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Abstracts

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Contents

Note: The abstracts have been processed automatically using the abstract forms e-mailed by the authors. Only one substantive type of modification has been applied, i.e., in a few cases the co-author has been named first, if only he/she will participate in the Workshop.

Optimization of Auto-dispatching Problem in Vending Machine Network

MASAO ARAKAWA

Kagawa University

HIROSUKE KURIHARA

Shikoku Coca-cola botlings

Keywords: Optimization, Dispatching

In Japan, there are severe requirement of cutting off costs in the industry and it is spread out even to the delivery of their products. We have been making an effort to cut expense of delivery by using traveling sale man problem with adaptive range genetic algorithms, and tested the system to actual delivery works. However, because of lack of detail information from GIS and situation of parking, service person could not keep the turns of vending machines as the system ordered. Beside that, they turn vending machine so well, so that we cannot reduce their time adequately. Thus, we have tried auto-dispatching problem to reduce unbalance between service person and tried to know the best scenarios for delivery system.

Scientific and Policy Oriented Applications of the Internet Tools Developed in the Frame of the ENSEMBLE Project

JERZY BARTNICKI *and* JORGEN SALTBONES *and* ANSTEIN FOSS

Norwegian Meteorological Institute

Keywords: Emergency, nuclear safety, atmospheric transport, internet applications

The EU sponsored project ENSEMBLE is managed by three institutions: (i) Risoe National Laboratory, Co-ordinator, assisted by (ii) Joint Research Centre (JRC) Ispra, and (iii) University of Manchester (UoM). In particular, Risoe manages the administrative and financial coordination with the EU Commission and the sub-contractors to the project (like the National Meteorological Services), while Environmetal Institute (EI) at JRC manages the technical coordination of the ENSEMBLE experiments. UoM brings to the project its unprecedented experience with decision support based on uncertain information. The ENSEMBLE Website, with associated internet tools, has been developed by the ENVIROWARE-SRL on contract under EI JRC.

The ENSEMBLE project addresses harmonization and coherence issues for emergency management and decision making in relation to modelling long-range transport of debris emitted from nuclear accidents. Main assumptions, objectives and general description of the project were presented at the the CMS-2001 at IIASA in August 2001.

The project has been going on for more than one year now. During this time some interesting internet tools have been developed by the Environmental Institute at Joint Research Centre (JRC) in Ispra, Italy. These tools are routinely used by the project participants,including Norwegian Meteorological Institute in Oslo. They are available on ENSEMBLE WEB pages. Access to WEB pages requires a user-id and password, which are given to all project participants.

During the project duration altogether 10 exercise will be performed, which will simulate different types of nuclear accidents in different places in Europe. In each exercise, based on the information about the accident type and location, each project participant has to run a dispersion model in real time and send the results to JRC in Ispra. Information about accident and model results are sent via internet. Once the results of different models are uploaded, the internet tools can be used for visualisation and extended analysis. These tools can be used for all tasks related the exercise e.g. creation of different maps, scatter diagrams, frequency distributions, comparison of the results of different models and advanced statistical analysis.

The internet tools mentioned above will be presented on-line and explained during the CMS-2002 Workshop at IIASA. This presentation will focus on the SNAP model performance, which was developed and is routinely used at the Norwegian Meteorological Institute as part of the national preparedness against nuclear accident.

This work is based on the results obtained within the ENSEMBLE Consortium[1], which is acknowledged. ENSEMBLE is a project supported by the European Commission DEG-RES Nuclear Program.

[1] `http://ensemble.ei.jrc.it`

Ontologies to Structure Models and Modeling Tasks

ADRIE J.M. BEULENS *and* HUUB SCHOLTEN

Wageningen University, Information Technology Group, The Netherlands

Keywords: ontologies, modeling, complex problem solving

1. Introduction

Twenty years ago, most academics would have said ontology refers to an esoteric field in philosophy that studies being –what there is in the world (Gruninger & Lee, 2002). Today (May 2002) a Web search engine will find more than 310,000 sites with the keyword *ontology*. Among the first 10 of these websites you find some interesting ones, e.g. Enabling Virtual Business, What is an Ontology?, Gene Ontology Consortium, The Ontology Page, Ontology - Descriptive and Formal, The Enterprise Ontology. None of these links refer to philosophical questions on being, but to practical up-to-date research on (application of) knowledge engineering techniques. This leaves us with questions like what are ontologies and why this attention by academics in computer science, information science, business schools, but also from industry, and the educational and medical sectors? In this paper some of these questions will be addressed, focusing on the role of

There exists a rapidly growing class of problems in modeling for which there is no adequate support. Some of these problems are associated with the independent development of modeling paradigms, which work with quantitative, algebraic models. A common base, essential for being able to couple models in a higher level hierarchical or network model needs a common platform, a shared representation format with associated shared understanding to define models for all these modeling paradigms. In this way models can be easily combined into new models and tools for model analysis can be exchanged between modeling paradigms (simulation, optimization, soft simulation, multi-criteria model analysis, enabling a more comprehensive analysis of many various model instances. Such a development would widen the horizon of model based decision support enormously and facilitate interdisciplinary co-operation.

Besides this common platform for model definition/specification, there exists confusion concerning on how to model according to Good Modeling Practice. This confusion seems to partly originate within a modeling paradigm and is partly attributed to misunderstanding between model paradigms. A better understanding can be achieved by a better specification of the modeling process, covering, preferably, all quantitative modeling paradigms and the relationships between them. Such a specification should describe the concept behind a task, how tasks should be performed and how tasks are related.

Ontologies can and according to us must play a role in the development of both such a common model representation format ass well as in the specification of a network of tasks in any modeling project.

2. What are ontologies?

An ontology is an explicit specification of a conceptualization. The term is borrowed from philosophy, where an ontology is a systematic account of Existence. For AI systems, what 'exists' is that which can be represented (Gruber 1994). Gruber calls these things that can and need to be represented or discussed concepts. Obviously, one should try to get consensus on these concepts and the relations

between them, which is included in the next definition. An ontology is a formal specification of a shared conceptualization (Borst, 1997).

Ontologies are not only being addressed by AI researchers but in a wide variety of domains. For instance Uschold et.al. describe an Enterprise Ontology as a collection of terms and definitions relevant to business enterprises. As said before there is a booming body of knowledge on ontologies and their application along many scientific, medical and other (business) domains. Two basic elements of ontologies have to be explained: concepts and relations. Concepts are used to define and explain things, while the relations order the concepts in a kind of (sometimes) hierarchical structure. An ontology can be seen as a framework that represents the semantics of data about a certain domain, in a formal machine processable way. In order to describe the semantics of data, ontologies must provide one or more standard vocabularies, defining the terms (concepts) and relations that are used to describe this certain domain (subject area). To describe a certain domain an ontology contains sentences

The main reasons for the use of ontologies are:

- For communication between people, between people and computer systems, or between independent computer systems.
- To enable reuse of domain knowledge.
- To make domain assumptions explicit
- To separate domain knowledge from the operational knowledge.
- To analyze domain knowledge.

Ontologies can be described through the following 5 main elements:

- Concepts: can be anything about which something is said. It can be something abstract (time) or concrete (a table), existing or nonexistent, a process or a planning, etc.
- Relations: a logical association between two or more things. Mappings between a list of input arguments (domain) and its output argument (range). Formally they can be defined as a subset of a product of n sets: R: C1 x C2 x ... x Cn. Some examples of relations are: has-expressions, has-elements,etc.
- Functions: are special kinds of relations where the input arguments (domain) have exactly one output argument (range).
- Axiom: a formal statement or principle accepted without proof as, that can be used as the basis for (reasoning and inference) logically deducing other statements. Axioms are formed through, logical relations between concepts, like: negation, conjunction and disjunction.
- Instance: is an individual object of a certain class (concept). An instance can be seen as specific member of a certain concept that has been defined in the ontology.

These elements are needed to structure knowledge in an ontology. Besides these content related aspects of ontologies, most ontologies are expressed in a formal way by using an ontological format. The last ten years an avalange of ontology representation formats and their associated tools has been developed. A classical one is Ontolingua, but more recent ones are all based on XML. An international co-operation seems to win the race with DAML+OIL. In the rat race of tools a preliminary winner seems to be the ontology design environment Protg-2000.

3. Why ontologies to solve modeling problems?

In the previous section we have briefly addressed what ontologies are meant for, what a definition is and what needs to be specified in an ontology. We are working in the area of model based decision support systems. That means that we are confronted with problems with respect to modeling in a multi paradigm environment where the definition and use of ontologies might be instrumental to arrive at efficient and effective modeling with assured quality. That means to our opinion that there is a need for:

- An ontology which will allow us to adequately describe the processes of modeling and use of models in a practical business or research situation to assure the quality of that process. Such a process ontology is popular in describing medical protocols (de Clercq et al., 2001). In domain of modeling bot the Good Modeling Practice Handbook for Dutch water management (Scholten, 1999) and the HarmoniQuA project (Scholten and Osinga, 2001) are examples of initiatives to define the modeling process.

- An ontology for the object systems to be represented in the network of models that may be needed to arrive at real support for solving decision problems at hand. As addressed before we then may have to do with sub-models associated with a variety of modeling paradigms with differing and non-explicitly formulated ontologies and associated solvers. As a consequence there is no formal specification for the exchange and communication between these models and the automatic solvers dealing with these sub-models. It is to our idea evident that for automatic interfaces an explicit and shared specification of the object system ontology is a necessity. Further, in addition, a shared associated understanding of all the concepts and terms used in that ontology is a necessity to ensure usability in the problem context.
- Finally an ontology of the broad class of quantitative algebraic models is needed as a definition of these type of models and to design a common representation format for these models, describing of what kind of components these models consist of and what kind of data and meta-data are essential to allow a proper model development and model analysis.

In our presentation we will briefly discuss the need for these types of ontologies just described and on the work we are doing in this area.

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Kemeny's Median Algorithm: Application for Determining Group Judgement

HANNA BURY *and* DARIUSZ WAGNER

Systems Research Institute of the Polish Academy of Sciences, Warsaw, Poland

Keywords: group judgement, preference order, Kemeny's median

In many real life situations one has to deal with problems of choice. Problems of this kind that can be formalized, may be solved by means of mathematical programming methods. However, in many cases the nature and complexity of such problems as well as difficulties of formalization of the choice criterion (criteria) are the reason to ask for expert judgements.

The expert judgements can be given in the order as well as in the number scale. Moreover they may have the form of preference orders as well as of pairwise comparisons. If the number of elements is large, then the task of ordering the whole set of elements may be difficult to accomplish. In such a case the experts are asked to perform pairwise comparisons of elements only.

In general, methods used to determine group judgement can be divided into two categories. The first category includes methods based on pairwise comparisons. They are derived from the method of Condorcet (Condorcet, 1785). The method of Condorcet is intuitively based on the assumption that the best (according to a judgement of given group of experts) alternative is the alternative that is ranked higher than any other alternative by a majority of experts. Such an alternative is called the Condorcet winner. A difficulty with the Condorcet winner is that in general it need not exist (Nurmi, 1987).

