TRAINING OF MANAGERS WITH DSS SVIR (SHORT REVIEW OF M.SC. STUDENT)

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Abstract: *Decision support systems (DSS) are well-known tools for multicriteria object ranking and selection. Such systems are important not only in practical applications but also for training managers to make decisions under complex conditions. This paper shortly describes a) possibilities of DSS SVIR developped at St. Petersburg State Transport University b) personal experience in laboratory practicum for studying SVIR. This review will be useful for those who teach courses on multicriteria selection and who want to train for making rational decisions.*

***Keywords**: decision support system, multicriteria selection, object ranking.*

***ACM Classification Keywords**: H.4.2 [Information Systems Applications]: Types of Systems – Decision support.*

Introduction

A Decision Support System (DSS) is a computer-based information system developed to solve problems of selection and ranking. When we have only one specified scalar criterion for object evaluation then a usual optimization system can cope with this problem. But in case of complex and informal situations related to decision-making one has to use DSSs. For example, we meet with such problems when we want to find objects for investment or to select a strategy to expand market of given goods. Here complexity is a consequence of variety of attributes and variety of criteria based on these attributes. And informality is a consequence of subjectivity in integral assessment of objects. We can mention here such well-known DSSs as iThink [iThink, http] and Analitica [Analitica, http]. On the Russian market there are two known and accessible DSSs: Pilot [Pilot, http; Semenov, 2004] and SVIR [SVIR, http; Mikoni, 2009a].

Many managers, first of all the managers from large and middle companies, need tools for decision making support. However DSSs are not still as popular among practicians as various optimization systems or systems including optimization procedures. One of the principal reasons (apart from DSS price) is a certain complexity in studying such systems. To get rid of this obstacle two approaches are used. The first one consists in creating a simplified version of corresponding industrial DSS with a set of examples. These examples serve for studying DSS. Such a way is fit for independent study. The second one consists in development of laboratory practicum with corresponding manuals. This laboratory practicum should be studied step-by step independently but under the regular control of a teacher (skilled expert from a company, or a university professor).

The second way is successfully used in the St. Petersburg State Transport University where by this moment many students and Ph.D. students have defended their theses using DSS SVIR applications. They study the theory of multicriteria selection in the course of decision making support and study applications of this theory in the framework of laboratory practicum based on DSS SVIR [Mikoni, 2009b]. In the Russian Presidential Academy of national economy and public administration we study the theory of decision making as a part of the course Data Mining. Some students use in their B.Sc. theses the simplified version of the system Pilot mentioned above. This way proves to be easy for students of economical specialties. The students from the program “Two diplomas” (applied mathematics and economy) select the second way: they implement laboratory works from the laboratory practicum using DSS SVIR. Then they use this experience in their B.Sc. theses. The examples of both types of B.Sc. theses are presented in [Alexandrov, 2013; Mogilyev, 2013].

The purpose of the paper is to pay attention of managers to possibilities of DSS SVIR and to meet them with the laboratory practicum based on this system. I suppose that now DSS SVIR is one of the strongest helpers for those who teach or train to make rational decisions.

The paper is structured by the following way. Section 2 presents the methods of DSS SVIR. Section 3 shortly describes the laboratory practicum based on SVIR. Section 4 includes conclusions.

DSS SVIR

Essential characteristics of the system

The system for selection and ranking SVIR is an instrumental system designed to solve the problems of multicriteria selection. It satisfies the following requirements [SVIR, http]:

- Universality. A universal model of data representation for solving different multicriteria problems is used. Some criteria can be structured as an hierarchy with several levels;
- Ability to use together objective and subjective estimations;
- Autonomy in solving real problems of high dimensionality. The maximum number of objects and attributes is several hundreds;
- Interconnecting with other systems to share data and processing. Ability to import data from a relational database and MS Excel;
- Ergonomics. Ability to manage easily the process of decision making and analysis of results.

