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Abstracts

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Contents

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Emission Trading and Uncertainty

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Keywords: emission trading, permits, uncertainy

In emission permit trading system, a new type of property right is introduced. This property right allows to emit some amount of pollutants. Each permit entitles its holder to emit one unit (for example one tone of pollutant). If an emitter posses 100 permits it would be allowed to emit 100 units of pollutants. Thus, the total number of permits held by all sources puts a limit on the total quantity of emissions. These permits can be sold to anyone participating in the permit market. First, system is initialised by central decision on the number of permits which are to be put into circulation. As the total number of permits is usually lower than current total emissions, some emitter will receive less permits than their current emissions. In permit systems a regulatory agency distributes emission permits to polluters in accordance with the environmental goal.

The permits are allowed to be transferable among polluters, resulting in an equalization of marginal abatement costs between pollution sources. In the paper we present the benefits from emission trading and then we describe marginal abatement curve, which is the starting point for determining the demand and supply for emission permits. We distinguish five regions and attempt to calculate how much each region reduce emissions or buy permits. We consider different level of uncertainty coefficient in emission reporting and then provide simulation of the abatement costs. The costs of reduction will be minimized if the marginal cost of control are equalized across all emitters. Regions have an incentive to trade since the marginal cost of control for the one region is higher than that for the second region. The second region would lower its costs as long as it could buy emissions reduction permits from the first region at price lower than equilibrium price. The equilibrium would result in a cost-effective allocation of control responsibility. With trading, the control authority can achieve optimal allocation despite its lack of knowledge about control costs.

Marginal abatement curves are the basis for determining how many permits are needed. Vertical line represents the amount of abatement required for a region to meet Kyoto target. In the absence of any trading the region would abate what is on the intersection of this line with MAC, and the corresponding price would be "autarkic " marginal costs. If emission trading were a possibility, the region would purchase or sell permits according to the relation of the market price to its autarkic marginal cost. We can distinguish following cases:

- permit price lower than autarkic MAC; therefore region wants to buy permits corresponding to quantity difference between the autarkic emission reduction and the domestic abatement it would undertake at the market price,
- market price is higher than its autarkic marginal cost, it would abate more and sell permits to other region,
- if autarkic MAC is zero, than those regions would be only suppliers of permits.

Our problem is to define the least cost for Regions to comply with Kyoto protocol for a given amount of permits, Yi as the minimization of total emission reduction costs From presented three scenarios it is clear that the highest abatement is necessary in second scenario, ie. when the uncertainty is fully accounted for. In this case, regions derive not only the highest cost of abatement, but also highest gains from trading system. Variation in necessary emission reduction, due to uncertainty leads to lower supply

of permits, and thus higher market shadow prices. The benefits from emissions trading is not evenly distributed. Regions whose autarkic marginal cost is further from the trading equilibrium will benefit more than those regions whose autarkic marginal cost is closer to the trading equilibrium. The greatest benefits obtains Japan that imports more permits and Former Soviet Unions countries, that exports most of permits.

Towards a Process Ontology for a Model Based Support System for Problem Solving: the Ontology Bootstrap Problem

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Keywords: process knowledge, ontologies, workflow management

Introduction

Following up on an earlier working paper (Beulens and Scholten, 2004), in this paper we pay attention to the problem of developing a process ontology that is to be used in model based support systems where all participants need to be supported in the generation of an adequate design or research process followed by the effective and efficient execution of that process. In our previous paper (Beulens and Scholten, 2004) we clarified the problem addressed. An important problem in business and science is associated with managing projects. Managing is then briefly described with activities such as making a proposal and quotation, negotiation and obtaining the project, and then executing and controlling a project aiming at:

- A product and service with integrity and quality attributes as envisaged in a negotiated and agreed upon proposal.
- Delivering the project in time within budget while satisfying constraints and requirements (quality assurance).
- A project administration and reporting with integrity for reasons of accountability, auditing, quality assurance and control.

In our earlier paper we further discerned a number of important interdependent dimensions to take into account in project management:

1. The *process dimension* of the project.
2. The *content dimension*. That has to do in particular with the problem addressed in its object system context and with disciplinary approaches (different paradigms), methods and models that may be employed in the solution of the problem.
3. The *transparency and quality assurance dimension* which is concerned with:
   * What is to be achieved (product, quality and process), how, and at what cost and when;
   * Complying with these specifications in the execution phase.

Further, main components of a generic process description for defining and executing a project are also described in our earlier paper and here depicted in Figure 1. It is used as basis for the development of the process ontology. For model-based support of a project manager, team member, client and auditor of a project we need a support system that contains a formalized description of:

- The process to be executed and monitored;
- Contents of sub/processes, steps and activities to be executed and
- Records to be made during project execution to allow for monitoring, control and auditing.

In the remainder of this paper we will focus on steps to be made to arrive at a generic process ontology that can serve as a starting point for a domain specific process ontology that is incorporated in the HarmoniQuA system developed in our department. These steps have to start *somewhere*. Therefore in the title we refer to the bootstrap problem.