The second one comprises so-called positional methods derived from the method of Borda. Borda called his method as "election by order of merit" (Borda, 1781). Using these methods, group judgement is determined taking into account positions taken by alternatives in judgements of particular experts.

One of the most difficult problems in group decision judgement is the choice of an algorithm to be used for such a purpose. It is well known that in some situations the application of various methods of determining the winner results in different solutions.

In 1959 John Kemeny in his book "Mathematics without numbers" formulated the rule for determining a preference order that is the "closest" to the wishes of the voters. In this approach the problem considered is reduced "to one, which is analogous to those of classical statistics" (Kemeny, 1959, Kemeny and Snell, 1960) with the use of the concept of a distance between any two preference orders. This rule is also called the median rule and the Slater's rule in literature on tournaments.

J. Kemeny concentrated his analysis on the problem of distance minimization, paying less attention to the fact that his rule is a decision function possessing the important properties. Kemeny's approach has been widely accepted, however real applications have been limited due to computing difficulties.

The growing interest paid to Kemeny's rule considered as a method of determining group judgement results from the fact that this rule enjoys remarkable properties and does not exhibit pathological behaviour typical for other methods, for example it has consistency in group judgement when candidates are dropped (Saari, Merlin, 2000).

Kemeny's median in its classical form belongs to the first group of methods mentioned. It is based on the concept of pairwise comparisons. The aim of the paper is to present the use of Kemeny's median as an algorithm for determining group judgement.

Basic definitions concerning Kemeny's median as well as its modification proposed by B.G. Litvak are discussed (Litvak, 1982). The latter is based on the concept of so called preference vector. A given

component of this vector is equal to the number of alternatives that precede it in the preference order under consideration. Some heuristic algorithms making it possible to compute both of the medians are investigated.

The problem considered in the paper is the following: There is a set of n alternatives to be ranked by the group of K experts from the point of view of a given criterion or a set of criteria. It is assumed that their judgements have the form of preference orders and that ties can occur. One has to determine a group judgement being the aggregation of experts' opinions. For aggregation purposes two types of median mentioned above are used.

For a given preference order of n alternatives presented by the k-th expert the matrix A of pairwise comparison can be constructed. The elements of this matrix are defined as follows: $a_{ij} = 1$ when in expert's opinion element O_i is better than O_j, $a_{ij} = -1$ when in expert's opinion element O_j is better than O_i and $a_{ij} = 0$ when O_i is equivalent to O_j.

The notions of distance between two preference orders introduced by Kemeny and Litvak are presented. Moreover, for a given set of preference orders the distance of some preference order P from this set is defined. A preference order PM is the median of a given set of preference orders if in the sense of the distance considered it is the "closest" one to all the preference orders of the set under consideration (Bury et al., 1999).

The problem of determining the preference order minimizing the distance from a given set can be solved with the use of integer optimisation software (eg. CPLEX, MS Excel, LINDO), (Bury and Wagner, 2000). However, for the purposes of constructing an interactive computer system of group judgement support this may be neither convenient nor possible. Such a system, called Mediator plus, is being developed in the Systems Research Institute (Bury and Wagner, 2001). Therefore some heuristic algorithms, which make the task of determining Kemeny's median as well as Litvak median much more easy to handle, have been proposed. Some real life examples are presented.

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A Prototype of Distributed Modelling Environment

PIOTR CELEJ *and* PIOTR RZEPAKOWSKI

National Institute of Telecommunications, Warsaw, Poland

Keywords: modeling, distributed environment, object oriented programming

For an individual or organization wishing to use mathematical models for solving decision problems, there is a plenty of relevant concepts, methods, models, and software. Most of them reside on heterogeneous geographically distributed systems. There is a need to combine them in an efficient and coherent system. A natural way to do this is to apply internet technologies for communications and a web based front end to provide end user with an efficient access to modelling resources. Such a system can provide a distributed and sophisticated tools on user computer. The only software which is needed to use the prototype is a web browser. Such system requires a representation of a decision problems using various paradigms.

Modelling environment should provide such a functionality. Also implementation of communications techniques is needed. The system should operate on resources (data, models and solvers), which are geographically distributed on heterogeneous platforms. The program aim is to construct computational task on user's demand. The system helps to go through the whole modelling process by managing the use of resources for various modelling tasks e.g. building symbolic models, operating data sets, generating model instances, and analyzing them with various types of analyzes.

To fulfill the needs described above a prototype of distributed modelling environment is developed. The system is designed as distributed software operating with relational database. Main parts of the software are the user interface, supplier agents[2] and the broker - manager system. All parts are described here:

- The user interface provides user with all wizards and windows necessary to operate on resources registered in the system.
- The agents are responsible for managing and connecting resources provided by suppliers to the system and providing the interface of using those resources. Agents resides on supplier machines and manages passing the computational task to the resource and getting the results in return.
- The broker is responsible for managing metadata about resources and managing connections between them. It also handles a communications with database which stores this metadata. The broker resides on dedicated server with connections to all other parts of the system.

All three elements of the system use CORBA[3] for communications. CORBA technology allows the developer to declare interfaces of communication separately from the implementation. In this case elements of the system can be implemented in various programming languages. The user interface is implemented as applets which run on the Web. It provides functionality similar to windowed applications. The agents run computational tasks (that are constructed by broker) and manages results of computations. The broker keeps all the information about registered resources in a relational database which contains also the

[2] Small programs operating on resource owner machine. The agents are responsible for managing corresponding resources and communicate with the broker.

[3] Common Object Request Broker developed by OMG (`www.omg.com`)

location of resources. When a user wants to use a resource (e.g. data or model) or to perform a modelling task (e.g. solve an instance of a model), the system resolves resource references from database. It manages all steps of modelling process including composing computational task and forwarding it to the proper agent. The selected agent manages running the resources and returns the results (which become a new resource) to the broker. Broker identifies the user and provides the results to him or her. Accessing the resources is restricted. Every time a user needs to access the resource his or her access rights are checked. Users can also be assigned to groups with the same rights. All information about user rights and groups are also kept in the relational database.

One of resources available in the system is common model representation, called ALMOR[4], is based on SML[5] proposed by A. Geoffrion. Its purpose is to represent analytical models and to provide a modeler with a tool for defining different models using different modelling paradigms. ALMOR allows users to build a models with Object Oriented approach. The objects contain parameters and methods. Objects can consists of other objects which allows the users to build more complicated structures. ALMOR objects takes the advantages of Object Oriented Paradigm which includes inheritance and encapsulation. Models are defined as abstract objects, which corresponds to a symbolic representation and later can be instantiated with various data. Symbolic models and data are kept in the relational structure and, can be shared by users (e.g for developing other models).

The prototype of distributed modelling environment supports users in the whole modelling process consisted of constructing the symbolic model, instantiate the model with various data, and analyze the instances of the model with different kinds of analysis.

[4] Algebraic Model Representation
[5] Structured Modelling Language

A Bicriterion Routing Model for Multimedia Traffic

JOAO CLIMACO *and* JOSE CRAVEIRINHA *and* MARTA PASCOAL

University of Coimbra, 3000-033 Coimbra, Portugal

Keywords: Routing, Multicriteria Evaluation, Multimedia Applications

Routing problems in communication networks supporting multiple services, namely multimedia applications, involve the selection of paths satisfying multiple constraints of a technical nature, designated as QoS (Quality of Service) requirements while seeking simultaneously to ”optimise” the chosen objective functions. These objective functions are concerned with the necessity of minimising the consumption of transmission resources along a path and to obtain a minimal negative impact in all other traffic flows that may use the network. In general the specific models of these cost functions and QoS constraints depend on main technical features of the network and the type of multimedia ”calls” which are being routed from origin to destination. Typical objective functions are the number of arcs (usually designated as hops or links) and the cost of accepting a call in a link, as measured by an appropriate traffic model related with the bandwidth available in each link. As for the constraints on the paths, in the case of multimedia applications these are typically the minimal bandwidth required by the call and maximum allowed delay and jitter.

Although traditional models in this area were single-objective, in many situations it is important to consider eventually conflicting objectives. Routing algorithms that have been employed in current networks or proposed for this type of problem, are heuristics based on Dijkstra or Bellman-Ford shortest path algorithms.

Having in mind to explore the multicriterion nature of this type of problem we formalised a bicriterion model dedicated to calculating the whole set of non-dominated paths for traffic flows associated with multimedia services in multiservice networks. For this purpose an exact algorithmic approach was developed based on the bicriterion shortest path algorithm by Climaco and Martins [1] and on MPS algorithm [2] (a deviation algorithm for ranking shortest paths). The contents of this work are the following. Firstly the basic definitions and the mathematical formulation of the routing problem will be presented. The proposed algorithmic approach dedicated to calculating the set of efficient solutions will then be described. An application of this model to a specific routing problem of video traffic in a high-speed network, together with extensive computational results will be discussed. The computational implementation of the model and the results showed the fastness of the proposed approach in calculating the efficient solutions and suggest that it is attractive and flexible for the effective resolution of routing problems of this type in many practical situations, including networks with up to thousands of nodes.

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Dominance-Based Rough Set Approach: Features, Extensions and Application

KRZYSZTOF DEMBCZYŃSKI

Institute of Computing Science, Poznań University of Technology, Poland

SALVATORE GRECO

Faculty of Economics, University of Catania, Italy

ROMAN SŁOWIŃSKI

Institute of Computing Science, Poznań University of Technology, Poland

Keywords: Rough Sets, Decision rules, Multicriteria sorting

Classification is one of the most frequent decision problems. It concerns an assignment of the objects to pre-defined classes. The objects are described by a set of attributes. Very often, in analysed data, there may appear some inconsistencies corresponding to the situation where two objects having the same description are assigned to different classes. To deal with such an inconsistency, the rough set approach has been proposed by Pawlak in early 80's.

The Classical Rough Set Approach (CRSA) has often proved to be an excellent mathematical tool for the analysis of multiattribute classification problems. When the classes are preference-ordered and the objects are described by criteria, i.e. attributes whose domains are preference-ordered, the classification is called multicriteria sorting. Such situation is typical for data related to economic issues, like financial or marketing data. In this case the original rough set approach is failing. Consider, for example two firms, A and B, where the firm A is characterized by better economical parameters, but it is assigned to a class of higher bankruptcy risk than the firm B. This is obviously inconsistent with the dominance principle that requires that an object having a better (in general, not worse) evaluation on considered criteria should not be assigned to a worse class. Within CRSA, the two firms will be considered as just discernible and no inconsistency will be stated. Greco, Matarazzo and Słowiński have proposed an extension of the rough set idea called Dominance-based Rough Set Approach (DRSA) that is able to deal with inconsistencies typical for multicriteria sorting problems. The DRSA, as well as CRSA, ends with a set of decision rules induced from rough approximations of decision classes. In the DRSA the set of decision rules plays a role of a comprehensive preference model. It is more general then the classic functional or relational model and it is more understandable for the users because of its natural syntax. Recently, Pindur and Stefanowski have proposed more general rule syntax that involves special kind of hyperplanes.

