A Scheme for a Secure Decision Support System of Semiotics Type

Ayman M. Brisha
Taibah University. Faculty of Computer science and engineering), Information systems dep, KSA
abrisha@taibahu.edu.sa

Abstract Semiotics refers to systems which can discover knowledge intelligently and help in decision-making. Algebraic semiotics provides a rigorous notation and calculus for representation that is explicitly value sensitive, while compassion supports both better analysis and better ethics in design. Semiotic Systems enable researchers to design beneficial and powerful systems. The contribution in this paper to enhance the Intelligent Decision Support Systems (IDSS) to the Secured Intelligent Decision Support Systems (SIDSS) to enhance his work. In this paper, the focus is on designing the coding model which encodes the representative sample of the data. The proposed (SIDSS) design is a coding base model which takes a sample representing the raw database from which processing can produce a secured knowledge base that helps making definitive system decisions in a short time. The proposed methodology provides the designer and developer specific guidance on the intelligent tools most useful for a specific user with a particular decision problem.

Keywords: *Decision Support Systems (DSS), Knowledge Discovery, Data Mining, Analytic Hierarchy Process (AHP), Intelligent Decision Making*

1. Introduction

Knowledge-Driven Decision Support Systems (KDDSS) can suggest or recommend actions to managers. Each KDDSS is a person-computer system with specialized problem-solving expertise. The expertise consists of knowledge about a particular domain, understanding of problems within that domain, with necessary skills for solving some of these problems[24]. A related concept is Data Mining, which refers to a class of analytical applications that search for hidden patterns in a database. Data mining is the process of sifting through large amounts of data to produce data content relationships. Tools used for building KDDSS are sometimes called Intelligent Decision Support Methods (IDSM). Many researchers such as in [24], have designed systems for implementing semiotic applications . Knowledge Discovery in Database (KDD) [34]. Provides organizations with the necessary tools to sift through vast data stores to extract knowledge, which supports and improves organizational decision making . KDD is defined as a nontrivial process of discovering useful knowledge from data [34]. The KDD process consists of such steps as data pre-processing (data selection – data cleaning and transformation), data mining (i.e. extracting patterns such as classification rules extracted from a decision tree, that can support decision making [34]. Incremental data mining maintains patterns over a dynamic data source by revising patterns learned from a previous run of data mining, instead of learning from scratch. The value of information to the decision maker is often measured indirectly by evaluating information systems against some surrogate criteria. For example, the value of a decision support system (DSS) in the decision making process, and improvements in the outcomes from the use of the DSS [5-6]. However, none of these approaches provide a good measure of the decision value of DSS [5]. Several incremental data mining algorithms were proposed for major data mining models (as classification, association rule mining and clustering. For classification, algorithms ID4 and ID5 [34], were developed to revise a decision tree induced from old data as new data were added in. To support effective decision making , the KDD process needs to be completed. The KDD process cannot be fully automated, except for the data mining step. The success of the computer as a universal information-processing machine lies essentially in the fact that there exists a universal language in which many different kinds of information can be encoded and that this language can be mechanized [17]. Computers can compute, using binary notation for representing numbers is certainly of great interest, however there is nevertheless another key issue for making them able to process higher-levels of information. The first step in processing high level information was to code alphabetical symbols, therefore moving from the realms of numbers to the realms of words. The first binary encoding of alphanumeric characters was indeed designed nearly a century ago, by G.Peano [17], who is also responsible for the first axiomatization of arithmetic.

In section 2 discuses semiotic approach with algebraic semiotic. Section 3 explains the Intelligent Decision Support Systems and how we can evaluate it.