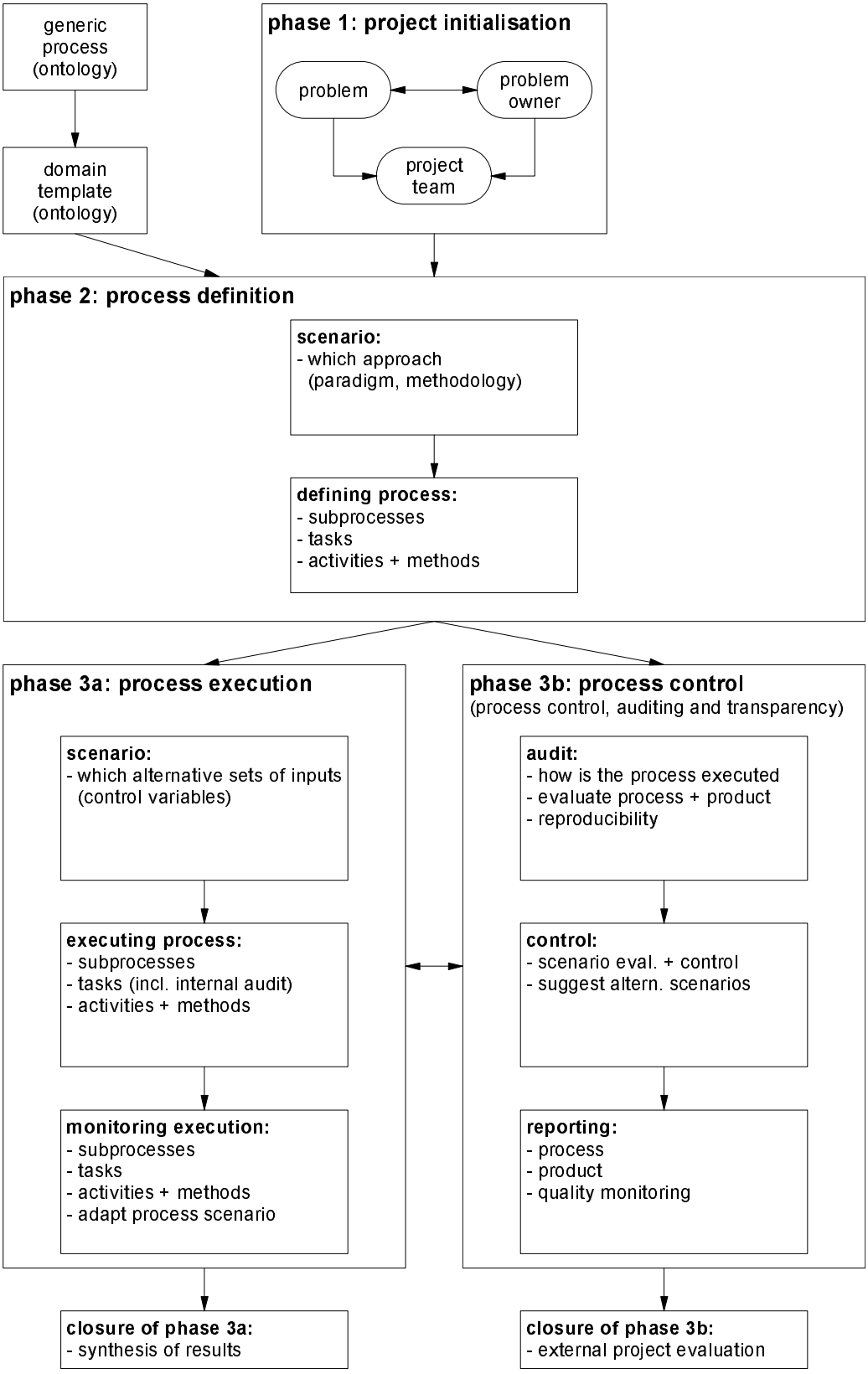

Figure 1: Main components of a generic process description for defining and executing a project.

An ontological framework for structuring process knowledge

Our department participates in the EU-HarmoniQuA project (Scholten *et al.*, 2004) that deals in particular with supporting project management tasks addressed in previous sections. Automated support for making specifications of these phases and thereafter obtaining meta data about the execution for monitoring and control with their effect on the specification for processes of model-based problem solving is the topic of this paper. Automated support calls for a formal and precise description of a process specification that:

- Uses terms and relationships that are unambiguous for both man and machine;
- Is derived from a generic one in the problem domain that is accepted as a best practice in that domain for named reference problems. Practices too, that develop over time as knowledge increases. As a consequence we may assume that a resulting specification will adhere to dynamic quality requirements in the problem domain. We therefore also opt for this reference strategy, as is done for many ICT projects.

In order to be able to satisfy needs for automated support we have opted for:

- A reference strategy. We assume that models and approaches, as used for accepted reference problems and projects, can be effectively used to come up with solutions for new problems that have similarities with these reference problems. In turn, new problems and solutions may contribute to enhance the knowledge base of the problem domain.
- An ontological approach for structuring and describing knowledge about process specifications. Previously we addressed the need for a formal, precise, unambiguous specification of process-models. An ontological approach provides us with a method to achieve that if we follow definitions as given by Gruber (1993, 1995) and Borst (1997). We therefore use the following definition. An ontology is a formal specification of a shared conceptualisation (shared meaning: there should be consensus about concepts and relations). For a further elaboration on the topic of ontology and its use to support process modelling we would like to refer to two other papers Scholten *et al.* (2004), Kassahun *et al.* (2004), Uschold *et al.* (1998) and Chandrasekaran (1999).

In previous parts of this paper we have described the problem to be solved, characteristics of the problem and the approach adopted to arrive at a model based support system. In our projects we have been able to design and develop a(n):

- Ontological framework for developing a knowledgebase for process-models;
- Bootstrap for generating process ontologys;
- Generic process model ontology (Scholten *et al.*, 2004);
- Specific domain process ontology in the area of water management. This ontology and knowledge base provides for proof of principle.

Based on extensive qualitative evaluation and experiences and validation so far we have concluded that the approach can also be used in other domains. Further, evaluations and validations by partners indicate that objectives of effectiveness, transparency and quality assurance can be met by our approach.

The Bootstrap problem

In previous sections we have briefly described problem situations addressed, functional requirements for a model and knowledge and model based support system (KBS), an informal process description and results obtained. Then one question arises how did we arrive at a generic process ontology? In brief we followed a bootstrap approach very similar to the one advocated by Uschold *et al.* (1998). An approach that has similarities with approaches used in semantic data modelling (Date, 2004) and in Ontolingua's *Glossary of Ontology Terminology* (`http://www-ksl-svc.stanford.edu:5915/doc/frame-editor/glossary-of-terms.html`). That approach can be summarized as follows (see Figure 2):

1. We use a simple and well-defined language (limited set of terms) as a starting vocabulary for a meta-ontology, required for generic processes in general and modelling project processes specifically. Uschold (1998) uses as basic terms for deriving the business ontology: *entity*, *relationship*, *role*, *sub-*

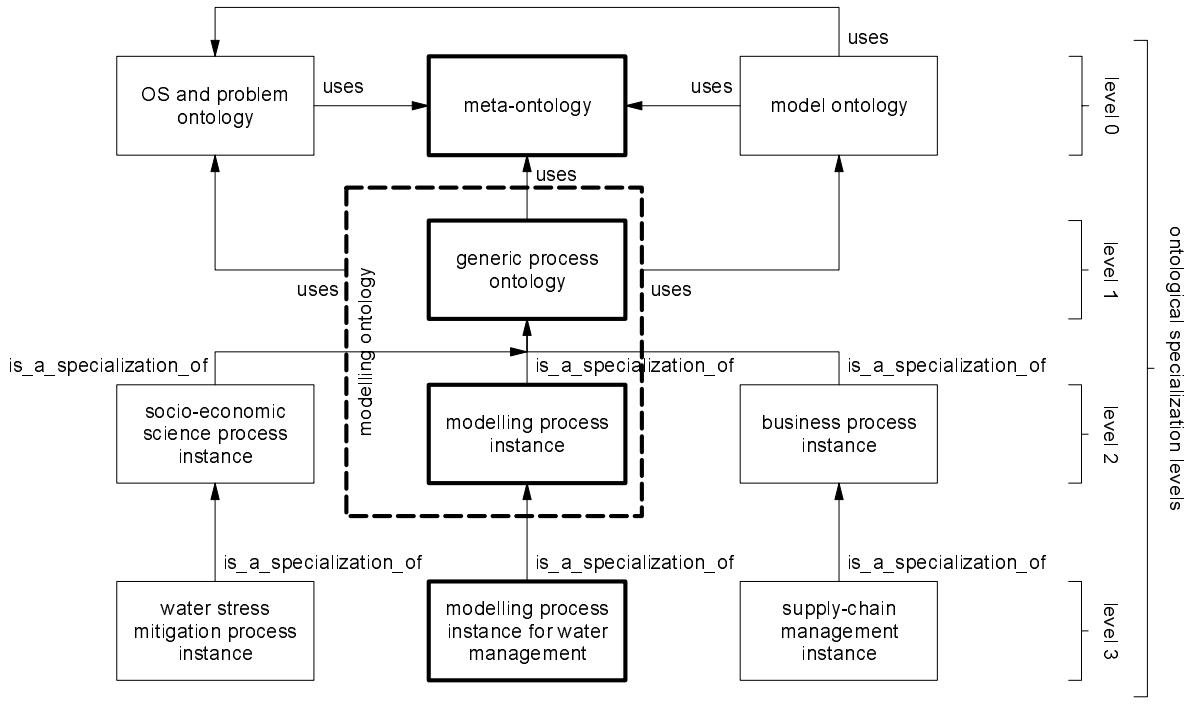

Figure 2: A stepwise ontology specialization with the modelling ontology expanded to some more specialised ontologies. The top (meta-ontology) is the most generic ontological level and the concepts at the bottom the most particular ones. An instance is more particular than the ontology where it is based on. Bold lined concepts refer to the modelling thread, discussed in this paper.