Decision making is complicated area. There are no samples of correct decisions for the majority of cases. The main attention should be paid to formulating a given problem, to building tree of goals and, as a result, to creating a model for object selection. Model itself should be confirmed during experiments. SVIR allows one to correct quickly the model.

To solve problems of multicriteria selection one should use several methods and compare their results. SVIR offers a basic set of methods. Cognitive graphics and post-analysis (analysis of attribute contributions, new weights for criteria, etc.) allows one to improve the final selection.

There are two basic types of problems related to multicriteria selection: optimization and classification. They are described below.

Optimization problem

Optimization methods can be divided into two classes: *vector optimization* and *scalar optimization*.

1) Vector optimization on a finite set of objects means revealing objects (alternatives), which have no other objects being better or equal than this one for all its parameters.

The system SVIR includes the following methods of vector optimization:

- Pareto optimization;
- Leximin optimization;
- Optimization by priority criteria (lexicographic optimization).

Pareto Optimization uses the Pareto-dominance relation. It gives preference to one object over the other one only if a) the first object is not worse than the second one for all criteria; b) at least one criterion of the first object is better. When this condition is true then the first object is considered to be dominant, and the second one-dominated. The result of Pareto optimization is a ranked graph showing the ratio of Pareto dominance on a set of objects.

Figure 1 illustrates the example of such dominance graph. This graph can be characterized by 4 parameters: dominance, indistinguishability, incomparability and order completeness coefficient. The upper level of the graph forms a Pareto set. Ranking objects by means of the number of links can be used to increase the completeness of the order. Preference is given to the elements of ranged graph that have the minimum number of entering arcs and the maximum number of outgoing arcs. Note. In this moment there are russian and english versions of interface. In this paper the russian version is used.

Leximin optimization is based on the principle of criteria indifference. The order of criteria can be changed for different objects in various ways. Estimates of each object are ordered by quality. The necessary condition for reordering is the equality of scales of all attributes, so here the normalized scale [0, 1] can be used.

Optimization by priority of criteria (lexicographic optimization) is used when the information about importance of criteria is available and estimated in a rank scale. Unlike leximin optimization now the estimates are reordered by criteria priority for all objects together (in leximin optimization the objects were ordered on descending sort and they were considered separately). Further multidimensional sorting guarantees full linear order of the objects.