2. Semiotic Approach and Algebraic Semiotic

Semiotics is an interesting and powerful tool for rephrasing information theory and computer science. Semiotics provides a means of analysing the language of different healing modalities and our cultural understandings within which healing modalities are embedded [13]. It can also be used to show how social and political life may be shaped and influenced by the language we use to describe information and security. in this study, the semiotics are used to, focus on a particular aspect of language, such as the metaphor, across a range of texts but the analysis tends to be quite broad and general. A semiotic approach to information systems provides a tool to represent organizational knowledge and activity. The theory of signs originates in the work of Peirce [12] who shows that a sign must be capable of evoking responses from the interpreter or a person. Semiotics makes us recognize the importance of an agent as being responsible for the existence of a sign and its meaning. Organizations can be seen as complexes of signs communicated among people who, acting as semiotic agents, are responsible for assigning meanings [1,5,12,14– 15 , 31]. Researchers have offered the concept of designing perspective intellectual systems as systems of semiotic type. The direction of an artificial intelligent named applied semiotics [13] has arisen and actively developed in the last few years. It unites researches in the field of semiotics modeling, semiotics knowledge bases, logic-linguistic and cognitive models, etc., which are necessary for the creation of highly effective intellectual systems (IS) capable of training (adaptation) and functioning in open and dynamic problem solving areas. The typical representative of such systems are intelligent decision support systems (IDSS) [2,32]. IDSS and Real-Time Support Systems (RT-IDSS) are intended to help decision makers manage complex objects and processes of various natures. These processes depend on conditions of hard time restrictions and concentrate on integrated intellectual systems. The primary goals decided by the RT IDSS are outlined in[16]. Forecasting involves drawing up a forecasting model of a progressing situation for an estimation of efficiency of recommended decisions for a particular solution ; Interaction with Decision Making (DM) (expert) - formation of the base of expert knowledge and delivery of the information (advice) to the DM. In the IDSS and RT-IDSS the data was treated as a whole, where any discrepancy in data or inaccuracy could lead to wrong decisions that may affect the system. This led to the proposed secured IDSS architecture in this paper in which only a sample of the data is used. The accuracy of the decision depends on the accuracy of the sample. Algebraic semiotic systems are a central notion of algebraic semiotics; describing axiomatic theories for systems of signs, including hierarchical ``constructors" for signs, and (socially determined) measures of their relative importance. An example is the space of potential displays for some application running on the setting of a given sign, can be at least as important for meaning as the sign itself. On the contrary, the sentence ``Yes" can mean almost anything, given an appropriate context. In algebraic semiotics, certain aspects of context dependency can be handled by constructors that place signs within larger signs, so that the original signs become contextualized sub signs. However, human interpretation is still needed for signs to have any meaning in any human sense[25]. Moreover, human interpretation is needed in deploying the formalism of algebraic semiotics, since it is intended to be used flexibly in musical performance [16]. Algebraic semiotics also provides precise ways to compare the quality of representations, and to combine representations, such that conceptual blending (in the sense of cognitive linguistics is a special case as in [3]. Case studies for this theory include web-based displays for mathematical proofs that integrate motivation, background and explanation with formal details and information visualization [10]. It is difficult to design systems that satisfy users; failure is common, and even successful designs often overrun time and cost. Algebraic semiotics provides a rigorous notation and calculus for representation that is explicitly value sensitive, while compassion supports both better analysis and better ethics in design [16]. Algebraic semiotics help in solving the lack in scientific theories and support the design of virtual worlds, which are increasingly important in scientific research. In the next section the suggested technique for IDSS and its evaluation will be explained in detail.

3. Evaluation of Intelligent decision support systems (IDSS)

IDSS adds artificial intelligence (A. I.) functions to traditional DSS with the aim of guiding users through some of the decision making phases and tasks or supplying new capabilities. This notion has been applied in various ways. For example, [13] provided two layers in their framework for IDSS; a pragmatic layer associated with the actual performance of the task, and the conceptual layer associated with the processes and structure of the task. The study in [14] can be combined with other concepts to develop the IDSS architecture shown in Figure 1. Figure 1 illustrates an IDSS consisting of a data base, a knowledge base, and model base, some or all of which will utilize AI methods. The data base contains the data directly relevant to the decision problem, including the values for the states of nature, courses of action, and measures of performance. The knowledge base holds problem knowledge, such as guidance for selecting decision alternatives or advice in interpreting possible outcomes. The model base is a repository for the formal models of the decision problem and the approaches (algorithms and methodologies) for developing outcomes from the formal models. Decision-makers utilize computer and information technology to process the inputs into problem-relevant outputs. Processing will therefore involve: (a) organizing problem inputs; (b) structuring the decision problem decision model; (c) using the decision model to simulate policies and events; (d) finding the best problem solution. The IDSS can use knowledge drawn from the knowledge base to assist users in performing these processing tasks. Processing will generate status reports, forecasts, recommendations, and explanations. The status reports will identify relevant states, courses of action, and measures of performance and show the current values for these problem elements. Forecasts will report the states and actions specified in the simulations and the resulting projected values for the measures of performance. The recommendations are used to suggest the values for the actions that best meet the measures of performance.