class of, *attribute*, *axiom* and *instance*. Date (2004) uses similar concepts such as: *entity*, *property*, *entitytype*, *relationship*, *subtype*, *domain* and *instance*. In Ontolingua they use *ontology*, *class*, *relation*, *slot*, *subclass*, *function* and *axiom*. For a comparison of these bootstrap terminologies we refer to a working paper of Scholten (2005b).

2. This language is then used as a vocabulary to define new concepts and relations that we need in order define the concepts and relations needed to describe (generic) process descriptions. That means that we created a new, more extensive and richer vocabulary. Together with the bootstrapping terminology we call this our meta-ontology.
3. On top of our meta-ontology we will build a generic process ontology. Some of the concepts of the informal process description given in Figure 1 like *process*, *subprocess*,*step*, *task*, *activity*, *method*, *tool* belong to this generic process ontology.
4. Specialising this generic process ontology for modelling processes requires that other concepts of Figure 1 have to be defined like *model*, *domain*, *result*, *data scenario*, *process scenario* and many others. These concepts and relations of importance between them in the context of projects need to be precisely defined using concepts and relations in the meta-ontology, including the bootstrapping terminology.
5. Subsequently, we also distinguish the need to further specialise that generic modelling ontology for the problem domain of water management, where we want to incorporate knowledge about best project practices in the problem domain, both on the level of project approach and, interdependently, on the level of methods, models and tools to be used in steps or activities of the project. Here we make the connection with the content dimension as described earlier. This leads to a more specialized, domain specific version of the generic process ontology, with linkages to the knowledge base of methods, models, and tools to be employed. Further, related to auditing and quality control on this level we also introduce an interactive ontological knowledge base (called *model journal*) encompassing records of what has been done in the modelling process. Finally, this specialization process in combination with an ontology editor allows for dynamic adjustments of the process model and the model knowledge

base. The tool MoST facilitates to keep records actual model-based water management projects in model journals. The water management specific modelling ontology containing water management modelling guidance and the tool to monitor actual projects embody together the KBS.

6. Finally, using the water management specific version of the generic modelling KBS for a specific project calls for instantiating or using the generic models in the KBS and filling them in by selecting from them and changing where appropriate. After that the instantiated process and metadata model are used in the execution, monitoring and auditing of the project.

Closing remarks

In this paper we have dealt with the conceptual part of the problem addressed and with a method to arrive at the knowledge content of the KBS. A system that aims at effective and efficient support of the creation of good process models for research, development and design projects. To solve this problem we have opted for an ontological approach of which part of the framework has been briefly described in this paper. In a series of papers (Beulens and Scholten, 2002, 2004, Kassahun *et al.*, 2004, Scholten *et al.*, 2004, Scholten, 2005a,b) we deal in more detail with the development of the ontology, knowledge base and associated support tools.

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The Priority-Pointing Procedure: A Generic Inter-Cultural Tool for Solving Problems that Emerge in Project Development Life Cycles

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Keywords: decision science, nomology, systems, development, adjustment, epistemology, priority pointing

Nomology is introduced and presented as a universal generic system for structuring qualitative decisions. It is based on the premise that intelligent beings' choices tend to follow a common set of simple decision rules. Thus if several different fields of human activity have similar categorisations of some type of behaviour, then it is more likely than not that they emerge from the same common decision structure. Brugha (1998a, b & c) has formalised the rules of Nomology, and shown that there are only three qualitatively distinct types of decision structures: Adjusting, Convincing and Committing, each corresponding to a process.

WSR is given as a modern Chinese system that verifies the nomological claim. It has corresponding decision structures: Wuli, Shili and Renli. Comparisons between both sets illuminate some of the inter-cultural differences between East and West (Brugha, 2001a).

Committing and convincing are subjective processes containing three stages or levels that operate in a dialectical fashion. Adjusting is an objective process that has typically four or eight aspects, based on two or three dichotomies that operate between balance and imbalance.

In the context of project life-cycles a committing process works through phases of analysis, design and implementation. The three stages or levels in a parallel convincing process start with technical or self-orientated issues, then relate to the context of the problem as indicated by the perceptions of other people, and finally take account of situations.

An important combination of these is where the decision-maker(s) wish to be convinced about the commitments they intend to make. This leads to an imbedding of the convincing process within committing, which corresponds to a generic form of the well-known Systems Development Life Cycle (SDLC) (Brugha, 2001b) (see Table 1).

Table 1
Systems Development Life Cycle Activities

Analysis	Survey project scope	Study current system	Define end-user requirements
Design	Select a feasible solution	Design new system	Acquire hardware and software
Implementation	Construct new system	Deliver new system	Maintain and improve system

The key decision issue in the SDLC is that of ownership of the process by the decision-maker. Consequently the decision when to move from one stage of development to the next should be determined 'subjectively' by the decision-maker or organisation. Each stage of the SDLC is best implemented 'objectively' as an Adjusting process in which balance should be retained with regard to three issues, what should be done, where should it be done, and which way should it be done.

The Priority-Pointing Procedure (PPP: Brugha, 2000) is introduced as a tool for empirically researching answers to these questions. It uses open-ended questions and provides a next-step priority for action

at each stage of the life cycle. PPP clusters responses by managers to open-ended questions about how to achieve defined development objectives. The clustering pattern was always uses an adjusting structure. The highest clustering differentiates between the need for more planning and for more putting plans into effect. At the next level down the question addressed was whether or not the problem concerns mainly the people involved in the process. At the third level the issue is always about the best approach to use; whether it be inter-personal or not. Despite this structural stability each case is so different that it requires its own set of descriptors and names for the individual clusters. Combining the answers to these three dichotomies generates eight principal adjustment activities: Pounce, Procedure, Price, Policy, Promotion, Productivity, Pliability and Practice (Brugha, 1998b).

An illustration is given and software is demonstrated (Brugha, 2002).

The generic nature of the PPP suggests that practitioners could apply it in different fields and using their own native language. In fact, an accumulation of case experience in culturally distinct parts of the world could help to elucidate the bases for inter-cultural research collaboration.