In the presentation, we will show short overview of DRSA and its extensions: Variable-Consistency DRSA and Multi-Valued DRSA. We will also discuss applicability of further extensions of DRSA to cases, for which the decision criterion is continuous-numerical. The presentation will contain an illustrative example that shows the process of data analysis using DRSA and its extensions.

Catastrophic Risk Management and Welfare Growth

YURI ERMOLIEV *and* TATIANA ERMOLIEVA *and* JOANNE LINNEROOTH-BAYER

IIASA, Laxenburg, Austria

Keywords: Catastrophic risks, GIS-based modeling, welfare growth, robust loss-sharing and loss-mitigating strategies, insolvency constraints, CVaR risk measures, nondifferential stochastic optimization

The goal of this talk is to discuss a catastrophic risk management model that takes into account the specifics of catastrophic risks: highly mutually dependent losses, the lack of sufficient information, the need for long-term perspectives and geographically explicit analyses as well as the involvement of various agents such as individuals, governments, insurers, reinsurers, and investors. As an illustration we consider some important case studies from seismic prone regions in Italy and Russia, and a flood prone region in Hungary. Special attention is given to the evaluation of a public loss-spreading and loss-reduction program involving partial compensation to victims by the central government and the spreading of risks through a pool of insurers and financial markets. GIS-based catastrophe models and stochastic optimization methods are used to guide policy analysis with respect to location-specific risk exposures and decisions. We use economically sound risk indicators strongly connected with the insolvency constraint and CVaR, and sustained welfare growth of regions. The resulting management policies combine purely adaptive (ex-post) decisions with forward-looking (ex-ante) anticipative strategies to ensure their robustness against uncertainties.

Optimal Social Security System Financing

TATIANA ERMOLIEVA

International Institute for Systems Analysis, IIASA, Laxenburg, Austria

Keywords: Social Security Risks, Optimal Composition of Pension Arrangements, Intergenerational Fairness, Stochastic Optimization, Expected Shortfall Indicators

Aging processes now typical for industrialized countries pose significant strain on the dominating public social security sector and overall economic performance of these countries. They raise a question on intergenerational fairness: "Who pays for retirement?" To overcome scarcity of the labor force as well as economic uncertainties, a lively discussion takes place about an appropriate combination of pension pillars that would guarantee to workers and retirees sufficient level of consumption. In this talk we address issues of optimal social security composition in the contents of an overlapping generations growth model designed to track accounts of households as they receive incomes, consume, and save for retirement in various financial institutions and pension arrangements. Two sources of uncertainty are considered the possibility of lower-than expected fertility and mortality (the main downside demographic risk factor) and uncertain capital returns. Stochastic optimization goal function measures exposure of households and social security pillars towards risks. It maximizes the expected weighted consumption utility of young and old, thus establishing fairness between the generations, and is formulated using value-at-risk and conditional-value-at-risk indicators (shortfalls and conditional shortfalls). Also, it takes into account specific for social security long-term liabilities.

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Lifestyle Change by Ubiquitous Information Technology

MOTOHISA FUNABASHI *and* KATSUMI KAWANO *and* SHIGETOSHI SAMESHIMA

Systems Development Laboratory, Hitachi, Ltd., Kawasaki, Japan

Keywords: Ubiquitous Computing, Super Distributed Objects, Lifestyle Change

We are going to have very economical devices equipped with processing and wireless communication capabilities based on recent micro-mechanics systems technology. Ubiquitous information society is expected to appear where appliances with such devices carefully support human activities through networking each other. So far Internet and mobile technologies have mediated and extended human communication capabilities. The technologies have contributed to free human being from position constraints. However, this causes exceeded virtualization in thinking way of human that results in causing new type of crimes often.

Ubiquitous information technology has potential capability that makes human to come back to real world from exceeded virtual world. We have developed a prototype system for home application of ubiquitous computing technology based on our SDO (Super Distributed Objects) idea [1]. By using this prototype system, we have conducted a survey of reactions of housewives to introduction of the ubiquitous technology to their everyday lives. The survey suggests that there is an opportunity forming real world community because of nature of the technology.

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Framework of Methodology Base for Knowledge Management

FEI GAO *and* YOSHITERU NAKAMORI

Graduate School of Knowledge Science, Japan Advanced Institute of Science and Technology

Keywords: Critical Systems Thinking; Knowledge Management; Total Systems Intervention; System of Systems Methodologies

In the past thirty years business related knowledge has grown more and more to dominate other socio-economic factors and become one of the most important elements in economic development. As the characteristics, nature, and function of knowledge are totally different from the other traditional production factors. The traditional approaches and ways of thinking about managing production factors ceased to be effective in managing knowledge. Knowledge and knowledge management requires new way of thinking and new techniques to deal with the complexity and complicatedness. In our previous study, we classified organizational knowledge into two aspects: static substance knowledge and dynamic process knowledge. Static substance knowledge, as impersonal-specific-organizational knowledge accumulated over time, consists of visionary knowledge (organizational vision, mission, ethics, and morals), objective and/or subjective knowledge (scientific-aspect knowledge, technological-aspect knowledge, and managerial aspect knowledge), and generic knowledge (information and data) in a hierarchical structure. Dynamic process knowledge, as human practical activity system or an assembly of knowledge workers and other resources (both hard and soft ones) organized as a whole to accomplish organizational goals, is composed of high-autonomy human activity system (defined vision or mission), autonomy human activity system (defined goals), and deterministic human activity system (defined problems). Our analysis also showed that knowledge management in economic organizations is to manage the activities of knowledge workers through offering both ”hard” and ”soft” support to enable a high-quality environment, in which they do two things effectively and efficiently: (1) use their personal knowledge and existed available knowledge to abstract, codify, categorize, compile, and create static substance knowledge and arrange it systematically into the form of substance knowledge system to make the system be easily and friendly accessed and utilized by those who need it for work; (2) transform their personal knowledge and available existed knowledge into products and services.

In this paper, we briefly introduce a modern systems philosophy-critical systems thinking (CST) and its implementation tool-total systems intervention (TSI) developed by Flood and Jackson. Then, we use them as a thinking guide and a meta-management-technique to discuss the framework of methodology-base for supporting knowledge management for both knowledge managers and knowledge workers.

CST has three theoretical commitments which are (1) critical awareness (observing and thinking critically and consciously at both theoretical and practical levels), (2) emancipation or improvement (holistically considering humanity or the ethical and moral dimension), and (3) pluralism (in the broadest sense to compensatively use of different methodologies, methods, and techniques in applied disciplines). TSI has three phases labeled as (1) creativity (appreciating different opinions, methods, and techniques; understanding the strengthens, limitations, and weaknesses of them; finding out the most crucial issues or concerns), (2) choice (choosing an appropriate systems-based intervention methodology or set of methodologies to address the problem situation), and (3) implementation (using a particular systems methodology or set of systems methodologies to arrive at and implement specific proposals to bring about change in those aspects of the organization currently vital for its efficient, effective, and ethical functioning).

The philosophy of CST and the spirit of TSI make both knowledge managers and workers the leading figures in their specialties equipped with modern systems thinking and methodology. They can broaden the minds of knowledge managers to critically and continuously ”sweep in” ”new” ideas, approaches, models, and techniques in practice and appreciate and utilize them to understand and inspire knowledge workers. Likewise, CST and TSI make knowledge workers appreciate and understand each other through interactive dialogues and constructive debates that is the guarantee of perfect cooperation. The morale of individual learning will lead to continuous organizational learning, which is a crucial element of a qualified competitive enterprise in an ever-changing world.

The framework of the methodology-base for supporting knowledge management is classified into three dimensions: human, value, and autonomy level dimension. Human dimension is divided into knowledge managers and knowledge workers; value or culture dimension is grouped into unitary and pluralism; and autonomy level of the activity is categorized into high-autonomy activity (defined mission or vision), autonomy activity (defined goals), and deterministic activity (defined problems). Based on the classification of problem contexts and the system of systems methodologies in TSI, we introduce other theories and approaches developed from the fields of management (e.g., R&D management, project management, innovation management, management of technology, organizational behavior, and organizational psychology) like Nonaka and Takeuchi’s knowledge creation theory, Leonard’s unique innovation competitive advantage, Wiig’s intelligent action, Edvinsson & Malone and Sveiby’s visualizing and cultivating intellectual capital or intangible assets, Petrash’s licensing intellectual capital, Boisot’s information perspective, Davenport and Prusak’s working knowledge, and Mintzberg’s covert leadership, to form a concrete toolkit for supporting knowledge activities.

Application of Data Mining to Network Management

JANUSZ GRANAT

National Institute of Telecommunications, Warsaw, and
Institute of Control and Computation Engineering, Warsaw University of Technology, Poland

Keywords: network management, data mining, fault detection

Data mining is becoming a powerful tool in various application areas. We will focus in this presentation on intelligent software support for network management. Existing tools that supports network management provides functionality of network monitoring and configuration of network devices. Administrator of the network have to detect failures and changes in quality of services by analyzing various graphs and reports. These tools were sufficient in case of simple network configurations. As complexity of network increases even an experienced administrator has problems with recognizing unexpected behavior of the network. The network devices generate huge amount of data that characterizes behavior of the network. This information usually is stored only for short period of time, and is used for network monitoring. However, this data can be stored in a data base, or in a data warehouse, and can become a source of significant knowledge for network administrators. Such knowledge might be extracted by data mining approach.

We will present the preliminary results of the project focused on applying the advanced data mining algorithms to network management. These algorithms can be used for network administrators on operational level e.g. for fraud detection as well as for strategic planning e.g for optimal expanding of the network. We can distinguish four phases of data processing. In the first phase the software, provided by the producer, that is installed on the devices store elementary data related to the work of specific device. Usually the data is stored only for short period of time. Therefore, in the next phase we will provide a tool for capture and store data on the intermediate server. There are various solutions that might be applied at this stage including installing the dedicated hardware. In our case we applied software solution based on SNMP (Simple Network Management Protocol). The PERL scripts run on intermediate server and send the messages to the devices. As a response the devices send the required data. After this step we have rough data on intermediate server. The software for the next step is installed on analytical server. The rough data must be transformed to the format required by analytical tools. Then we can use the data mining algorithms. At the beginning we have used tools available on the market. We formulate data mining goals like fault detection and finding the week point of the network that should be upgraded. This research give us a guidelines for further algorithms developments. The main conclusion was that we had to develop a dedicated temporal data analysis algorithms in order to have a better results. This is the subject of research of the currently running project.