Explanations will justify the recommendations and offer advice on further decision making. Such advice may include suggestions on interpreting the output and guidance for examining additional problem scenarios. Input feedback from the processing provides additional data, knowledge, and models that may be useful for future decision making. This feedback is provided dynamically to update the model and inputs in real time without external intervention. Output feedback is used to extend or revise the original analyses and evaluations. The literature provides numerous examples to show that IDSS can improve the decision making process and outcomes [9,19] . To provide a recent illustration of the use of both metrics, [38] has evaluated consumer DSS with the user's cognitive effort to make and express preference in the decision processes and decision accuracy outcomes. IDSS supports cognitive tasks by playing an active role in aiding task performance, processing data and information to produce knowledge, and learning from experience [13]. They also support better decisions in terms of the outcome of the decision itself. The author propose that the ''decision value" of IDSS should be evaluated by the effect on both the process of, and outcome from, decision making. Decision making in organizations and decentralized enterprises of today is increasingly distributed. Accurate and readily-available information can be provided through networked resources from a variety of sources and delivered to the decision maker in any location, and to a distributed group for collaborative decision making. Artificial intelligence enhances the potentialities of decision support systems in real management situations [27]. Hence, disparate resources are combined together and extend the support capabilities. In addition to IDSS improved outcomes, the use of AI techniques affects the process of decision making by providing the potential for real-time response, automation, personalization, sophisticated reasoning patterns, and broader information sources on which to base the decision. Intelligent systems achieve things differently than systems that do not embed intelligence. It is therefore appropriate, to specifically identify system benefits originating in process, as well as outcome support. The decision value of an IDSS, can therefore be determined from a multi-criteria evaluation using the process of, and outcome from, decision making as a top-level criteria.

4. The Analytic Hierarchy Process [AHP]

The analytic hierarchy process (AHP) is a multi-criteria method that can incorporate both qualitative and quantitative criteria into a single metric [28, 30]. Multi criteria decision making implies that a decision maker needs to identify the best course of action while considering a conflicting set of criteria. Complexity in decision making situations involves quantitative and qualitative criteria, multiple scales, and multiple comparisons. The ability to assign a preference rank for general decision making situations is needed as well as the simplicity of methods [29]. The AHP is a plausible method that provides a logical and scientific basis for such multi-criteria decision- making [11]. AHP has been widely applied to both individual and group decision making scenarios from the early 1980s [30, 33]. According to [29], the AHP was founded on three design principles:(1) the decomposition of the goal-value structure where a hierarchy of criteria, sub criteria, and alternatives is developed, with the number of levels determined by the problem characteristics, (2) comparative judgments of the criteria on single pairwise comparisons of such criteria with respect to an upper criteria, and (3) linear-based synthesis of priorities where alternatives are evaluated in pairs with respect to the criteria on the next level of the hierarchy, with each criteria being assigned with a priority expressed as a weight in the AHP matrix. An advantage of the AHP for our evaluation of IDSS is that the contribution of the AI methods used in the system to individual criteria can be determined. For example, we can get more system process benefits by applying AI methods, or an AI method contributes to a specific phase of decision making. Such information assists the system developer as well as the user to understand the precise contributions of the components of the IDSS to the overall decision value. Previous studies have implemented the AHP to compare DSS and to determine their effect on the process of, and outcome from, decision making [5-7,18, 20-21]. In this research the study uses an evaluation of IDSS founded in [38], with the contribution of adding external memory to enhance the results founded in Table 1. The system performance can achieve the decision objective, for example, if the decision is intended to deliver decreased operating costs, then the organizational performance criterion is measured in terms of the cost decrease associated with the decision. Another possible outcome criterion shown in Table1 illustrates the growth in decision maker maturity.

Table 1 Weights assigned for the criteria in the AHP model

Level	Criteria by level	Weights	Comments
	Process/outcomes to decision value	[0.40, 0.60]	User consider outcome more important than process (60% for 40%)
Decision making	(Decrease in redundant complaints/precision of decision making to outcome)	[0.70, 0.30]	User considers the decrease in redundant complaints more important than precision of decision making (70% vs. 30 %)
	(Intelligence /design/choice/ learning proficiency to process)	[0.20, 0.50, 0.20, 0.10]	The user considers the design of the infrastructure solution more important than other phases
	(Analysis /synthesis to intelligence)	(0.80, 0.20)	For the intelligence phase, the user considers the support provided by analysis to be most important.
	(Analysis /synthesis to design)	(0.10, 0.90)	For the design phase, the user considers synthesis to be most important
Decisional service task	(Analysis	(0.50, 0.50)	For the choice phase,