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Maintenance of Model Analyses in Structured Modeling Technology

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Keywords: model-based decision support, structured modeling, algebraic models, decision rules, model analysis, preferential structure, documentation of modeling process, results analysis, distributed modeling

Structured Modeling Technology (SMT) is a framework which aims at the structuring modeling process in a sequence of well defined steps. A user or interdisciplinary team of developers can control the whole modeling process in an easy and intuitive way, starting from symbolic specification of model entities, through data management, model instantiation, diversified analyses, up to management of the results. All the activities are documented and a set of links between all the components and activities is maintained.

This presentation will focus on the analyses and results management part of modeling with SMT. Model instance being a combination of symbolic specification and selected data set may be subject to many types of analyses, e.g. simulation, optimization or multicriteria analyses. At the current stage we have a fully functional optimization module. The way in which a user may specify preferences for selected instance analysis will be presented.

A preference structure consists of a goal function and an optional set of lower and upper bounds on outcome variables. However SMT allows the definition of more than one goal function. Goals are then evaluated in a loop. Moreover it is possible to specify compound, parametrized bounds, which values may be defined as a set, by a specification of a start, end value and number of steps, or may be explicitly enumerated. The database representation of preferential structure will be outlined as well as possible extensions.

Needless to say that such a way of organizing specification of preferences may result in a relatively large amount of optimization tasks understood as an atom of analysis task that may be read and solved by a specialized solver. This will be also presented here.

After an optimal solution is found (or infeasibility or unboundness is stated), results are stored in the SMT database for further examination and use. All the links between results, computational tasks the solver handles, compound analysis and, moreover, model instance (data and specification) must be trackable. This presentation will cover the issue of those interrelations.

In the end some extensions to already implemented functionality will be proposed, as well as plans for the near future.

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An Automatic Reference Point-like Approach for Dealing with a Multicriteria Teletraffic Routing Model

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Keywords: routing, automatic decision, multicriteria, reference point

Nowadays the exponential and convergent development of informatics and telecommunications makes that, in many communication networks, important decisions of technical nature have to be made in short time periods or even in real-time. In these circumstances problems of "automatic decision" become increasingly important. In these cases the main function of automatic decision is not just to replace humans in the execution of repetitive decisions but also to enable a rapid adaptation of the systems to diverse working conditions that are known from an automatic monitoring of the systems.

This work is dedicated to a case where, in the context of multicriteria shortest path problem, on the one hand it is necessary to be prepared to replace a route (i.e., a loopless path to be used by a certain origin-destination communication flow) by another route, motivated by failure or congestion and, on the other hand, it is necessary to up-date periodically the conditions in which the choices are made, taking into account the state of the network. The latter function will not be object of study in this work and could be implemented by a rule-based decision system capable of executing an adequate periodic up-date of the parameters of the mathematical model used for selecting the implemented paths and the candidate substitute paths, indicating the corresponding priority order. Obviously such rule-based decision system should be dedicated to the case study that we seek to treat.

In this paper we will present a mathematical model for the automatic ordering and selection of paths in telecommunication networks using multicriteria routing models and a method of analysis dedicated to this type of model, based on a reference point-like approach. Although the proposed model is not of universal use it can be applied in studies concerning diverse routing systems.

We will begin by describing the main features of the addressed bicriteria routing model. This is based on the formulation of a biobjective shortest path problem with additional constraints, for application to the routing of traffic in Asynchronous Transfer Mode (ATM) type networks. The considered objective functions are the cost of using a path by a call of a given type of traffic flow, expressed in terms of the available bandwidths in the arcs, and the number of arcs of the path. The constraints refer to the minimum required available bandwidths, maximal delay and maximal delay jitter associated with the path.

The aim of the developed method is the automatic determination (for each node to node traffic flow), ordering and selection of K loopless paths between the originating and terminating nodes, which are solutions to this problem, taking into account preference thresholds for the objective functions. The use of preference thresholds establishes sub-regions of the objective function space with different priority

order, concerning the choice of solutions. The appropriate selection of reference points and a tuning of the Chebyshev metric allows us to search exhaustively the different sub-regions taking into account their priority order.

This communication, beyond describing the features of the routing model and the implementation of the proposed procedure, presents the application of the method to a number of of video traffic routing problems in ATM type networks. The obtained computational results are presented and discussed.

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An Automatic Segmentation Method Combined with Length Descending and String Frequency Statistics for Chinese Text

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Keywords: string frequency statistics, length descending, segmentation

Text is an important tool for exchanging information and knowledge. With the rapid increase of text in electronic format, it is more and more crucial for effective text retrieving, text filtering and text classification. Most text operations base on word, so word segmentation is a precondition and foundation of information processing and determines the effect of information processing of Chinese text.

In this paper, we put forward a new method about automatic segmentation based on the characteristic of Chinese and Chinese text. With no thesaurus, no acquiring the probability between words in advance and no Chinese character index, this method can automatically segment Chinese characters string (CCS) in text based on processing longer strings first, length descending and strings frequency statistical information, This method can effectively distill new universal words, special terms and proper nouns, and it can effectively avoid statistical error about the shorter string which belongs to a longer one.

Experimental results show that our method can rapidly and exactly segment phrases and words whose frequency is larger than predefined value. We also give the distribution rule of phrases and words in Chinese scientific and technological text. The work in this paper will be useful to automatic classification, clustering and retrieval of Chinese text. This method can be used for reference for other languages of East Asia.

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Overcoming Internal Knowledge Search through Firm-Institute Alliances: A Survey of Knowledge Flow in Xi'an, China

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Keywords: knowledge search, knowledge flow, firm-institute alliances, survey

Due to organizational and relational constraints, firms or institutes are bounded within the organizations in their search for new knowledge. But external networks may provide ideas and insights that can be extremely useful to innovation through knowledge recombination and knowledge sharing. So how can organizations reach beyond their organizational bounds or existing relational bounds in their search for new knowledge? In this paper, we suggest that a mechanism of firm-institute alliance that links firms and institutes together can serve as a bridge and, thus, enable firms and institutes to overcome the constraints of internalized search in their innovation processes. Although there is considerable literature regarding alliances, few studies specifically focus on inter-organization learning, knowledge flows and knowledge sharing associated with firm-institute alliance-a special alliance mechanism, which may enable organizations break through the restrictions in knowledge search, and facilitate knowledge flows among organizations. Generally, firms emphasize on the provision of new products or services whereas institutes focus on the development of theories in science and technology. As a result, firms are more concerned with applicable, profitable, and friendly-used knowledge while institute are more concerned with novel, advanced, and revolutionary knowledge. Firms are application-oriented in their search for new knowledge while institutes are theory-oriented in their search for new knowledge. Therefore, they both are bounded within their stereotypes in their search for knowledge if they do not join each other. If entering firm-institute alliances, both firms and institutes may reach beyond their organizational bounds or relational bounds and obtain external knowledge from each other. Hence, among available alliances, firm-institute alliance is a unique mechanism, from which alliance members can benefit in their knowledge search processes and then in their innovations. In firm-institute alliances, knowledge suitable for practical applications may travel along established ties from firms to institutes while knowledge distinguished for its theoretical innovation may travel from institutes to firms. In this way both parties may sharpen each other's capability by acquiring the "real" external knowledge, which apparently differs from their own internal one.