A Neural Network Approach to the Solution of Optimization Problems in Computational Engineering

MANFRED GRAUER *and* OLAF ARNDT *and* THOMAS BARTH

Dept. of Information Systems, University of Siegen

Keywords: neural networks, simulation-based optimization problems, computational engineering

Typically, the optimization of products, planning, or production processes is characterized by the fact that a lot of parameters affect the result. Unfortunately, in many cases it is impossible to predict their explicit or implicit influences, and sometimes influences are not even known precisely. Formally, an optimization process can be defined as a pair comprising an objective function and a set of constraints on the variables of this objective function. The goal of the optimization is to find optimum values of these variables that lead to an optimum value - either minimum or maximum - of the objective function. Optimization problems have to be solved in many real-life systems. These systems can be mechanical structures (e.g. in automotive or aircraft design and manufacturing), environmental systems (e.g. groundwater management, wastewater treatment), or any other system with complex interdependencies determining their behavior. Expensive computations have to be performed to simulate the behavior of even simplified models of these systems. The results of numerical simulations of these systems are e.g. the weight of a mechanical structure, internal stresses of a structure, or the groundwater level in a certain region. In terms of optimization, these values are the values of the objective function or of constraints. Typically, optimization needs hundreds or even thousands of simulations to find an improved solution of an optimization problem. Therefore, one must decide whether using small (inaccurate, fast to compute) models or large (accurate, long-running simulation) ones during the optimization. Applying techniques from distributed computing to speed up optimization is an approach which has proved to be suitable for a certain reduction of computation time. Using improved methods to generate new realizations from a limited number of simulations results in a significant reduction of simulation effort required.

Simulation systems are often handled as a kind of black box, as their internal structure is usually unknown. Neural networks are also known as a black box-type solution to reproduce physical processes by learning formally measured data, so that they are able to predict results from new, unknown input values; their potential to solve industrial problems has been demonstrated in many different application areas. The basic idea of the approach presented in this paper is to combine simulation and neural networks, so that results computed by simulation can be used to train a neural network, and then to optimize the problem using predicted values produced by the neural network. Since a neural network – once trained – could predict the results for many input data sets very fast, the demand for computational power raised by optimization could be substantially reduced. Time-consuming simulation has to be used just for creating the required training set and to monitor the validity or precision of the predicted values.

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Study on the Metasynthesis of Data, Information, Model and Expert Opinions

JIFA GU *and* XIJIN TANG

Graduate School of Knowledge Science, Japan Advanced Institute of Science and Technology, Ishikawa, Japan

Keywords: Metasynthesis, consensus building, model integration

For some complex system problems it is often the case we couldn't only use the data and models to solve them, We have to combine the human judgment (qualitative) and mathematical models (quantitative), even more we have to use the Metasynthesis from qualitative to quantitative approach proposed by Prof. Qian et al. This Metasynthesis approach suggested that when solve the problems arisen in the open giant complex system, we must integrate the Data, Information, Knowledge, Models and expert opinions with the help of advanced computer technology. In order to realize this approach there were a lot of Chinese researchers engaged in it. In June of 1999 The National Natural Science Foundation of China (NSFC) had approved a large key project titled in "Metasynethetic systems with combination between man and machine for decision support of macroeconomics" (1999-2003). There are four subprojects in this project:

- P1. Information and model systems for macroeconomics and their functions;
- P2. Metasynthetic systems with combination between man and machine and supporting environment;
- P3. Metasynthetic method systems and systematology researches for decision support of macroeconomics;
- P4. Knowledge discovery system (KDD) and cognitive researches for macroeconomics.

The main task of subproject P3 is to find the way to realize this approach. After two years research the three research organizations in this subproject-P3 Shanghai Jiaotong University, Xian Jiaotong University and Institute of Systems Science had found some techniques and ways to realize the task individually. Shanghai Jiaotong University had developed the Multi-agent technology to integrate the forecasting models for macroeconomics and Feasible Desirability Method (FDM), Xian Jiaotong University had developed the design of "common brain" to support unstructured group process. Institute of Systems Science provided the consensus building and metasynthesis reconstructability analysis (MRA). After several discussions we had integrated all these techniques and methods altogether and used the web technology to connect them.

Developing Autonomous Flight Control Systems for Unmanned Helicopter by Use of Neural Network Training

KOICHI INOUE *and* HIROAKI NAKANISHI

Graduate School of Engineering, Kyoto University, Kyoto, Japan

Keywords: Neural Network, Unmanned Helicopter, Autonomous Flight Control

Interim results will be reported obtained from a three year on-going project, funded by the National Funding Agency of Japan, the object of which is to fly an unmanned helicopter autonomously and to apply it for monitor and rescue activity in case of natural or manmade disasters. The project is of collaborative efforts between a group in Kyoto University and a group in Yamaha Motor Co. LTD. , a major producer of unmanned helicopters for agricultural uses. Our presentation will include:

- Methods to design robust feedback control systems by training neural networks using either simulators or real controlled objects are proposed. Since any detailed information about the controlled object is not required in the proposed training algorithm of neural networks, then our methods can be easily applied to general control systems design at least in principle. Our methods quantitatively give us the degree of robustness of the trained neural network controller and it is even possible to implement required robustness into the controller by training. Moreover, by adding online training of neural networks, it is possible to compensate undesirable effects which are not modeled or sudden changes of the target and environment, therefore the control system can be highly reliable.
- Proposed methods are applied to designing an autonomous flight control system for an unmanned helicopter in monitoring and observation activity in natural or manmade disastrous environments such as volcanic eruptions.
- Neural network based autonomous flight control systems have been implemented on the unmanned helicopter "RMAX" produced by Yamaha Motor Co. LTD. . Experimental flights are now going on in the test field. Video of some experimental flight tests will be shown.

Two Directions toward Generalization of Rough Sets

MASAHIRO INUIGUCHI *and* TETSUZO TANINO

Graduate School of Engineering, Osaka University, Osaka 565-0871, Japan

Keywords: Rough set, similarity relation, cover, rule extraction

Rough sets [5] provide useful tools especially in data analysis. Rough sets are originally defined under an equivalence relation. In order to extend the ability, rough sets have been generalized under a similarity relation [6], a dominance relation [2] and a fuzzy relation [1, 3]. It is shown that two kinds of generalizations can be obtained by interpretations of rough sets [4]. One interpretation is rough sets as distinction among positive, negative and boundary elements and the other is rough sets as approximations of sets by means of elementary sets. Previous generalizations may be classified into those two categories.

Such a classification will be important for developing the methods consistent with interpretations of rough sets. If the proposed method was not consistent with an interpretation of rough sets, it would be meaningless or at least ad hoc. In other words, we should design a rough set method consistent with the interpretation. However, the difference between methods based on the two interpretations has not yet clarified.

In this paper, under a given similarity relation, we define rough sets in two different way. One is based on the interpretation of rough sets as distinction among positive, negative and boundary elements and the other is based on the interpretation of rough sets as approximations of sets by means of elementary sets. For the former interpretation, we consider a set with a vague boundary and we estimate the sets of unquestionable and possible members from a given set under an assumption that only elements which are similar to an unquestionable member can be regarded as questionable members. Thus, we use a similarity relation. On the other hand, for the latter interpretation, we build meaningful groups of elements so that the collection of groups form a cover and we define a lower approximation by a union of groups and an upper approximation by an intersection of complements of groups. The fundamental properties are examined in those two kinds of rough sets under the generalized setting. The definability is also discussed for two definitions of rough sets.

Finally, we discuss the rule extraction from information tables based on those rough sets. We demonstrate that the extracted rule type corresponds to the interpretation of rough sets. In the interpretation of rough sets as distinction among positive, negative and boundary elements, safe but passive if-then rules are obtained. On the other hand, in the interpretation of rough sets as approximations of sets by means of elementary sets, active and expansive but conflicting if-then rules are obtained. Those characteristics are demonstrated by simple examples.

Both extracted if-then rules have their own advantages and disadvantages. Therefore both approaches are susceptible of modifications, which would be a future topic. Moreover, in the latter interpretation, a relation is not necessary to define rough sets but a cover is. Thus, this interpretation can be more useful in the sense that we can obtain a cover more easily than a relation.

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A Flexible Management Method of Supply Chain by Using Logistics Information with RF-ID Tag and Bluetooth

NORIHISA KOMODA *and* YOSHIOMO IKKAI *and* HIRONORI OKA

Osaka University

Keywords: Supply Chain Management, RF-ID Tag, Bluetooth, Picking

Background

A supply chain is a network of facilities in order to supply customers' products according to their demands. It consists of several companies' facilities, and materials are processed, constructed, and delivered through them. Recently, companies have become more integrated and production has been diversified. Therefore, the structure of a supply chain becomes very complex.

In order to deliver products to customers by the appointed time, each company has to have inventory of final or intermediate products. However, superfluous inventory causes excessive cost, and may become risk when the product's lifecycle is short. Because of the difficulty to pursue the movement of intermediate product in a factory or logistics, it is not easy to realize the efficient supply chain management.

A Constraction of Flexible Supply Chain by Using RF-ID Tags and Bluetooth

In this research, a concept of the flexible supply chain management by using two wireless communication technologies, the radio frequency identification(RF-ID) tags and Bluetooth. The construction of the system is following;

- Each intermediate product has a **RF-ID tag**, which contains the information of the product ID, the product type, the number, and the customer name to be delivered(if decided).
- A small terminal where **Bluetooth** is installed is attached to each container which carrys many intermediate products. The terminal records the product information of the products in the container.
- **Handy terminals** are introduced for logistics operations in the warehouse, for example, picking, cross-dock and so on. The handy terminal has RF-ID tag reader/writer and Bluetooth. Whenever the handy terminal is connecting to the RF-ID tag and/or the small terminal. It can read the information stored in the RF-ID tag and the small terminal. And, it can also update the information if those logistics operations are performed.
- The handy terminals also send or receive the information by wireless LAN to/from a **inventory computer** which manages inventory information of the warehouse.

In this system, a worker for picking and cross-dock in warehouse has the handy terminal. When he/she searches a target product in the warehouse, he/she selects the ID of the product from the product list which is sent from the inventory computer and walks around the warehous. The handy terminal tries to connect all the small terminals which has connectable Bluetooth(the communication range is about 10–20m), and queries whether they have the ID infromation to them. When he/she comes near the small terminal which has the target ID, the handy terminal gets the answer through Bluetooth connection

and alarms the detection. After the detection, the handy terminal tries to read the RF-ID tag near the terminal(the communication range is about 30cm). When it finds the RF-ID tag which has the target ID, the terminal informs this information to him/her and he/she can find the target product easily near the handy terminal.

The advantages of this system are following;

1. In this system, all intermediate products are assigned ID. Current information about intermediate products in the supply chain can be identified in real time. Because of this supervision, it becomes possible that the intermediate product on transportation can be regarded as a virtual inventory. Therefore, total inventory in the warehouses can be reduced.
2. The logistics activities in warehouse, for example picking, cross-dock and so on, can be performed efficiently and accurately. This shortens the time of the activities and it leads to efficient supply chain flow.

A Flexible Supply Chain Management Method

Against the proposed supply chain system by using the wireless communication technologies, a flexible supply chain management method is proposed, where the realtime and accurate information of intermediate products on logistics is made full use of. ¿From the forecast of customers' demand and transportation time, the virtual inventory points and the numbers of each virtual inventory on the logistics are decided. Production, transportation and inventory management are built up on the base of the virtual inventory concept. The management algorithms and the tuning methods of the parameters in the algorithms are proposed.