	/synthesis to choice)		the user considers both analysis and synthesis of equal importance
	(Analysis /synthesis to learning)	((0.30, 0.70)	For the learning phase, the user considers synthesis to be more important
	(Analysis /synthesis to decrease in redundant complaints)	(0.75, 0.25)	The user considers analysis to be important in the decrease in redundant complaints
	(Analysis /synthesis to precision of decision making)	(0.30, 0.70)	The user considers synthesis to be more important in the precision of decision making
Architectural capability	(User interface/D&K/ processing to analysis services)	(0.10, 0.45, 0.45)	The user considers D&K and processing to be important for analysis
	(User interface/D&K/ processing to synthesis services)	(0.10, 0.20, 0.70)	The user considers processing to be most important for synthesis

Figure 2 illustrates an AHP model for IDSS evaluation. The Decision Value of the IDSS is at the top of the hierarchy and depends on the decision process and outcome. The outcome describes the achievement by the decision maker as a result of using the IDSS. Presumably, such learning would improve the decision making skills of the user in both the current and subsequent situations as found in[5]. The improvement can be measured by the user's enhanced ability to perform decision making phases and steps, increased productivity (generating more alternatives and comparisons in a given time period), and enhanced efficiency (evaluating the same number of alternatives in a fixed time period). These improvements can be measured qualitatively (for example, self or expert ratings for decision task proficiency) and quantitatively (for example, productivity and efficiency in decision making). The process is described by the decision making phases of intelligence, design, choice, implementation and learning. As we move down the hierarchy, there is a Decisional Service-task Level, an Architectural-Capability Level, and finally a Computational-Symbolic Program Level with AI computational mechanisms as alternatives. The evaluator may choose to modify the AHP model to tailor the desired criteria for a specific IDSS[38]. The study in [38] has shown one possible implementation as shown in Figure 3, along with potential alternative AI methods including a genetic algorithms, intelligent agents, neural networks, a hybrid systems, or none meaning that no intelligence is embedded. In the AHP model, the alternatives are evaluated in pairs with respect to the three elements in the Architectural-Capability level: user interface, data & knowledge capabilities and processing capabilities. Thereafter, the alternatives are compared in this paper with respect to how well they provide personalization in the user interface. The user might indicate that agents are much better than a neural network in providing personalization in the user interface, and this judgment is expressed in the AHP as a relative rating. An Eigen value computation is utilized to reconcile the pair wise judgments, and a ranking of alternatives on the specific criteria is produced using the judgments and the weighting of the criteria. The AHP then proceeds by evaluating the user interface, data and knowledge capabilities, and processing capabilities with respect to the three types of decisional services: analysis, synthesis or complex services. Numeric ranking values are produced for the alternatives using the criteria weights provided by the evaluator. The elements of the Decisional Service-task level are similarly evaluated with respect to the Decision Process level: intelligence, design, choice, implementation, and learning. Finally, a numeric ranking of the alternatives is computed for outcome, and these ratings are combined with the overall ratings calculated for process to provide an overall ranking of the alternatives with respect to the decision value representing, the highest level in the AHP model. The ranking at the top level indicates which alternative, has the best decision value, and a highest ranking can be interpreted as an selection of the best design for the IDSS. In addition, the precise contributions of each AI method for each criterion in the hierarchy can be determined.

5. Proposal for secured-IDSS design

The Architecture in figure 3 shows a generalized base architecture of an IDSS for the semiotics type. This architecture consists of the following nine blocks: problem analyzer, decision search, block of learning, raw database, model base, knowledge base, block of modeling, block of forecasting, and knowledge acquisition and accumulation. In the proposed method, the design of the Model-Base block is modified by using a Model coding instead of a Model Base. The newly proposed architecture is called a Secure IDSS (SIDSS). Throughout this study, this new architecture consists of the blocks shown in figure 3. The block of Modeling is classified by its output going to the block containing the table of coding where it is processed. Coding is being processed according to the type of data available and the output code is provided in the Model Coding. This modification contributes in securing information and keeping it confidential so no one can know the meaning of the data except those who have the right to examine the Table of Coding and understand the encryption code. The ability to understand the real meaning of the information helps in making decisions in addition to securing such data. SIDSS consists of two interfaces an environment and a user interface. The IDSS compiles and analyzes the data as well as creating models for the data. The IDSS also includes models to help in decision-making and other models used in training, modifying, and checking the data. Through models of knowledge, the IDSS can make accurate decisions. In this paper, the model base is replaced by a data encryption model that secures and protects information. The goal is to prevent information access / interpretation by unauthorized personnel accessing the system. This approach helps in increasing overall accuracy and security.