Therefore, we propose the following hypothesis. Hypothesis 1. The likelihood that a firm (institute) will employ the knowledge base of an institute (firm) increases with alliances between the firm and institute. Hypothesis 2. The likelihood that a firm (an institute) will employ the knowledge base of an

institute (a firm) through alliance increases when the institute is geographically proximate. Hypothesis 3. The likelihood that a firm (an institute) will draw upon the knowledge stock of an institute (a firm) through alliances increases with technological proximity. Hypothesis 4. The likelihood that a firm (an institute) will employ the knowledge base of an institute (a firm) through alliances increases when the institute is not geographically proximate if internet conditions hold. Hypothesis 5. The likelihood that a firm (an institute) will draw upon the knowledge stock of an institute (a firm) through alliances increases with technological distance if internet conditions hold.

In this study, we use a variety of data to shed light on the knowledge acquisition patterns of firms and institutes. The data fall into 3 categories: experts data, Research and Development projects data, and patents data. Because our purpose was to explore the mechanisms that allowed firms to exploit related technological knowledge and institutes to impel technological innovations, we attempted to gather data from two types of organizations: firms and institutes. Thus, we examine our hypotheses in the context of some firms and institutes registered in Yanta Region, Xi'an, China. In order to collect enough data, we choose all state-owned firms and research institutes (including institutes in universities), and parts of private firms (most of them are newly startup businesses) and institutes in Yanta Region. The surveyed objects total 249, including 182 firms and 67 institutes. We obtained experts data, projects data, and patent data from our sampled firms and institutes through questionnaire survey, which are used in our data analysis. To measure knowledge flow between firms and institutes, our study design uses a nominal dependent variable KF. We predict KF as a weighted additive function of knowledge flow with experts, KFE; knowledge flow with Research and Development projects, KFR; and knowledge flow with patents, KFP. Furthermore, we predict KFE, KFR, and KFP as functions of some experts data, Research and Development projects data, and patent data.

On the basis of our prediction that KF is a weighted additive function of KFE, KFR, and KFP, we first estimated the knowledge flow with experts, the knowledge flow with projects, and the knowledge flow with patents; then to characterize the nominal knowledge flow, KF. Then we introduced firm-institute alliance mechanism to demonstrate its effects. Finally we introduced other contexts such as technological similarity, geographic proximity, and internet condition. Our findings support the fact that many people recognize and search for internal knowledge within their own organization while rarely recognize and search for external knowledge. Our results also support that establishing firm-institute alliances mechanism can be helpful to overcome the internal knowledge search. In addition, our findings show that external knowledge search is affected by both technological and geographic contexts. We were interested in uncovering whether and when firm-institute alliances mechanism would enable organizations to reach beyond their contexts. We found support for the idea that firm-institute alliances with technological similarity and geographic proximity facilitate interorganizational knowledge flows by increasing mobile experts, collaborative projects, and transferred patents. While for the firm-institute alliances without technological similarity and geographic proximity, great internet conditions are necessary to facilitate interorganizational knowledge flow.

Recovering Data from Incomplete, Uncertain, Aggregate Information by Using Sequential Rebalancing Method

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Keywords: cross-entropy, sequential downscaling, minimax likelihood, prior informations, spatial estimation, agricultural production

The analysis of global change processes requires the development of methods that deal in a consistent manner with data on a multitude of spatial and temporal scales. Adequate treatment and assessment of spatial diversity of social and environmental impacts calls for the development of appropriate downscaling procedures. In particular, this brings up a number of new estimation challenging the conventional statistical methods. These methods are based on the ability to obtain observations from unknown true probability distributions, whereas the new problems require recovering information from scarce historical observations, on uncertain, partially observable or even unobservable variables.

Rich data may exist at aggregate global or national levels without providing any clue on variability of sub-national data. For example, the information on gross national income does not reveal a possibly alarming heterogeneity of its concentration among small fractions of population or within exposed to high risks regions of a country. Without such knowledge we are hardly in a position to make plausible projections. Or, aggregate regional annual concentrations of pollutants may well be within norms, whereas concentrations in some locations may exceed vital levels. Similarly, aggregate mean estimates of annual losses due to natural disasters may represent an insignificant share of gross national product; however, for an affected sub-region it may cause an economic collapse.

For the new estimation problems, referred to as "downscaling" problems, we often have only very restricted samples of real observations. Additional experiments to achieve more observations may be expensive, time consuming, dangerous or simply impossible. The main idea of estimation in these new problems is to rely on using an appropriate optimization principle, e.g., such as maximum likelihood, subject to a variety of constraints connecting observable and unobservable dependent variables.

In this paper we present a sequential rebalancing method, which can be used for a variety of practical downscaling problems. We show the convergence of the method to a cross-entropy maximizing solution. We also discuss that these solutions have close connections with the fundamental maximum likelihood principle; namely, they can be viewed as minimax log likelihood estimates. The proposed method has fast convergence even for rather large problems.

We illustrate the downscaling methods with a practical example of spatial estimation of agricultural production values. Agricultural production and land data are available at national scale from FAO and other sources, but these data give no clue as to the spatial heterogeneity of agricultural production within country boundaries. A downscaling method in this case has to achieve plausible allocation of aggregate national production values to individual spatial units, e.g. pixels by using all available evidence from observed or inferred geo-spatial information, such as remotely sensed land cover, soil maps, climate and vegetation distribution, population density and distribution, etc.

We discuss the main challenges related to appropriate priors (i.e., location specific initial distribution) and their inherent uncertainties that to a large extent determine the success of the downscaled results.

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Socio-technical Issues of the Ubiquitous Information Society in 2010 Identified by the Yaoyorozu Project

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Keywords: ubiquitous information society, socio-technical issues, scenario analysis

1. Introduction

Impact of the ubiquitous information technology on our society is so significant that directing technological development and preparing institutional apparatus are quite important and urgent. Previous works for studying socio-technical topics have been conducted mainly in European community that are basically based on a deterministic model insisting that technological advances dominate the society. In contrast to the previous works, we have elaborated, with the efforts by both humanity and engineering disciplines forming a trans-disciplinary project named "the Yaoyorozu Project [1][2]," to find out the socio-technical issues of ubiquitous information society in 2010 by inspecting implications of emerging technology as well as social expectations.

2. Identification of Issues by Scenario Analysis

Firstly we have analyzed driving technology towards ubiquitous information society and have concluded that important facets of new technology includes ubiquitous sensing and actuating functions as well as ubiquitous information and communication functions, that implies integration of information technology and human body in addition to increased communication capability and controllability in human environment. Secondly current social expectations have been investigated that include aging and individualism, needs of shift from production oriented industry to service oriented industry, and quick and legitimate transformation of government services according to change of demography in addition to global environmental problems. Thirdly scenarios describing possible future based on technological implications and social expectations have been developed in order to invite opinions from diversified disciplines. In this development, future quadrants are introduced that are specified by individual-community and life-production axes. The topics of the scenarios cover augmented memory service, CRM (Customer Relationship Management), homecare services, and e-democracy. Based on the developed scenarios, opinions are collected from diversified specialists such as community formation practitioners, cognitive scientists, IT researchers, law scientists, and so on.