In order to evaluate the proposed supply chain system and management method, we have developed a prototype system of the proposed supply chain management using RF-ID tags and Bluetooth. By applying those to a supply chain model, the effectiveness of the proposed method is confirmed.

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Modeling Innovation Activity: Multicriteria Optimization versus Utility Approach

LECH KRUŚ

Systems Research Institute, Polish Academy of Sciences, 01-446 Warsaw, Poland

Keywords: modeling, decision support, innovations, risk, financial analysis

The paper deals with decision analysis and support in the case of risky investments. Let us consider a research project aimed to construct an innovative product. The project requires resources concentrated within the time T, to finish the investment and start selling the product. The project can succeed or not. Longer the time T results in greater probability of success but in lower financial return. The innovative product is in this case selling on the market later and is less competitive to other products. From the point of view of decision-maker that invests, the project can be evaluated by expected capital return and by a measure of risk involved. Using a model (called substantial model of the problem) describing the expected capital return and a measure of risk, two approaches supporting decision analysis will be discussed.

The first is based on multicriteria optimization. In this case preferences of the decision maker are not included in the model. Using the substantial model and modern optimization techniques the decision-maker can scan pareto frontier of attainable outcomes in the space of his criteria. The scanning made in an iterative way by a learning procedure, see reference point approach (Wierzbicki 1986), (Wierzbicki, Makowski, Wessels 2001) enables the decision maker to find his best, nondominated, preferred outcome.

The second approach utilizes also the substantial model but the preferences of the decision maker are described by a utility function. The outcome maximizing the utility is also the best for decision-maker if the function accurately describes his preferences in this maximization point. In general preferences of the decision-maker can not be assumed to be constant. Therefore the constant, evaluated only once utility function can be hardly utilized for decision support. The utility approach is discussed including the view by Savage 1954) and results of mathematical psychology (Tversky 1967), (Coombs, Daves,Tversky 1970). In these papers, on the base of experiments which have been made, there are attempts to explain and describe how a man percepts and takes the risk into account in his decisions. Using the results, it seems, new view on the utility function approach in the decision support will be presented. An interactive procedure enabling the decision-maker to analyze the problem will be proposed. In the procedure, using pair wise comparisons made by the decision-maker, the utility function describing his preferences is successively reevaluated. Application of the procedure in computer based systems will be discussed.

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A Structured Approach to Multi-paradigm Modeling

MAREK MAKOWSKI

International Institute for Applied Systems Analysis, A-2361 Laxenburg, Austria

Keywords: modeling paradigms, decision support systems, object-oriented programming, robustness, multi-criteria model analysis, model management, distributed systems.

1. Background

Modeling is a network of activities, often referred to as a *modeling cycle*, or a *modeling process*. Typically, such a process starts with an analysis of the problem, and a selection of a modeling paradigm, i.e. of types of variables and the mathematical relations between them, which are translated into a *model specification* by either using a general purpose modeling tool or by developing a problem specific model generator. Different types of variables and relations are used depending not only on the kind of problem modeled, but also on the choice of model type that is relevant to its future use, available data, and resources for model development, analysis and maintenance. For any non-trivial problem, model specification is an iterative process which involves a series of discussions between developers (typically OR specialists) and users until a common understanding of the problem and its model representation is agreed. A *model instance* is defined by the model specification and a selection of data that define parameters of its relations. During the model implementation several model instances are created and tested in order to verify that the symbolic model specification is properly implemented. Model instances differ by various selections of data used for *instantiations* of the model specification. Typically many instances of a model are used for different sets of data corresponding to various assumptions that the user wants to examine in order to check to what extent the model adequately represents the problem. The data typically come from different sources (often also as results of analysis of other models); therefore, assembling and making data complete and consistent (e.g. defined in units consistent with specification of model relations) is a resource consuming process.

The next phase of the modeling process is *model analysis*. A typical decision problem has an infinite number of solutions, and users are interested in those that correspond to their preferences (assumptions, trade-offs). Therefore, a properly organized analysis of a model is the essence of any model-based problem support. Properly organized means that the user is supported in using all relevant methods of analysis, comparing the results, documenting the modeling process, and also in moving back to the first stage, whenever he/she wants to change the type of the model (e.g. for handling uncertainty, or imprecision of model parameters using a different type of variables or relations). During the model analysis different *computational tasks* are generated and solved by *solvers*, which are software specialized for specific types of mathematical programming problems.

2. Modeling paradigms

A *modeling paradigm* embodies the consensus of a scientific community on development and analysis of a model, and consists of the theories, laws, rules, models, concepts, and definitions that are generally accepted in science and practice, as well as of corresponding modeling tools. Due to the unquestionable

success of modeling in problem solving, various modeling paradigms have been intensively developing over last few decades. In this, to a great extent case study driven process, a growing tendency to focus on specific methodologies and tools was observed. Therefore different types of models (characterized by types of variables and relations between them) were developed (e.g. static, dynamic, continuous, discrete, deterministic, stochastic, set-membership, fuzzy, soft constraints) to possibly best represent different problems by a selected type of model. Moreover, different methods of model analysis (e.g. simulation, optimization, soft simulation, multicriteria model analysis) have been developed to best support various types of model analysis for different purposes and/or users. Finally, due to the growing complexity of various computational tasks, solvers have become more and more specialized, even for what was originally the same type of mathematical programming problem.

All these developments have been rational from the point of view of providing more efficient solutions for specific types of models or elements of modeling process. However, as a consequence of this long-term development, it has become increasingly difficult to apply all pertinent paradigms to a problem at hand. Models have become complex and/or large, therefore development and use of a model with even one specific paradigm is a costly and time-consuming process. Moreover, incompatible model representations used by different paradigms imply that resources used for modeling with one paradigm can hardly be reused when another paradigm is applied to the same problem.

Each modeling paradigm embodies a lot of accumulated knowledge, expertise, methodology, and modeling tools specialized for solving many of the problems belonging to each modeling paradigm. However, these resources are fragmented, and using more than one paradigm for a problem at hand is too expensive and time consuming in practice.

Multiparadigm modeling, defined as efficient application of all pertinent modeling paradigms, is one of the key issues of modeling complex problems. In some situations it is possible to use a more general paradigm, which "includes" a simpler paradigm.[6] Therefore instead of using a more general paradigm (one can formally treat a linear model as a non-linear one), it is rational to use a *unifying paradigm*, e.g. supporting non-linear models with (possibly large) linear part. However, in other situations it is not practicable to unify different paradigms. In such situations one needs to *switch paradigms*. The substantial difference between switching (within properly organized modeling process) paradigms, and applying different paradigms "independently" consists of appropriate handling of these elements of modeling process, which are common for different paradigms, and to support comparative analysis of results obtained with the help of applied paradigms.

3. How multi-paradigm modeling can be effectively supported

While the scheme of the modeling process did not change substantially, the complexity of each of its components has substantially increased. Therefore the existing modeling tools cannot provide adequate support for modeling of complex systems, and a new approach needs to be developed.

There are obviously two extreme approaches to provide support for multiparadigm modeling. The first is to leave the choice of a paradigm to a user, thus to support use of each paradigm by specialized software. However, such an approach (which is the-state-of-the-art in modeling) is actually not applicable to complex problems. The second is to integrate the relevant modeling paradigms.[7] This is not a promising approach for several reasons. First, many paradigms use very different model representations, therefore a design of a common representation for all existing leading paradigms would not be practicable. Second, it is by now commonly agreed that the problem of software integration remains open despite huge resources devoted over many years to find solutions to this problem. This is especially difficult for software specialized over the years for efficient handling of very different types of problems.

Therefore, a rational solution to support multiparadigm modeling is to provide an environment to exploit a large part of modeling legacy without any attempt to integrate various modeling paradigms and

[6] E.g. building a non-linear model, which contains a linear part. However, even in such a case it is typically rational to use non-linear and linear paradigms to respective parts of such a model.

[7] Integration in this context would mean to design a new modeling environment, which will support a selected subset of modeling paradigms and/or integrate selected modeling software.

software that supports them (such an attempt would result in another, rather closed, modeling system which could hardly be used with other modeling resources).

Two novel (not only new but requiring solutions of relevant scientific problems) elements need to developed for such a modeling environment. First, a structured model representation supporting leading modeling paradigms. Second, knowledge-engineering-based methods adapted for managing modeling resources and supporting developers and users through the whole modeling cycle. These two elements will make it possible to dynamically compose applications that will support modeling activities according to the needs and preferences of developers and users of models, and exploiting the richness of all relevant paradigms.

The first key element is a structured model representation supporting leading modeling paradigms will make it possible to represent various modeling tasks in formats suitable for software that is specialized for a particular task. This will facilitate exploiting all commonly known advantages of object-oriented approach (especially the power of inheritance, which allows for sharing resources for common tasks, and for specializing methods when required for specific tasks). The second needed element consists of knowledge-engineering methods adapted for management and use of modeling resources (models, data, modeling tools), and for guiding a user through the whole modeling cycle while supporting a number of diversified modeling paradigms. This has become a necessary element of any multiparadigm environment, because variety and complexity of modeling paradigms and modeling resources makes it impossible to effectively use them without knowledge-engineering-based support. Such a support is in fact more and more important for even a selected modeling approach applied for problems in a specific domain.

4. Instead of conclusions

One needs to explain how one can succeed in providing multiparadigm and multidisciplinary modeling support, if it is known that providing a platform for a single paradigm modeling support in some specific domains is so difficult. It is the power of abstract, precisely and consistently defined, and structured representations of algebraic models. A quick look at the success of the MPS format clearly shows, that it indeed does not matter from which domain of application or from which modeling paradigm an LP problem originates. This observation shows that from the mathematical point of view, it should not be more difficult to support multiparadigm multidisciplinary support than to support a single paradigm support in a selected domain, if both can be properly represented by the same type of abstract mathematical model. However, in order to make it possible, one needs a common model representation. The wide acceptance of the MPS format, and of several commonly used modeling environments shows that a wide acceptance of a structured representation of algebraic models that supports multi-paradigm modeling is likely. The theoretical foundations for such a representation are provided e.g. by SML developed by A. Geoffrion and his collaborators. Combining the solid mathematical foundations with the object-oriented paradigms and tools makes it possible to develop a structured model representation that will in turn make it possible to effectively support multi-paradigm modeling.

Two other presentations at the CSM'02 workshop are closely related to the ideas summarized here. First, by A. Beulens and H. Scholten (cf page 3) discussed how the legacy of ontologies can be used for multi-paradigm modeling. Second, by P. Celej and P. Rzepakowski (cf page 8) will deal with a prototype of a distributed modeling environment, and will therefore discuss possible approaches to a practical implementation of a structured approach to multi-paradigm modeling that exploit resources (data, models, and modeling tools) available on heterogeneous hardware connected through the Internet.