6. The proposed scheme

This section considers features of the functions for a selection and updating in SIDSS. The SIDSS is a system of distributed intelligence organized by the principle of semiotics system, integrating in itself various adapted models of knowledge representation and search of the decision.

The SIDSS of semiotics type can be formally represented by the following set:

$$SS = \langle M, R(M), F(M), F(SS) \rangle$$

where $M = \{ M_1,\ldots,M_n \}$ – is the set of the formal or logic-linguistic models which implement certain intellectual functions; R (M) is the set of rules to choose the necessary model or set of models in the current situation. $F(M) = \{F(M_1),\ldots,F(M_n)\}$ is the set of rules for modifying the models M_i, $i=1,\ldots,n$. F (SS) is the rule of updating actually systems SS, namely its base designs M, R(M), F(M) and, probably, itself F(SS).

The monotony violation as a rules are use for Updating model conducts or switching from one model to another model. This switch is carried out by means of reaction to corresponding event or by means of performing certain rules, for example fuzzy conclusion rules such as; $A' \bullet (A \rightarrow B)$, where A' and A are the fuzzy sets describing conditions of problem area or object (the fuzzy relation of similarity between elements from A and A' should be determined), B is the fuzzy set of allowable models or modifications within the model. $\bullet$ is a specified operation of a composition of fuzzy sets. One part to note is, that if corresponding sets of rules - for example, set of choice rules R(M) - are production sets then they can be preliminary transformed into treelike structures such as decision trees or decision tables, that simplifies the choice procedure [32, 35-37].

7. Conclusion

The proposed scheme for Secured IDSS is a suitable system in applications for securing files, information and services on networks. The implementation of the design will be the next step in our research . SIDSS coding blocks combines both security and decision making which is the main advantage of this system, providing the security required in Decision Support Systems. The analysis of documents can be a very useful way of exploring some important social and political aspects of security. The analysis of documents can be a very useful way of exploring some important social and political aspects of security. There are obvious limitations in relation to the range of research questions you can ask that documents will answer. The semiotic tool addresses the fundamental problem of reconciling differing perceptions within the organization to assist in overcoming the inherent problems of security. The suggested application case illustrated in this paper should be taken as a sample and initial effort to demonstrate the methodological design and evaluation potential capabilities of the proposed scheme.

References

1. J. Backhouse, "The use of semintic analysis in the development of information system, PhD thisis, Londen school of Economics and Political Science (1992).
2. A.A. Bashlykov, Yeremeyev A.P. Ekspertnye sistemy podderzhki prinjatija reshenij v energetike (Expert decision support systems in the power engineering). - Moscow: Izd-vo MEI (MPEI Publishing), 1994. p. 216.
3. L. David Ritchie, " Metaphors of conceptual integration", Metaphor and symbol 19, 31-50, 2004.
4. G . Dhillon, interpreting the management of information systems security, PhD thesis, London school of Economics and Political Science (1996).
5. Forgionne, G., 1999. An AHP model of DSS effectiveness. European Journal of Information Systems, 95–106.
6. Forgionne, G., 2000. Decision-making support systems effectiveness: The process to outcome link. Information Knowledge-Systems Management 2, 169–188.
7. Forgionne, G., Kohli, R., 2001. A multiple criteria assessment of decision technology system journal qualities. Information Management 38, 421–435.
8. Gupta, N., Forgionne, G., Mora, M. (Eds.), 2006. Intelligent Decision making Support Systems Foundations, Applications and Challenges. Springer-Verlag, Germany.
9. Harker, P., 1988. The Art and Science of Decision Making: The Analytic Hierarchy Process. Working Paper 88-06-03, Decision Science Department, The Wharton School, University of Pennsylvania, Philadelphia, PA.
10. Joseph A. Goguen, " steps towards a design theory for virtual worlds", university of California, san Diego, 2004.
11. M. KarmÜftÜoğlu, Knowledge based information retrieval: A semiotic Approach PhD Thesis, City University, London (1998).
12. K. Kitiyadisai, concepts of Relevance in a semiotic framework Applied to information systems analysis and design, PhD thesis, London school of Economics and Political Science (1990).
13. H. Linger, F. Burstein, 1997. Intelligent decision support in the context of the modern organization. In: Proceedings of the 4th conference of the international society for decision support systems – ISDSS'97, Lausanne, Switzerland, July 21–22.
14. M. M. Marche, Models of Information: the feasibility of measuring the stability of data models, PhD Thessis, PhD thesis, London school of Economics and Political Science (1991).