3. Socio-technical Issues in Ubiquitous Information Society

Referencing the collected opinions, commonly underlying socio-technical issues are identified as the followings:

1. Preparation to integration of information technology and human body: For example, the augmented memory service calls for development of legal framework for reusing information recorded personally,

development of technology for protecting infringement on privacy and copyright, and clarifying effects of recording and recalling mechanism on psychological and social behavior.

2. Preparation to smart sharable environment: Global warming becomes an extremely serious problem we are facing, and it is thought that shifting from possession economy to sharing economy is promising remedy for the problem. Ubiquitous information technology actually supports this shift that realizes ad-hoc collaboration of devices surrounding the user.
3. Protection of individuals in real and cyber combined space: Penetration of ubiquitous information technology means that anyone has a relation with IT deeply, and it is required to take protection from an unjust act for all people from a public point of view.
4. New business fostering in real and cyber combined space: New service businesses such as home care and health advice that connect body information to a network are appearing. A legal framework and corresponding technology shall be developed for enterprises that offer services to subscribers based on physical monitoring in terms of recording, privacy protection, and service liability.
5. Support of community symbiosis: Paying attention on increase of aged people and independent households, useful mechanisms for connecting people shall be developed based on socio-cognitive and network ecological knowledge. Needless to say, in this study divide problem shall be solved in parallel.

4. Future Works

Following the study, discussions and exploration of the solutions for the issues among citizens and specialists are expected for better controlling the technology development and preparing institutional systems.

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Applications of Computational Intelligence to Slope Failure Forecast

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Keywords: Computational Intelligence, Machine Learning, RBF networks, Support Vector Machines, Slope Failure

Computational intelligence such as machine learning has been effectively applied to many kinds of real problems. In this paper, focusing on slope failure, our trial of applying computational intelligence to natural disaster forecast will be reported.

Applied techniques of computational intelligence are RBF (Radial Basis Function) Networks and SVM (Support Vector Machines). Both methods have been recognized to be effective in wide ranges of classification/regression problems in real fileds. We have observed through our experience that many methods for machine learning such as artificial neural networks (ANN), RBFN and SVM can show almost similar performance, if their parameters are tuned appropriately. However, there are differences among costs to get those appropriate parameters. It usually takes much time to tune parameters in ANN due to nonlinearity of optimization problems. However, optimization of parameters in RBFN is reduced to linear equations, while that of SVM quadratic programming or linear programming problems. This fact ensures the global optimality of solutions in RBFN and SVM. In addition, RBFN and SVM can be applied to classification problems with one class. This point is very important in slope failure forecast, because there are usually only slight data of failure and very many data of non-failure. One class classification, therefore, plays an important role in problems with those extremely unbalanced data.

Getting the decision boundary called critical lines (CL) in slope failure forecast, we can forecast the failure on the basis of rainfall information. In comparison with simple linear CLs used conventionally, nonlinear CLs provided by RBFN and SVM can give more precise forecast in real situations. This will be shown in this paper. Recently, our proposed system for forecasting slope failures is adopted by Ministry of Land, Infrastrucute and Transport in Japan, and expected to be widely used in each prefecture in Japan.

A Multi-Attribute; Non-Expected Utility Approachto Complex Problems of Optimal Decision Making under Risk

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Keywords: multi-objective decision making, risk analysis, non-expected utility, multi-attribute utility

Modern organisations are typically faced with complex problems of decisionmaking under risk to the extent to which they operate in rapidly developingenvironments exhibiting large-scale non-linear social and ecologicalinteractions. In theoretical and applied decision research, multi-attributeutility theory (MAUT) is widely believed to provide a suitable conceptualframework for analysing alternative courses of risky action if actorssimultaneously pursue conflicting objectives in optimal ways. In fact, utility-characterisations of multi-attribute decision outcomes such as money gainedor lost, fatalities incurred, or loss of time are virtually indispensableto conceptualise risk management strategies and trade-offs betweentheir prospective consequences (Keeney and Raiffa 1976). However, in many applications MAUT may be difficult to employ for variousreasons. One is the well-known fact that the utility functions of decisionmakers are cumbersome to establish emp irically. They also tend to vary withthe probabilities of the decision outcomes ("Allais paradox"). Finally,they are hard to scale consistently, at least in instances involving morethan two attributes (Keeney and Raiffa 1976). In order to make MAUT operational in more complex, higher-dimensionalapplications, a new approach to risky choice based on a recently developedaccount of non-expected utility theory (non-EU) will be presented (Geiger2002, 2005). It differs from EU in that it makes the impact of the decisionmaker's current (economic) situation on his risk preferences explicit, inparticular, his aspirations, uncertainties of current wealth and income(status quo), and the dependence of risk attitudes on background risks.There is a unique utility representation of risk preferences, with anexplicit expression for the utility function which, in contrast to EU, isgenerally non-linear in the probabilities. Hence the term "non-EU". Becauseof its mathematical simplicity and realistic features, the non-EU modelmay be attractive from the perspectives of further theoretical andexperimental analysis, but also business applications and public policymaking. The presentation concentrates on theoretical extensions to MAUT,but possible applications will also be considered. They concentrate on the problem of how to assess low-probability, high-consequencedisaster risks quantitatively and in coherent ways. The non-EU approach and its extension to MAUT offer various technicaladvantages. Once the staus quo-risk and aspiration level of the decisionmaker are known, his utility function can be calculated explicitly. Solengthy and tedious empirical assessments of preferences are no longernecessary to establish non-EU. Multi-attribute utility functions canthen be defined from single-attribute cases in additive andmultiplicative ways. Since the single-attribute components can be scaledin a "natural" and universally applicable way, the problem of theconsistent scaling of the compound multi-attribute utility functionreduces considerably. Finally, possible applications of the approach will ber indicated, with-reference to decisions involving monetary gains but potentialcatastrophic consequences such as large numbers of fatalities. Literature Geiger, G. (2002), On the statistical foundations of non-linear utilitytheory: the case of status quo-dependent preferences. European Journal ofOperational Research 136, pp. 449-465. Geiger, G. (2005), Risk acceptance from non-linear utility theory. Journal of Risk Research 8, pp. 225-252. Keeney, R. L. and Raiffa, H. (1976), Decisions with Multiple Objectives.New York: John Wiley.

Event Mining for On-line Decision Support

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Keywords: event mining, temporal data mining, decision support

Data mining have many industrial and scientific applications. However, the existing algorithms consider limited information about the events. Recently, it can be observed increased importance of events in modeling and understanding complex systems. D. Luckham [1] provides us with a framework for thinking about complex events and for designing systems that use such events (see also [2]). Events are especially challenging for real-time analysis.

A key to understanding events is knowing what caused them and having that causal knowledge at the time the events happen. Another issue is the knowledge about the consequences of events. The ability to track event causality and consequences is an essential step toward on-line decision support and important challenge for new algorithms for event mining. Events might be described by structured and unstructured information. The structured information is is well recognized and is stored in databases. However, the organizations are working on improvement of the analysis of the external environment and influence of this environment on the performance of the organization. Environmental scanning is a new term and it means the acquisition and use of the information about events, trends, and relationships in an external environment. Therefore, the methods of dealing with unstructured information about events are especially important [3].