Acknowledgment

Several ideas presented here have resulted from many discussions and joint activities of the author with A. Beulens, A. Geoffrion, J. Granat, H. Scholten, H-J. Sebastian and A.P. Wierzbicki.

Mobile Decision Support System: Design and Implementation

WOJTEK MICHAŁOWSKI

School of Management, University of Ottawa

ROMAN SŁOWIŃSKI

Poznan University of Technology

SZYMON WILK

Poznan University of Technology

Keywords: DSS, clinical decision support, design, implementation

The paper describes an approach and methodology used to design and to develop a mobile DSS that can be used to support end-user during the decision making activity irrespective of a location and decision environment. It discusses computer architecture of such a system and its basic functions, including electronic data capture facility. The MET system (Mobile Emergency Triage) that supports clinical triage decisions of the emergency room staff is used as an example to illustrate specific design and implementation solutions. This system facilitates triage of a child presenting to a hospital with one of the following conditions: abdominal pain, scrotal pain, or syncope. Main processing component of MET is implemented on a stand-alone computer using the XTND Connect Server software, while its mobile front-end component is implemented on Palm handheld using Appforge RAD software. The experiences assocaited with development and implementation of MET are also discussed.

MOP/GP Approaches to Data Mining

HIROTAKA NAKAYAMA

Konan University, Kobe 658-8501, Japan

Keywords: Data mining

Recently, data mining is attracting researchers' interest as a tool for getting knowledge from data bases with large scale. Although there have been several approaches to data mining, we focus on the mathematical programming (in particular, multi-objective and goal programming) approaches.

One method for knowledg acquisition from data-bases is to utilize machine learning techniques for finding an implicit rule based on the decision boundary which is nonlinear in general. Due to this non-linearity of decision boundary, artificial neural networks have been widely applied to our aim. However, since the well known back propagation method can be reduced to a nonlinear optimization problem, it meets with difficulties in finding the global optimal solution as well as in deciding its structure. One of most popular methods in recent years is support vector machine (SVM).

In pattern classification problems with two class sets, its idea is to find a maximal margin separating hyperplane which gives the greatest separation between the classes in a high dimensional feature space. This task is performed by solving a quadratic programming problem in a traditional formulation, and can be reduced to solving to a linear programming in another formulation. The idea of maximal margin separation is not quite new: in nighteen-sixties the multi-surface method (MSM) was suggested by Mangasarian. MSM gives a piecewise linear decision boundary for two class sets by solving successive linear programming problems. MSM, however, sometimes provides too complex decision boundary resulting in a poor generalization ability. The author has suggested several devices to overcome the difficulties of MSM. One of them is to apply techniques in multi-objective programming and goal programming. This idea can also be applied to SVM.

This talk presents a survey how MOP/GP techniques are effectively applied to machine learning, such as pattern classification. Furthermore, important topics in machine learning such as additional learning and active forgetting will be discussed along several practical examples in financial engineering and in civil engineering.

Evolutionary Optimization System (EOS)

ANDRZEJ OSYCZKA *and* STANISLAW KRENICH *and* JACEK HABEL

Department of Mechanical Engineering, Cracow University of Technology

Keywords: Evolutionary optimization, nonlinear programming, single- and multicriteria optimization

In the paper an Evolutionary Optimization System (EOS) is described. EOS is designed to solve single and multicriteria optimization problems for nonlinear programming models using the methods described in [1]. The system is equipped with the following evolutionary methods:

- For single criterion optimization
  - Proportional selection method with the penalty function method for handling constraints.
  - Bicriterion methods.
  - Simple tournament selection method with the penalty function method for handling constraints.
  - Constraint tournament selection method.
- For multicriteria optimization
  - Simple distance method.
  - Pareto set distribution method.
  - Constraint tournament selection method.

For multicriteria optimization the method of the indiscernibility interval can be used for selecting a representative subset of Pareto optimal solutions after running the assumed number of generation. For both single and multicriteria optimization methods the following models can be solved:

- with continuous decision variables,
- with integer decision variables,
- with discrete decision variables,
- with mixed continuous =96 integer decision variables,
- with mixed continuous =96 discrete decision variables.

In EOS chromosomes can have:

- binary representation,
- real number representation.

Crossover operations can be performed as follows:

- one point crossover,
- two point crossover,
- variable point crossover.

Mutation operations can be performed as follows:

- uniform mutation,
- non-uniform mutation for binary representation and for real number representation.

EOS is the user friendly computer program with the window structure. The way the system works will be presented during the workshop.

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Conflicts and Decisions

ZDZISŁAW PAWLAK

University of Information Technology and Management, 01-447 Warsaw, Poland

Keywords: rough sets, conflicts, decisions

Conflicts are one of the most characteristic attributes of human nature and study of conflicts is of greatest importance both practically and theoretically. Conflict analysis and resolution play an important role in business, governmental, political and lawsuits disputes, labor-management negotiations, military operations and others. To this end formal models of conflict situations are necessary. Many theoretical models of conflict situations have been proposed and studied, e.g., Casti, 1989, Coombs et al, 1988, Dorclan, 1969, Fang et al 1993, Maeda et al, 1999, Nakamura 1999, Pawlak, 1998 and Roberts, 1976.

Conflict analysis seems to be important for decision making. Rough set based decision support plays important role in decision theory, see e.g. Słowiński, 1995. In this paper we will outline basic ideas of conflict theory, based on author's previous works on conflict structure (Pawlak, 1998) and decision analysis (Pawlak, 2002) combining some ideas of conflict models and decision making in the framework of rough set theory.

We start our considerations with a very simple illustrative example concerning voting analysis in conflict situations. Next basic concepts of conflict theory will be formulated and decision making in the presence of conflict will be analyzed. Some possible applications will be discussed at the end of the paper.

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An Agent-based Approach to Data Classification

MINA RYOKE *and* YOSHITERU NAKAMORI

Japan Advanced Institute of Science and Technology

Keywords: Agent based clustering, data analysis

The clustering technique using the agent group is proposed in this paper. The reason to use agent approach are the following.

First reason is to grasp the hidden feature in the database. The proposed method differs from the conventional method in that it does not have the criterion of the clustering technique for the whole of the database. The agent has a role to find and collect data points so that similarity or some other feature can be large as much.

Second reason is to reduce the number of parameters in the conventional clustering technique. The parameters are required before performing the clustering method in the traditional way. It is not easy to give nice parameters in advance. So far, the user usually gives the parameters again and again like sensitivity analysis.

Third reason is to treat either numerical database or symbolic database, or the mixed database which consists of numeric and symbolic data. The agent does not require the necessary condition like the traditional clustering method.

The definition of the agents is a unit which can determine the feature as values. The agent can hold data point as a kind of territory. The feature is determined by similarity from the representative data point to objects, and linearity based on the belonging data points in this paper.

The outline of the algorithm is the following. The algorithm is consisting of two parts. In the first part, the agents try to have data points which has high similarity from the representative data point of the agent. In the second part, the agents try to find another agent in order to make the feature strong more.

The agents, here, will find a fellow taking into account of the linearity when the database includes only numerical data. Through the process, the representative point of the agent is determined dynamically when a data point moves in or it moves out. It is determined so that the representative point is always one of the pair which has a most strong similarity inside. Some simple examples will be shown in the presentation in order to illustrate the power of this technique.

Multicriteria Decisions in Complex Systems

SIGRID STAGL

Vienna University of Economics and BA Department of Economics, A-1190 Vienna, Austria

GIUSEPPE MUNDA

Barcelona University, 08193 Bellaterra, Spain

Keywords: multicriteria evaluation; decision theory; evolutionary theory; hierarchy; learning

Sustainability and human development are multidimensional concepts. This is why multicriteria methods are used increasingly as modelling tools for decision-making about issues including conflicting socio-economic and nature conservation objectives. Another characteristic of socio-economic and environmental systems is that they are complex. While the process of decision making was emphasised by many authors, multicriteria decision aid has been employed primarily in (sequences of) static settings. Taking into account the dynamic and behavioural aspects of a decision making process changes central components of the analysis, like the role of criteria or the number of alternatives entering the evaluation matrix.

In this paper we suggest a framework for an evolutionary model of suitable for decision making in complex systems.In doing so we build on epistemological and operational aspects of the theory of reflexive complex systems (Giampietro and Munda 2000; Munda and Giampietro 2000). In particular we: (1) provide the reasoning for a hierarchical and evolutionary multicriteria decision framework; and (2) we point to the analytical consequences of such a shift. The approach presented in this paper is evolutionary insofar as path dependencies as well as novelty are addressed. Path-dependency defines the set of dynamic processes where small events have long lasting consequences that can be modified, but only to a limited extent. The trajectory of a path-dependent process cannot be fully anticipated on the basis of the original events. Path-dependence is analytically generated by the overlapping of irreversibility, indivisibility and structural action (intentional change of taste; potentially through learning) of agents. It makes it possible to allow both, for the effects of past behaviour of agents on the structure of the environment and the Lamarckian survival of agents by learning and adaptation to the character of the environment. Through learning during the decision process one (or several) criterion/a can be found so important that they become a constraint. Hence, the categorisation of an influencing factor may be modified over time. This evolutionary approach should be distinguished from interactive procedures. Interactive procedures, at least the search-oriented ones, usually assume that decision makers have clear stable reference structures in mind and that they act in a consistent way with this structure (Munda 1993). In contrast the approach presented here may, for limited or unlimited periods of time, lead to an expanding decision space instead of convergence by iteration. Learning-oriented interactive procedures (e.g.

Bana e Costa, et al. 1999; De Marchi, et al. 2000) focus on problem structuring and feedback, but do not exclude temporary decision space expansion. Not only can criteria, weights and alternatives develop in a certain manner, they are also interdependent; there are complex feedback mechanisms between their variation and selection environment. Insofar, the approach presented here is co-evoltuionary (Norgaard 1984:161). As criteria, weights and alternatives change, novelty can emerge. In sum, each of the following, criteria, weights, and alternatives, are (a) influenced by a number of factors and (b) are interdependent. Constraints and criteria are applied in a step-wise process which may lead to a gradual or non-gradual narrowing or expansion of the decision space.

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Systemic Thinking to Developing a Meta-Synthetic Support for Complex Issues

XIJIN TANG

Institute of Systems Science, Academy of Mathematics and Systems Sciences, Chinese Academy of Sciences Beijing 100080 P.R.China

JIFA GU

School of Knowledge Science, Japan Advanced Institute of Science and Technology, Tatsunokuchi, Ishikawa 923-1292 Japan

Keywords: Meta-synthesis, system thinking, Wu-li Shi-li Ren-li approach

Meta-synthesis method is proposed to tackle with complex, open and giant systems by Chinese scientists Qian, X.S. and his colleagues around the start of 1990s. It emphasizes the synthesis of collected information and knowledge from various kinds of experts, and combining quantitative methods with qualitative knowledge. Later it is evolved into Hall of Workshop for Meta-Synthetic Engineering (HWMSE) which emphasizes to take advantage of breaking advances in information technologies. In 1999, Natural Science Foundation of China (NSFC) approved a major project aiming to implement a pilot prototype for HWMSE for macroeconomic decision making. The project lasts 4 years (1999-2003) and gathers around 50 researchers from 16 education and research units around the nation. According to a top-down framework of original design, those people participate 5 groups or subprojects of work respectively: Group 1. HWMSE platform; Group 2. Macroeconomic modeling; Group 3. Meta-synthesis method and macroeconomic method research; Group 4. Knowledge discovery and cognitive process analysis of macroeconomic decision making. There is another group in charge of whole system design and those 4 groups' work as called as Group 0.