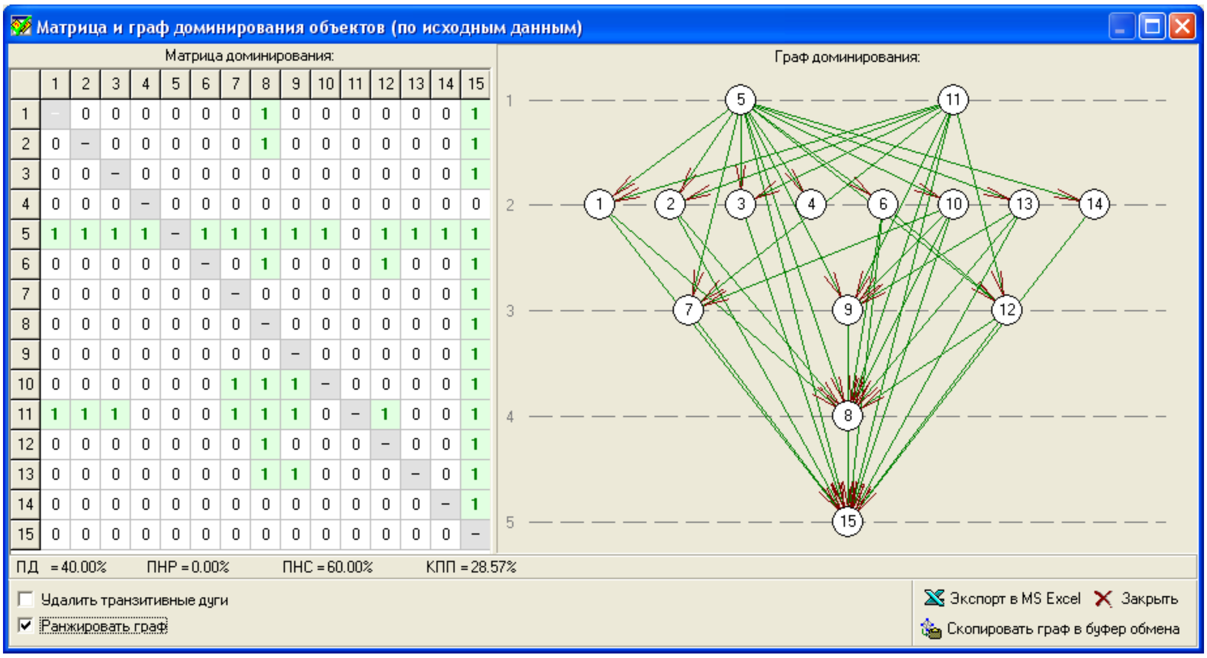

Figure 1. DSS SVIR interface. Dominance graph

2) *Scalar optimization* is based on the transformation of vector of estimates to a number (scalar). Having these numbers one can set a linear order of objects.

For this purpose the following aggregate functions are used:

- Weighted sum of normalized criteria;
- Average geometric criteria evaluation;
- Multiplicative function with additional cofactors;
- Multiplicative function with factors in the degree of criteria importance;
- Maximin function of criteria.

Scalar optimization can be used either on values of criteria or on deviation of these values from target values. Not only the type of aggregate function is important, but also criteria significance and scale. Because this information should be determined by experts, scalar optimization in multidimensional space cannot give the only one correct result.

Classification problem

The system SVIR aids to solve the following classification problems:

1) Selection of objects that satisfy specified requirements: all objects are divided regarding specified requirements into two classes: admissible and inadmissible objects. There are two types of such selection:

- Selection of non-dominated objects (based on the ratio of Pareto dominance);
- Selection with constraints.

If the feasible set of objects is empty then it is necessary step-by-step to reduce requirements for attributes. This problem can be solved by choosing softer constraints by trial and error. Solution of the problem can be simplified by using the scalar optimization method on deviations from the target values of attributes. It allows finding the object that responds to the most to specified goal, even if it is unattainable.

2) Multicriteria fuzzy classification: objects are grouped into classes that are ordered by their quality. The classes are assigned to each attribute using intervals of their values on given scales. The condition of fuzzy membership in a class is a non-empty intersection of adjacent intervals. The measure of a class membership is estimated by the membership function, formed by an expert. Membership functions can be interpreted as fragments of the utility function. So the utility function can be calculated by membership functions. Additionally it allows to rank the objects.

Application of the system

The system SVIR can be used to solve very different problems. For example, at St. Petersburg State Transport University the following researches were conducted [Mikoni, 2009]: estimation of activity of university departments; estimation of efficiency of the railways in Russian Federation; identification of weak points in railway operations; bank lending; selecting a strategy to expand market share; distribution of cadets from the Military Medical Academy on specializations; assessing the suitability of students to study at the military department; calculation of priorities of football teams using results of the Russian Football Championship, etc.

New features of the system

The latest version of the system SVIR has the following new features [SVIR, http]: ability to use both target and constraint types of criteria; use of constraint criteria in forming the Pareto dominance ratio; the set of basic aggregate functions; subsystem for determining the boundaries of attributes scales with graphical illustration; aggregation of selection problems by preferences (Pareto set) and by constraints (feasible set); unification of utility functions and membership in classes; different ways to build classes of membership functions from the initial data.

Laboratory Practicum

Laboratory works

The basic laboratory practicum consists of five laboratory works [Mikoni, 2009b]:

1) *Designing selection model.* This work is the basis for all consequent works. Designing a selection model is the first step for solving every multicriteria selection problem.
2) *Multicriteria selection with use of vector optimization methods.* For example, this work can be used to select candidates for the job positions.
3) *Multicriteria selection with use of scalar optimization methods*. This work can be used to estimate activity of the university departments.
4) *Multicriteria classification of objects*. This work can be used to distribute students among specializations.
5) *Identification of entities priorities based on pairwise comparisons*. This work can be used to calculate priorities of football teams on the basis of championship results.