Event mining might have various applications. On the business level it is the Business Activity Monitoring (BAM). BAM is defined (by Gartner Inc.) as a concept that provides real-time access to critical business performance indicators to improve the speed and effectiveness of business decisions. BAM involves alerts, triggers, sensors, and agents that determine a transaction or event that is meaningful. Another group of applications are on the level of the network infrastructure of the company. Computer networks produce large amount of event-based data that can be collected for network analysis. These data include alerts from firewalls and Intrusion Detection Systems (IDS), log files of various software systems, routing information from the Internet etc.

We will share an experience in building event-driven decision support systems for telecommunications industry.

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Global Environmental Problems and Corporate Strategy Produced from Cooperative Collaboration with Business Leaders and Experts in R&D System

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Keywords: cooperative collaboration, corporate strategy, business leader, natural resources, sustainable use of natural resources

In the activity of business enterprise, new projects are continuously required by the market. Such a requirement is based on the biological instinct given to the people who are members of market. It is considered that such instinct is commonly given to all creatures in the surface on the earth and it is the origin of control mechanism to the population of each creatures through the serious competitions in the hood chain. Of course, own techniques and knowledge of method in the production are quite important things in the enterprise activities. On such a basics in the enterprise activity, preparation to the suitable business environment is quite important which is referred to the role of Operating System (OS) in computer. The most common and considerable problems in the business background are considered to be the matching of the business activities to the global environment. Though the philosophy is already built-in to the leaders in enterprises and countries, many examples still show the results that the leaders put the direct profit above the philosophy in business actions.

It has been predicted that as the population in the world increases, That is, requirement by the market is suppressed and consumption-intensive life style of the people has oppressed harsh conditions. However, because the clear causality between the environment and the energy consumption can hardly proof, people have a tendency to require too much. To have long term business foresight based on such business environment, wide and deep knowledge in science and technology is required in business front. One of the solutions is considered to be in the collaboration by business leaders and specialists. Here, we discuss the conditions to the collaboration.

Because problems of the ecology in bio-system and natural environment in the earth are closely related, the problems are considered to be a kind of complex systems. Thus, the business enterprises are required careful corporate behavior to the global environment. When the board directors decide the direction of the enterprise, the directors are required to recognize the severe business circumstance. A possible method to obtain more suitable direction of the business enterprise is emerged from the place for the cooperative discussion by the directors and experts in R&D system. Though such business problems are on the complex system and detailed theoretical analysis can be hardly made, some excellent experimentalists and technicians can pick up much more correct results by the suitable selection from a huge number of the experimental data. Thus the collaboration with business leaders and the experts in R&D system are expected to make the most powerful corporate strategy in the business.

In our presentation, at first, we will discuss about the basic business system and philosophy to the members in the market and global environment and after that, an example of cooperative system to the corporate strategy in the business enterprise behavior is discussed. The system to make the cooperative collaboration is called "Ba" in Japanese which means "discussion site".

To realize such a collaborative discussion successfully, even if the participants such as business leaders and managers are not specialists, they should have some basic knowledge to feel with high sensitivity to the uniqueness and wonderfulness for the developing research and techniques. On the other hand,

the specialists are also required to have a common sense of the business transaction, money flow, role of marketing and finance systems. It seems to be difficult for the non-specialists to have such wide and deep knowledge. However, recent development of mobile computer is quite helpful to have rich knowledge stored in the memory system of the computer. That is, people can perform their work assisted by library or museum in the mobile computer.

Moreover, to make quick referring for the basic knowledge, recent computer system can powerfully help them. Especially the enormous large memory system in the mobile computer allows us to make a use of the encyclopedia including rich knowledge in the meeting. Moreover, recent development of filing techniques and search engine are quite helpful to make quick referring of the rich knowledge. Thus the techniques of the simple explanation to the professional work are the most requested items to the specialist or professional persons in the science and technology. Our group members in COE program in JAIST are selecting the items of scientific knowledge, called "science minimum" from physics to bioscience. On the contrary, business leaders and managers of non-specialists are required to cultivate strong power of imagination on the basic science minimum knowledge to recognize wide and flexible applications. If such a cooperative discussions are successfully performed, the most suitable evaluation and corporate strategy can be realized and such business leaders in the enterprise will realize the most powerful business operation.

Besides importance on such scientific knowledge, we should specially discuss about the load to the natural environment. The international opinion and movement to the problems on natural environment sensitively affect the direction of corporate activity. Thus, they are common problems for both business leaders and specialists in the discussion site of the corporate activity. In our presentation, the authors discuss as an experimentalist about how to refer the basic data in natural environment and how to obtain some suggestive information in the complicated data on green house effect and CO_2-gas data [1,2] global energy consumption, and sustainable use of natural resources. If we cannot find the suitable solutions for these problems, humankinds might have serious situation that is commonly adopted by other creatures. If humankind has enough intelligent, however, we can avoid such a movement.

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A Subscribers' Behaviour Simulation Tool to Support Mobile Game Business Decisions

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Keywords: decision support, simulation, behaviour model, mobile game business

The mobile content market in Japan has been expanding rapidly since 1999. Almost all mobile contents are monthly-subscription type. In the subscription type content business, content providers have to make effort for more users to start and continue subscription. The author of this report has been providing a quiz game content on the official menus of three domestic carriers in Japan since 2002. Using the customer data of this content, we have conducted following various customer analyses;

- an analysis and survey of the prime reasons for unsubscribing[1],
- a prediction of customers who will cancel subscription near future[2],
- an analysis of open-ended questionnaires data answered when users unsubscribe the contents [3][4][5],
- customer unsubscription intention analysis by using structural equation modeling[6][7].

In this presentation, we report a simulation tool aimed at evaluating promotion candidates for the mobile game provider.

The game provider does various promotions such as change of rule, increase the prizes, presentation of incentive gifts, and so on, for increasing the new subscribers and reducing the unsubscribers. Since the actualization of new promotions needs certain cost, the provider must carefully select the most effective one. To assist the provider's decision, we have developed a simulation tool for calculating the future subscriber number based on a subscriber behavior model and the rates of unsubscription changes.

The behavior model is generated based on subscriber game logs, questionnaire result, and regular subscription and unsubscription rates. Unsubscription rates depend on subscriber attributes such as consecutive months, stages, rankings, and game play times. Therefore, in the model, subscribers are divided into the 192 segments based on their attributes. Each segment is assigned own behavior parameters and unsubscription rates. However, since subscriber attributes change dynamically, the method deals with dynamic subscriber attribute changes. On the otherhand, the rate of unsubscription change for each segment is decided by the provider, considering the features of promotion, by intuition for each promotion candidate. The simulation tool simulates the subscribers' behavior of the next month individually. Accordingly, some subscribers may move the different segment. Others may unsubscribe. By iterating this stochastic operation, the tool forecasts the future subscribers' number.

For the following two purposes, we examined the proposed method with real data.