Besides concentrating on respective research tasks, each member unit also engages in their own interested job based on their own past research achievements and understanding toward HWMSE even with the original top-down framework. Therefore, bottom-up research brought out similar methods or tools for communications, collaborations or consensus building in HWMSE. After two-year work, we have at least 4 so-called halls for meta-synthesis, all of which support brainstorming, Delphi method, and voting, which are main tasks of Group 1. There are also other particular tools. How to integrate those research results into a whole system for project sponsor is a big issue. And many debates and discussions were held among different groups and within Group 0.

Here we take a system thinking to the whole project, not only considering the integration task of current separate computer applications, but also think why those applications bubbled up as there are no extra fund for those additional work, why such a situation could not be avoided and how to tackle with those complex issues through communication-collaboration-consensus spiral process. Even some principal investigators prefer only integrating methods (modules) instead of whole applications into the Hall by Group 1, we propose our solutions for that. The finished and normally working halls are not a waste of this project, but enrich our understanding towards HWMSE. Then we can redesign our top-down framework based on bottom-up emerging applications. Instead a hall which integrates all methods and tools, we regard the other three halls as 3 distributed advanced seminar rooms for meta-synthesis, and hall at Group 1 as the master room. Those 4 rooms construct the prototype of HWMSE for macroeconomic decision making, where communication- collaboration-consensus methods, economic models

and databases can be shared. As one problem comes, people can see which room is better for its solution and enter an appropriate room for discussion. Thus we also achieve a top-down framework for HWMSE. Wu-li Shi-li Ren-li system approach is applied to resolving the integration and synthesis issues and example will be given to show how it works in Group 3.

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A Simulation Based Optimization Model for Systems Design of Earthquake Insurance

HIROKAZU TATANO *and* NGUYEN DINH PHUC *and* NORIO OKADA

Disaster Prevention Research Institute, Kyoto University

Keywords: Earthquake Insurance, Simulation Based Optimization Model, Stochastic Quasi-Gradient Method

The paper proposes a simulation-based optimization model for integrated seismic risk management. Since earthquake is a low-frequent and high-impact event, observed data is not enough to assess disaster risk and to find effective counter measures. Simulation technique is the fundamental technique to overcome this sort of data scarcity problem. It is desirable to find a good integrated management strategy based on simulation. However, counter measures in integrated risk management against disaster risk consist of risk control and risk financing measures and its combination is easily become prohibitively large number. As to find effective risk management strategy against seismic risk, performance measure that corresponds to a risk management strategy is often estimated based on huge number of scenarios of occurrence of natural hazard, such as expected loss, probability of corrupts. This requires to huge computational effort to estimate performance. Stochastic quasi-gradient method is introduced to cope with such difficulty. Integrated design model is formulated to find efficient insurance scheme under the constraint of sustainability of earthquake insurance for building. A case study is carried out in Hyogo prefecture in Japan to illustrate the applicability of the model.

Models of Cooperative Conflict Situations in Fuzzy Environments

MILAN VLACH

Japan Advanced Institute of Science and Technology

MILAN MAREŠ

Institute for Theory of Information and Automation, Czech Academy of Sciences

Keywords: Cooperative games, Fuzzy payoffs

Since the basic concepts of cooperative game theory were established by von Neumann and Morgenstern [1], much work has been done in developing and analyzing solution concepts of various types of cooperative games. Most of this literature is concerned with cooperative games in characteristic function form where the characteristic function is defined on the system of the subsets (coalitions) of a given set of players and its values are real numbers.

Already in the early days of the game theory it was recognized that some components of the concept of a cooperative game should be extended to take into account various types of uncertainty. One of the first steps in this direction from the point of view of fuzzy set theory were undertaken by Aubin [2], and Butnariu [3], who consider cooperative games with fuzzy coalitions. In this approach fuzzy coalitions are defined to be fuzzy subsets of the set of players. It can easily be seen that such fuzzy coalitions can be represented by points of the unit hypercube whose vertices correspond to the deterministic coalitions. The characteristic function of such a cooperative game with fuzzy coalitions assigns to each fuzzy coalition again a real number (worth of a coalition, payoff to a coalition). Then analogues of traditional multi-point or single-point solution concepts can be introduced in a natural way and analyzed by conventional mathematical methods.

In contrast to the Aubin and Butnariu approach, Sakawa and Nishizaki [4], and Mares [5] consider fuzzy games in which the domain of definition of the characteristic function of a game remains to be the system of deterministic coalitions but the values of the characteristic function are fuzzy quantities. In [3], Mares discusses some difficulties and disappointing features connected with this approach.

The main purpose of this paper is to present an alternative approach to the cooperative games with deterministic coalitions and fuzzy payoffs, which alleviates these difficulties both in the case of games with transferable and non-transferable utility. The basic idea of this alternative approach lies in considering fuzzy games as fuzzy subsets of the set of all deterministic cooperative games in characteristic function form over a given set of players. We show how this idea leads, in a natural way, to the fuzzy counterparts of the standard game theoretic concepts like supperadditivity, convexity, core, and Shapley value, and study their properties both for games with transferable and non-transferable utility.

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Systems Analysis and Future Studies: Methodological Issues

ANDRZEJ P. WIERZBICKI

National Institute of Telecommunications, 04-894 Warsaw, Poland

Keywords: Forecast, Modeling, System Analysis

This paper discusses first misunderstandings concerning forecasting, foresight and future studies, typical for recent media publications that do not take sufficiently into account current knowledge on the methodology and goals of future studies.

The paper continues with a survey of methodological issues of future studies based on computerised mathematical models, so-called hard systems analysis. Such approaches have applications only in carefully selected subject areas, such as weather forecast or demography, but illustrate methodological issues also for more general future studies. Beside classical issues of mathematical modelling, well known to participants of IIASA conferences, the paper stresses issues such as:

- The art of model building and verification;
- Model complexity versus complexity theory;
- Exchange of data (information) and exchange of models (knowledge);
- Cyclic phenomena and chaotic phenomena; long duration cycles;
- Forecasting, understanding, influencing future, including:
- simulation and extrapolation, simple forecasting;
- parametric scenario analysis and warning forecasts;
- optimisation: usual, parametric, vector-valued (multicriteria) versus influencing future

If mathematical models cannot be applied, methods developed when using such models can nevertheless be treated as a methodological guide.

In problems involving essential human factors, in future studies on socio-economic or cultural or civilisation issues, the application of mathematical models is generally impossible. Between various methods of future studies for such problems most important are methods of soft systems analysis, related to deliberative and holistic approaches to decision making. The paper recalls the concepts of general systems theory of Bertalanffy and English school of deliberative, soft decision making (by P.Checkland and others). The work of H. i S. Dreyfuses (from Berkeley): Mind over Machine gives another dimension to this dispute - with an essential experiment showing that experts of master class make decisions in a deliberative way.

The paper shows that soft systems analysis is also related to an older philosophic idea of hermeneutics that expresses actually the same ideas, only applied to arts and humanities.

The paper proceeds then to analyse the relation of soft systems analysis to a rational theory of intuition, developed by the author in a paper published in MCDM Journal (Wierzbicki, 1997). Own experiences of the author suggest that politicians are negatively inclined to computerised decision support and prefer to use intuition instead. This motivated research on the rational theory of intuition. By rational we understand here not economic rationality of decisions (utility theory etc.), but rationality of scientific theories following K. Popper (the possibility of falsification). Thus, we try to give a definition of intuition that allows to draw falsifiable (subject to falsification tests) practical conclusions. The rational theory is based upon two premises:

- Primo, our contemporary knowledge about relative complexity of speech (audio) signals and optics (visual) signals gives the ratios: relation of bandwidth 1:100, relation of processing complexity 1:10,000.

- Secundo, we use the following thought experiment: how we (our human minds) processed signals from our environment just before we discovered speech in our evolution?

We come to the conclusion that the discovery of speech was an excellent evolutionary shortcut: it turned out that we can process signals 104 times simpler. This resulted in the transfer of knowledge between human generations and started that way new evolution of human civilisation. The biological evolution of humans slowed down starting with speech discovery, intellectual evolution accelerated. But what happened with our pre-verbal or beyond-verbal abilities to process signals and draw conclusions? Speech discovery suppressed these abilities, put them into sub-consciousness. Our consciousness, especially its logical and analytical part, became strictly related to speech and verbal articulation. The point is, however, that we still use the old, pre-verbal abilities, only for the lack of a better word we call them intuition.

On this basis - entire rational theory of intuition was developed, with definitions, characterisation of intuitive decision processes, relations to mind science (left brain - right brain), etc. There is an important subdivision on two types of intuitive decisions:

- repetitive, operational intuitive decisions
- unique intuitive strategic decision processes or creative decisions

The theory includes further practical conclusions, empirical tests, etc. One important conclusion is as follows: Methods of influencing future applied practically by large corporations are an example of an intuitive strategic decision process.

The paper proceeds to an example of using soft system analysis methods or an intuitive strategic decision process to the development of 6-th Framework Programme of European Union in the field of Information Society Technology, based on the vision of Ambient Intelligence (AmI). This vision relates similarly to current Internet as Internet relates to classical voice telephony. It can be illustrated by a simple example m in home telematics:

- Imagine a simple room;
- A person comes to this room and says: Connect me to Maria;
- A wall changes into a huge screen;
- A hidden telecommunication device can:
  - recognise the person and find who is understood by Maria;
  - make a broadband connection to backbone network and find Maria, who might be travelling and be accessible only by a mobile device;
  - organise a videoconference with diverse options.

This vision was a basis of an intuitive strategic process, leading through Related AmI Scenarios to specific themes and priorities of diverse parts of IST sub-programme of 6-th Framework Programme of European Union.

On Evaluation of Efficiency of Local Government Finance by Using DEA

YEBOON YUN

Faculty of Engineering, Kagawa University, Kagawa, Japan

MASAO ARAKAWA

Faculty of Engineering, Kagawa University, Kagawa, Japan

HIROTAKA NAKAYAMA

Faculty of Science and Engineering, Konan University, Kobe, Japan

WATARU SHIRAKI

Faculty of Engineering, Kagawa University, Kagawa, Japan

HIROSHI ISHIKAWA

Faculty of Engineering, Kagawa University, Kagawa, Japan

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There are 47 prefectures in Japan, which carry out an administrative with an independent organization respectively. Every fiscal year, accounts of local governments have been taken public. In this research, by using DEA, we evaluate an efficiency for administrative projects to the investments of local governments in order to reform the local administration. By performing it year-by year, we investigate changes of curves -efficient frontier- to the investment' effects by the year before. Additionally, we get hold of a state of the year by estimating the current efficiency to the cumulative efficient frontiers, and propose a method to support a planning of local government budget.

