective activity of the Ukrainian clusters and world leaders in the different areas of the industry and service, with the influence of following factors:

- demographical situation (more number of enterprises appears when number of young people is more);
- prosperity (the higher its level the more chances to create the companies which owns the capital or they are able to have it up);
- the level of the professionalism and education and the ways of the working force in the city;
- the good popularity of the small companies in city;
- the infrastructure city advantages, which help to have more infestations for city so on.

Conclusion

We should mention the offered points in creation of competitiveness mechanisms, algorithmic and cluster approaches as a tool of the socio–economic city development will be able to solve a lot of problems. These problems are very actual nowadays for the mayor, for municipality, so they are:

- the increasing of the cooperation effectiveness between government and people;
- improvement of the social-and-economical and cultural city development;
- employment and solving the problem of unemployment;
- increasing the attractiveness of city' investment;
- the use of the information technologies as the way of activity optimization of the local self-government.

The clusterization will definitely lead to the socialization of activity – bringing of the population in the production, increase member' number, creating of the "open" society, which will be satisfied morally, financially and mentally.

It would be wrong to assume that administrative bodies have the easy way to build the new system of municipal management. However they have no alternative but to learn new system methods, to use both new organizational forms and technological instruments, to think radically new way.

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Bibliography

[Banerji, 1978] Banerji R.B. A Language for Pattern Recognition. // Pattern Recognition, No 1. – 1978.

[Chumachenko V., 2008] "Recommendation for territorial clusters creation and its information supply// Proc. of sci. symp. "Independent environ. assessment and evaluation of devel. trends of depressed areas", Odessa, Ukraine, 2008 (rus).

[Gladun, 2000] V. Gladun, N. Vashchenko. Analytical Processes in Pyramidal Networks. // Proc. of 5th Intern. Conf. ITA 2000, Foi-Comm., Vol.7, No. 3. – Sofia, 2000.

[Krissilov, 1962] A. Krissilov "Synthesis method of reading computer device", Inventor's Certificate № 152248, Inv. Bull. № 24, M., 1962; (co-auth. – M. Gliklikh, G. Poddubnyj, rus).

[Krissilov, 1984] A. Krissilov. Algorithms for the Quantitatively Grounded Decisions in Situations under Uncertain Conditions. // Kijev, 1984, «Znanije», 1984, (rus).

[Krissilov, 2000] A. Krissilov, V. Krissilov, A. Shutko. Decision Making Procedures that Operate with Dependent Features and Their Environmental Applications. // Proc. of 5th Intern. Conf. ITA 2000, Foi-Comm., Vol.7, No 4. – Sofia, 2000.

[Krissilov, 2005] A. Krissilov, V. Krissilov Creation of Aim-oriented vector model for complicate socio-ecological objects estimation. // Monogr. "Methods of environm. problems solving", ed. Prof. L. Melnik, Sumy, "Kozatskij Val", 2005 (rus).

[Krissilov, 2007] A. Krissilov, A. Shutko, I. Baryshnikov, B. Kostenyuk. Forming of Geo-Information Environmental Monitoring System for management and harmonious use of ecological Belts surrounding large cities. Proc of International Workshop on Environmental Problem in Metropolitan Cities; Istanbul, Turkey, June 2007

[Krissilov A., 2010] V. Chumachenko, M. Saenko U. Sedova. Intelligent Agent` development as a means of knowledge representing in information and expert systems // Proceedings of the innovative projects competition, Odessa innovative information center "INVAZ", Odessa, Ukraine, 2010 (rus).

[Krissilov V., 1998] V. Krissilov, A. Krissilov et al. Transformation of Object Feature Space Under the Goal of Evaluation. Proc. of Conf. «Infrm. Processing and Manag-t of Uncertainty in Knowledge-Based Systems» – IPMU'98, Paris, 1998.

[Popov, 1971] A. Popov, A. Krissilov et al. On Automation of Medical Diagnostic Procedures // Proc. of IFIP-71 Congress, TA-7, – Nederl., 1971, P.841-847.

[Schlaifer, 1979] R. Schlaifer. Analysis of Decisions under Uncertainty. – McGraw Hill. 1979.

[Zagoruiko, 1976] N. Zagoruiko. Applied Methods of Data and Knowledge Analysis. – Novosib., Math. Inst., 1976 (rus).

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