15. S. Marche, on what a building might not be – a case study International journal of information Management 11 (1991) 55-66.

16. Organizational Semiotics Workshop, 11-12 July 2003 at the University of Reading, UK.

17. "The semiotics of the web", Philippe eodognet, universite paris6, 4 palace jussive, 75005 paris France, 05.

18. Phillips-Wren, G., Hahn, E., Forgionne, G., 2004. A multiple criteria framework for the evaluation of decision support systems. Omega 32 (4), 323–332.

19. Phillips-Wren, G., Jain, L. (Eds.), 2005. Intelligent Decision Support Systems in Agent-Mediated Environments. IOS Press, Amsterdam.

20. Phillips-Wren, G., Mora, M., Forgionne, G., Garrido, L., Gupta, J.N.D., 2006a. Multi-criteria evaluation of intelligent decision making support systems. In: Gupta, J.N.D., Forgionne, G., Mora, M. (Eds.), Intelligent Decision-Making Support Systems (i-DMSS): Foundations, Applications and Challenges. Springer, pp. 3–24.

21. Phillips-Wren, G., Mora, M., Forgionne, G., Gupta, J.N.D., 2006b. Evaluation of decision-making support systems (DMSS): An inte-grated dmss and AI approach. In: Adam, F., Humphreys, P. (Eds.), Creativity and Innovation in Decision Making and Decision Support (Proceedings of CIDMDS 2006), London, UK, 29 June–1 July.

22. G. Phillips – Wern , M. Mora, G.A. Forgionne, J.N.D. Gupta, " An integrative evaluation framework for intelligent decision, European journal of Operational Research 195 (2009) 642-652.

23. C.S. Pierce, in : C Hartehome, P. Weiss(Eds), collected papers, vols. 1-8 , Harvard University Press, Cambridge, 1931-1958.

24. Pospelov D.A., Osipov G.S. Prikladnaja semiotika (Applied semiotics) // Novosti iskusstvennogo intellekta (Artifical Intelligence News), Moscow, 1999, N1. - P. 9-35.

25. B. B. Rieger: Meaning Acquisition by SCIPS. In: Ayyub (ed): ISUMA-NAFIPS-95, Los Alamitos, CA (IEEE) Computer Society Press), 1995, pp. 390–395.

26. B. B. Rieger: Situations, Language Games, and SCIPS. Modeling semiotic cognitive information processing systems.In: Meystel/Nerode (eds): Architectures for Semiotic Modeling and Situation Analysis in Large Complex Systems, Bala Cynwyd, PA (AdRem), 1995, pp. 130–138.

27. Rosenthal-Sabroux, C., Zarate´, P., 1997. Artificial intelligence tools for decision support systems. European Journal of Operational Research 103, 275–276.

28. Saaty, T.L., 1977. A scaling method for priorities in hierarchical structures. Journal of Mathematical Psychology, 234–281.

29. Saaty, T.L., 1986. How to make a decision: The analytic hierarchy process. Interfaces 24 (6), 19–43.

30. Saaty, T., Vargas, L., 1994. Decision Making in Economic, Political, Social and Technological Environments with The Analytic Hierarchy Process. RWS Publications, Pittsburgh, PA.

31. R. Stamper, Research issues in information systems: semintics, in R. J. Boland, R.A. Hirschheim (Eds), critical issues in information system research, Wiley, Chichester, 1987.

32. Vagin V.N., Yeremeyev A.P. Nekotorye bazovye principy postroenija intellektual'nyh sistem podderzhki prinjatija reshenij real'nogo vremeni (Some base principles of construction of intellectual real time decision support systems Izv. RAN: teorija i sistemy upravlenija (Proceedings of the Russian Academy of Sciences: the theory and control systems), 2001, N6. p. 114-123.