List of Participants

Prof. Masao Arakawa
Dept. RISE, Kagawa University
2217-20 Hayashicho,
Takamatsu,761-0396
Japan
email: arakawa@eng.kagawa-u.ac.jp
telephone: (81-87)-8642223
fax: (81-87)-8642223

Dr Jerzy Bartnicki
Norwegian Meteorological Institute
P.O. Box 43 Blindern
N-0313 Oslo
Norway
email: jerzy.bartnicki@dnmi.no
telephone: (47-22)-963315
fax: (47-22)-696355

Prof. Adrie Beulens
Wageningen University,
Social Sciences Department,
Applied Computer Science Group
Dreijenplein 2
6703 HB Wageningen
Netherlands
email: AJMBeulens@edict.nl
URL: www.info.wau.nl
telephone: (+31-317)-484460
fax: (+31-317)-483158

Ms Hanna Bury
Systems Research Institute of the Polish
Academy of Sciences
Newelska 6
01-447 Warsaw
Poland
email: bury@ibspan.waw.pl
URL: www.ibspan.waw.pl
telephone: (48-22)-8373578.271
fax: (48-22)-8372772

Mr Piotr Celej
National Institute of Telecommunications
Szachowa 1
Warszawa
Poland
email: celej@iiasa.ac.at

Prof. Joao Climaco
Faculty of Economics
University of Coimbra
Av. Dias da Silva 165
3000 Coimbra
Portugal
email: jclimaco@inescc.pt
telephone: (351-239)-790595

Mr Krzysztof Dembczynski
Institute of Computing Science
Poznan University of Technology
Piotrowo 3A
60-965 Poznan
Poland
email: kdembczynski@cs.put.poznan.pl
telephone: (48-61)-8528503.280

Prof. Yuri Ermoliev
IIASA
Schlossplatz 1
A-2361 Laxenburg
Austria
email: ermoliev@iiasa.ac.at
URL: www.iiasa.ac.at
telephone: (43-2236)-807.208
fax: (43-2236)-71.313

Dr Tatiana Ermolieva
IIASA
Schlossplatz 1
A-2361 Laxenburg
Austria
email: ermol@iiasa.ac.at
URL: www.iiasa.ac.at
telephone: (43-2236)-807.581
fax: (43-2236)-71.313

Dr Motohisa Funabashi
Systems Development Laboratory, Hitachi, Ltd.
1099 Ohzenji, Asaoku
Kawasaki 215-0013
Japan
email: funa@sdl.hitachi.co.jp
URL: www.sdl.hitachi.co.jp
telephone: (81-44)-959.0215
fax: (81-44)-966.4673

Dr Fei Gao
School of Knowledge Science
Japan Advanced Institute of Science and Technology
1-1, Asahidai
Tatsunokuchi, Ishikawa, 923-1292
Japan
email: fgao@jaist.ac.jp
telephone: (81-761)-511727
fax: (81-761)-511149

Dr Robert Genser
IFAC-Beirat Austria
Malborghetgasse 27-29,6/6
A-1100 Vienna
Austria
email: rgenser@aon.at
telephone: (+43-1)-6074187
fax: (+43-1)-6074187

Dr Janusz Granat
National Institute of Telecommunications
Szachowa 1
04-894 Warsaw
Poland
email: J.Granat@itl.waw.pl
URL: www.ia.pw.edu.pl/~janusz
telephone: (48-22)-5128303
fax: (48-22)-8729007

Prof. Manfred Grauer
Institute of Information Systems
University of Siegen
Hoelderlin-Str. 3
57068 Siegen
Germany
email: grauer@fb5.uni-siegen.de
URL: www-winfo.uni-siegen.de
telephone: (0049-271)-740.3269
fax: (0049-271)-740.2372

Prof. Jifa Gu
School of Knowledge Science
Japan Advanced Institute of Science and Technology
1-1, Asahidai, Tatsunokuchi,
Ishikawa 923-1292
Japan
email: jfgu@jaist.ac.jp
telephone: (81-761)-51-1725

Dr Tomoharu Hori
Department of Civil Engineering Systems,
Kyoto University
Yoshida-Honmachi, Sakyo-ku
Kyoto 606-8501
Japan
email: hori@iiasa.ac.at
telephone: (43-2236)-807.338

Dr Koichi Inoue
Dept. of Aeronautics & Astronautics,
Graduate School of Engineering,
Kyto University
Yoshida-Honmachi, Sakyo-ku,
Kyoto 606-6501
Japan
email: inoue@kuaero.kyoto-u.ac.jp
URL: vib.kuaero.kyoto-u.ac.jp/
telephone: (81-75)-7535795
fax: (81-75)-7534975

Dr Masahiro Inuiguchi
Department of Electronics and Information Systems
Graduate School of Engineering
Osaka University
2-1 Yamadaoka
Suita, Osaka 565-0871
Japan
email: inuiguti@eie.eng.osaka-u.ac.jp
URL: vanilla.eie.eng.osaka-u.ac.jp/
~inuiguti
telephone: (81-6)-6879-7787
fax: (81-6)-6879-7939

Prof. Norihisa Komoda
Dept. of Information Systems Eng.,
Faculty of Eng.,
Osaka University
2-1, Yamada-oka
Suita 565-0871
Japan
email: Komoda@ist.osaka-u.ac.jp
URL: www-komo.ise.eng.osaka-u.ac.jp
telephone: (81-6)-6879-7825
fax: (81-6)-6879-7827

Dr Lech Krus
Systems Research Institute of the Polish
Academy of Sciences
Newelska 6
01-447 Warsaw
Poland
email: krus@ibspan.waw.pl
URL: www.ibspan.waw.pl
telephone: (48-22)-8373578.272
fax: (48-22)-8372772

Mr Dominik Loniewski
National Institute of Telecommunications
ul.Szachowa 1
04-894 Warszawa
Poland
email: loniew@iiasa.ac.at

Dr Marek Makowski
IIASA
Schlossplatz 1
A-2361 Laxenburg
Austria
email: marek@iiasa.ac.at
URL: www.iiasa.ac.at/~marek
telephone: (43-2236)-807.561
fax: (43-2236)-71.313

Dr Wojtek Michalowski
School of Management
University of Ottawa
136 Jean-jacques Lussier St.
Ottawa, Ontario K1N 6N5
Canada
email: wojtek@management.uottawa.ca
URL: www.admin.uottawa.ca/wojtek/
telephone: (1-613)-562-5800.4955
fax: (1-613)-562-5164

Dr Hiroaki Nakanishi
Dept. of Aero. and Astro., Kyoto University
Yoshidahonmachi, Sakyo-ku
Kyoto
Japan
email: nakanishi@kuaero.kyoto-u.ac.jp
URL: vib.kuaero.kyoto-u.ac.jp
telephone: (81-75)-7535808
fax: (81-75)-7535808

Prof. Hirotaka Nakayama
Dept. of Info. Sci. & Sys. Eng.
Konan University
8-9-1 Okamoto, Higashinada
Kobe 658-8501
Japan
email: nakayama@konan-u.ac.jp
telephone: (81-78)-435-2534
fax: (81-78)-435-2540

Prof. Andrzej Osyczka
Cracow University of Technology
Department of Mechanical Engineering
Al. Jana Pawla II, 37
31-864
Poland
email: osyczka@mech.pk.edu.pl
telephone: (48-12)-6283214

Prof. Zdzislaw Pawlak
University of Information Technology and Management
Newelska 6
01-447 Warsaw
Poland
email: zpw@ii.pw.edu.pl
fax: (48-22)-8251635

Mr Walter Reinisch
Gudrunstrasze 11
A-1101 Vienna
Austria
email: walter.reinisch@siemens.com
URL: www.siemens.at
telephone: (+43-5)-1707.45392
fax: (+43-5)-1707.56399

Mr Maciej Romaniuk
Systems Research Institute, Polish Academy of Sciences
ul. Newelska 6
01-447 Warszawa
Poland
email: romaniuk@iiasa.ac.at

Dr Mina Ryoke
School of Knowledge Science
Japan Advanced Institute of Science and Technology
1-1 Asahidai, Tatsunokuchi
Ishikawa 923-1292
Japan
email: ryoke@jaist.ac.jp
telephone: (+81-761)-51-1757
fax: (+81-761)-51-1149

Mr Piotr Rzepakowski
National Institute of Telecommunications
Szachowa 1
Warszawa
Poland
email: Piotr.rzepakowski@centertel.pl

Ms Ai Sakamoto
Keio University, Graduagte School of Media and Governance
CII 3F, 5322 Endoh
Fujisawa, Kanagawa, 252-8520
Japan
email: asaka@sfc.keio.ac.jp
URL:
http://www.sfc.keio.ac.jp/~asaka/
telephone: (81-466)-491198

Dr Jorgen Saltbones
Norwegian Meteorological Institute
Niels Henrik Abels vei 40
N-0313
Norway
email: jorgen.saltbones@met.no
telephone: (47-22)-963000.3357
fax: (47-22)-963050

Dr Sigrid Stagl
Vienna University of Economics and Business Administration
Department of Economics
Reithlegasse 16/1/4
1190 Vienna
Austria
email: stagl@wu-wien.ac.at
URL:
www.wu-wien.ac.at/inst/vw9/stagl/
telephone: (43-1)-31336.5800

Prof. Yeboon Yun
Department of Reliability-based Information System Engineering
Faculty of Engineering, Kagawa University
2217-20 Hayashicho, Takamatsu, Kagawa
761-0396
Japan
email: yun@eng.kagawa-u.ac.jp
telephone: (81-87)-864.2246
fax: (81-87)-864.2246

Dr Xijin Tang
Institute of Systems Science
Academy of Mathematics and Systems Sciences
Chinese Academy of Sciences
A1 Nansijie, ZHongguancun
Beijing 100080
China
email: xjtang@staff.iss.ac.cn
URL: iss02.iss.ac.cn/xjtang/index.htm
telephone: (86-10)-62553291
fax: (86-10)-62568364

Dr Hirokazu Tatano
Disaster Prevention Research Institute
Kyoto University
Goka-sho
Uji, Kyoto 611-0011
Japan
email: tatano@imdr.dpri.kyoto-u.ac.jp
telephone: (81-774)-38 4308
fax: (81-774)-38 4044

Prof. Milan Vlach
Charles University
Faculty of Mathematics and Physics
Malostranske namesti 25
118 00 Praha 1
Czech Republic
email: vlach@jaist.ac.jp
telephone: (420-2)-2451 0286

Prof. Andrzej P. Wierzbicki
National Institute of Telecommunications
Szachowa 1
04-894 Warsaw
Poland
email: a.wierzbicki@itl.waw.pl
telephone: (48-22)-8729021