The authors of the system now plan to add new laboratory works using new features of the system listed in the paragraph 2.4. Russian and English versions of the interface are available.

Example of laboratory work

Multicriteria selection with use of scalar optimization methods.

Purpose of the work is to study the properties of scalarization methods. Here the selected groups of criteria and all given criteria are considered.

Problem setting:

1) Determining the effect from using scalar estimates in contrast with vector estimates;
2) Finding borders of scales, which provide a stable rating of objects;
3) Comparison of preferences implemented by different aggregate functions;
4) Comparison of results for the lexicographic method and scalar optimization method with additive aggregate function.

The work was completed on the example of choosing the bank for mortgage lending. Selection model consisted of 15 different objects (banks) and 15 attributes. The criteria were structured in the following hierarchy (fig.2):

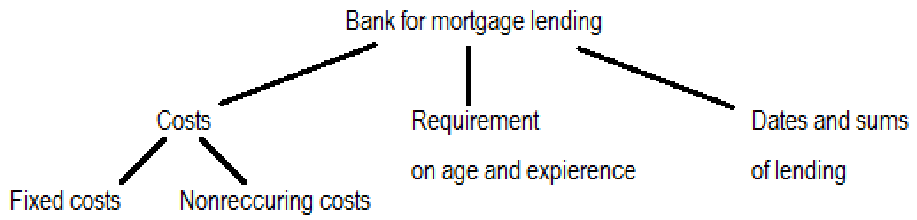

Figure 2. Criteria hierarchy

The main operations of the laboratory work were: tuning SVIR on different methods, work with the borders of attributes scales and basic aggregate functions, compare and analyse the results. On figure 3 the illustration for the third part of the laboratory work is presented.

Conclusions related to laboratory work:

1) Using scalar estimations gives the linear order because scalar estimates provide the comparability of any pair of objects.
2) If one of attribute values lies on the border of the range, the multiplicative aggregate function equals to zero. This problem can be solved by expanding the range for all the primary attributes.
3) The additive and multiplicative aggregate functions give the closest order of objects because they have the compensation property. Minimax function gives the noticeable different order in comparison with averaging functions because it reflects the extreme estimates of objects.
4) Result of lexicographic method differs from scalar optimization with additive aggregate function for two reasons: the different importance of attributes is used; lexicographic method uses not all values of attributes. The second method gives more trustworthy result.