33. Wind, Y., Saaty, T.L., 1980. Marketing applications of the analytic hierarchy process. Management Sciences 26 (7), 641–658.

34. Xiao Fang, Ram Rachamadugu , "Polices for knowledge refreshing in databases", www.elsevier.com/locate/omega.

35. A.P. Yeremeyev O. korrektnosti "produkcionnoj modeli prinjatija reshenij na osnove tablic reshenij (About a correctness of the production model of decision-making on the basis of decision tables) Izv. RAN. Avtomatika i telemehanika (Proceedings of the Russian Academy of Sciences: Automatics and telemechanics), 2001, N.10 p. 78-90.

36. Yeremeyev A.P., Denisenko L.S. Obrabotka nedoopredelennoj informacii v sisteme podderzhki prinjatija reshenij real'nogo vremeni primenitel'no k operativnoj sluzhbe elektrostancij (Processing of not predetermined information in real time decision support systems with reference to operative service of power stations) // Izv. RAN. Energetika (Proceedings of the Russian Academy of Sciences: Power Engineering), 2002, N.2. - P. 32-43.

37. A.P. Yeremeyev, Troickiy V.V. Modeli predstavlenija vremennyh zavisimostej v intellektual'nyh sistemah podderzhki prinjatija reshenij (Models of representation of the time dependences in intellectual decision support systems) Izv. RAN. Teorija i sistemy upravlenija (Proceedings of the Russian Academy of Sciences: the theory and control systems), 2003, N.5, p.75-88.

38. J. Zhang, Pu, P., 2006. Performance evaluation of consumer decision support systems. International Journal of E-Business Research 2 (3), 38–45.

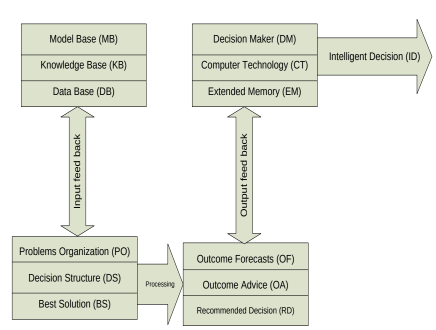

Figure 1 Intelligent decision support systems structure

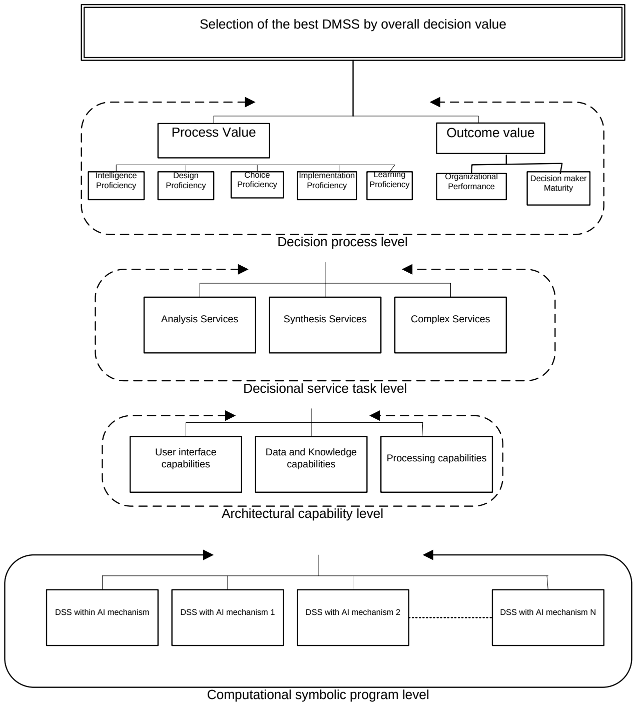

Figure 2 AHP model for IDSS evaluation

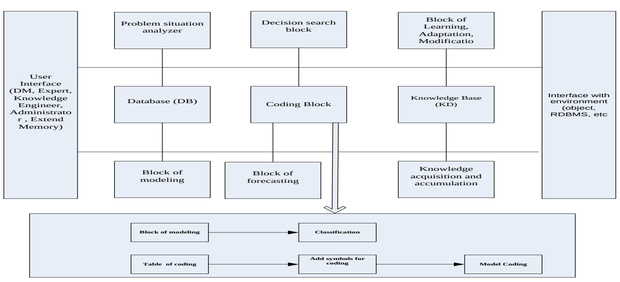

Figure 3 Suggested Architecture for Secured IDSS (SIDSS)