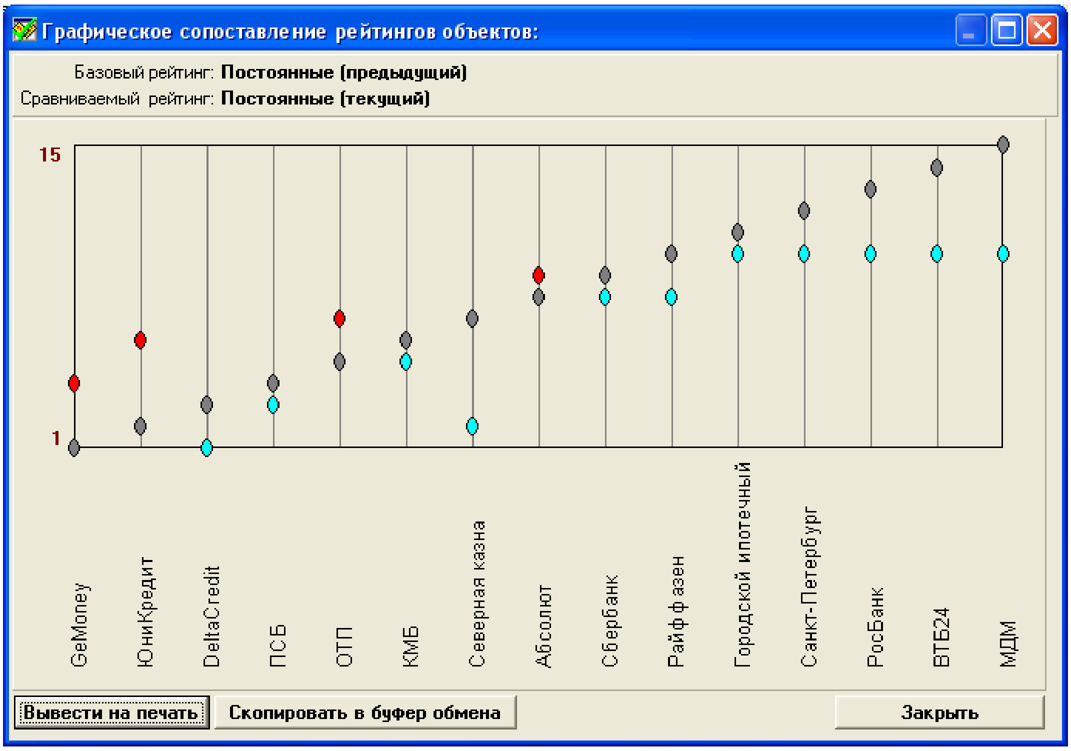

Figure 3. DSS SVIR interface. Comparison of results of ranking with additive (grey color) and minimax (blue and red colors) aggregate functions

Personal recommendations

To complete the laboratory practicum one needs about 3 months:

- Literature. Reading the main chapters of textbook takes about 1 months;
- Basis for course study. It is discrete mathematics, graph theory, informatics, microeconomics, decision theory;
- Mode of implementation. Each laboratory work takes 1-2 weeks, consultations between laboratory works are required;
- Difficulties. Setting membership functions in the 4-th work requires practice and attention.

Conclusions

The paper includes:

- General description of methods from DSS SVIR;
- General description of laboratory practicum and example of one laboratory work;
- Personal experience of the author.

Official website contains all necessary information to start work with SVIR [SVIR, http]. The free trial version is available. Universities can purchase SVIR for a special price.

Acknowledgement

The author is very appreciated to Dr. Stanislav Mikoni, professor of St. Petersburg State Transport University and the author of SVIR for his numerous consultations during the practicum.

Bibliography

[Alexandrov, 2013] G.M. Alexandrov. Improvement of the company "Gefest" work using DSS Pilot. Bachelor diploma. RPANEPA, Moscow, 2013 (rus).

[Analitica, http] DSS Analitica: http:// www.lumina.com/why-analytica/

[iThink, http] DSS iThink: http:/ /www.iseesystems.com/Softwares/Business/ithinkSoftware.aspx

[Mikoni, 2009a] S.V.Mikoni. Multicriteria selection on the finite set of alternatives. Lan', Saint-Petersburg, 2009 (rus).

[Mikoni, 2009b] S.V.Mikoni, M.I.Garina. Decision theory. Laboratory practicum. St. Petersburg State Transport University, Saint-Petersburg, 2009 (rus).

[Mogilyov, 2012] P. Mogilyov., M. Alexandrov, S. Mikoni. Multicriteria selection of perspective objects for investments: DSS SVIR vs. Muchnik method. ITHEA Publ, vol.27, 2012., pp. 61-68

[Mogilyov, 2013] P. Mogilyov. Multicriteria selection of perspective objects for investments: DSS SVIR vs. Muchnik method. Bachelor diploma. RPANEPA, Moscow, 2013 (rus).

[Pilot, http] DSS Pilot: http:// www.decisionsupporter.com/

[Semenov, 2004] S.S. Semenov, V.I. Harchev, A.I. Ioffin, Assessment of technical level of weapons and military equipment. Radio, Moscow, 2004 (rus).

[SVIR, http] DSS SVIR: http:// www.mcd-svir.ru/index.html

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Major Fields of Scientific Research: multicriteria selection, system analysis, investment climate