Evaluation of the accuracy: We compared the forecasting result and the real data of the no promotion period. The average error at the three-month forecasting is 3.9%. The proposed method is twice as precise as the forecasting based only segments.

Comparison of three promotions: The provider considered three new incentive promotions in which 10 winners selected by lottery will receive small gifts. As target, following three subscriber groups were considered; (Plan A)who give 15 correct answers, (Plan B)whose subscribing periods are less than 3 month, and (Plan C)whose stages are higher than 2. Using the simulation tool, these three candidates were compared, and the selected candidate Plan A was executed in January, 2005. The error of the number of all subscribers is -0.1%, and the error of each stage is from -0.5% to 1.9%.

The accuracy of the forecasting result is dependent on the accuracy of the rate of unsubscription change for each segment decided by the provider. So, this tool can be considered as a calculator which reduces the provider calculation effort. Therefore, more elegant user interface is desired.

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Wavelet transform oriented methodologies with applications to time series analysis

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Keywords: wavelet analysis, filtration, approximation, periodicity identification, forecasting

Wavelet transform provides a representation of a time series in a different domain. This domain may be considered as a set of a series of observation points (wavelet coefficients) derived from the original time series based on a special single (but scaled and modified) function. Each point in each of these series may be interpreted as a difference of weighted averages in neighboring intervals. A very important (although not always used) feature of this transform is inversability, which means that having wavelet coefficients one may derive original data.

The beginning of the 20th century is regarded as a starting point of wavelet analysis. At that time a mathematician from Hungary, Alfred Haar, presented a theory [2], nowadays considered a basis for a variety of methodologies, known as "wavelet methods". In the 1990s wavelets gained popularity as they proved to be useful in many domains and applications including acoustics, economics, geology, health care, image processing [7], management, and more recently data mining [5].

Some wavelet-based methods are very useful for the analysis of time series [6]. The use of these methods in some domains will be reviewed, particularly in network traffic analysis, stock market shares analysis, business data analysis, and analysis of crop yield and weather data for supporting a process of discovering the impact of weather on crop production. Herein applications of wavelet oriented methodologies to filtration, approximation, periodicity identification, and forecasting of time series will be presented.

Two very common approaches to analysis based on wavelets will be discussed. The first one is based on the analysis of the results of a wavelet transform of a given time series and then on an inverse transform of new results to the original domain. The second one performs the analysis using information from both, original and wavelet domains, and derives results about the original domain without using inverse transform.

Two methods dedicated to filtration will be discussed, namely WaveShrink [1] (with three different shrinkage function variants) and Wavelet Noise Suspect approach [4]. Processing and results of both of these methodologies will be illustrated on one (network traffic) example. A wavelet-based approach to approximating time series will be reviewed and illustrated on crop yield and weather data. A method of periodicity identification utilizing modified discrete wavelet transform will be introduced along with a review of some examples including specifically generated time series, real-life supermarket data and weather observations.

Finally two approaches to forecasting time series (both using wavelet transform) [3] will be presented. The first one is a direct application of discrete wavelet transform. The second one utilizes additional information about the seasonality feature in the time series. Some estimations of accuracy of both methods will be presented on example data from the stock market and supermarket environment.

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Computer-based support of individual and cooperative risky decisions with use of the utility concept

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Keywords: mathematical modeling, risk, utility, decision support, computer-based systems, cooperative games

In the presentation given by R. Kulikowski [1] the concept of utility is proposed which enables the implementation of sustainable development strategies. The concept is consistent with the prospect theory introduced by A. Tversky and D. Kahneman [14]. In the research carried on and presented in papers [1-5] the management of different forms of capital has been considered in the presence of different forms of risk (market, credit, operational, research risks) and the methodology based on the utility concept was developed. The management problems deal with optimal allocation of the capital on different investment options including traditional production options as well as innovative activities. They deal also with minimization of losses which can be result of failures or disasters. In the last case an allocation of founds for preventive or insurance actions is considered to reduce the risk and the threats of expected losses.

To apply the methodology effectively for decision analysis and support, computer-based decision support systems are proposed. In this paper the construction of such systems is discussed and illustrated on an example, which relates to the support of education decisions. The proposed system includes a model representation, a utility function evaluator, modules supporting analysis of individual and cooperative decisions, as well as modules including optimization solver, respective data bases, procedures enabling interactive sessions and a graphical interface. The model consists of two parts. The first part describes the decision situation. It is constructed according to the rules of the control theory. The second part describes preferences of decision makers. The preferences are described with use of an assumed, given utility function form, which enables decision analysis taking into account the risk. The assumed form is considered only as an approximation of real in-mind utility aggregating the decision maker's criteria. In practice decision analysis is accompanied by a learning process. The decision maker, obtaining new information about possible results of decisions, can correct his previous preferences. Therefore iterative procedures are proposed for evaluation of subjective parameters of the utility function. The support of cooperative decisions has been developed among others in the papers [5, 9, 11] with application of the utility function methodology considered here as well as in [6, 7, 8, 10, 12] where the multicriteria approach has been applied utilizing ideas developed in [13, 15]. Iterative procedures supporting the negotiation process are proposed. Mediation proposals are generated taking into account preferences of decision makers. They are based on the solution concepts developed in the theory of cooperative games.

The support of education decisions is the subject of the case study started in 2003 [5] and currently developed in the cooperation with Warsaw Information Technology (WIT) University. In the case study relations between students and the private university are analyzed and described. One of the questions a student has to answer relates to selection of the perspective specialization area. The area corresponding to the student predispositions should assure high probability that he/she will find the job with a high salary after the studies. On the other hand, the university should organize studies in such areas, which assure large number of candidates. The methodology proposed enables analysis and comparison of different specialization areas. In particular the university deals with the questions: What number of places should be prepared for students? How to allocate resources among traditional and innovative areas? What

should be the tuition, taking into account its own benefits, as well as benefits of students? To answer the questions a model and an experimental computer-based decision support system are constructed. In the model the university and a statistical student are regarded as partners in a joint venture. They act in the presence of risk. The cooperative strategies, which are beneficial for the students and for the university, can be derived and analyzed using the system.

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Support of risky decisions by using the concept of utility which enables the implementation of sustainable development strategies

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Keywords: utility, sustainable development, market risk, operational risk, decision support, knowledge management, disutility of losses, allocation of resources

The paper presented is concerned with (based on knowledge) support of decisions, which are undertaken by managers of firms and leaders of organizations who are responsible for increasing the welfare, by planning and implementation of sustainable development strategies. Development is defined as the welfare improving change in the set of options open to the society. The welfare is a state represented by different forms of capital (natural, built, human, intellectual, institutional) and safety, self and social esteem, reputation, etc.

Sustainable development is defined as the process characterized by the two principles: inter-generational equity (between people alive today and future generations) and intra generational equity (between individuals or groups of people alive today). Besides achieving expected (in long run) objectives, which maximize the welfare it should enable also the survival of short term crises and avoid the possible losses (disasters).

The human (supported by knowledge) planning of behavior should enable to foresee the welfare increase, due to the action planned, asses its value (utility) and choose the best option from the set of possible alternatives. In order to make the decision of choice rational, i.e. consistent and coherent, the normative (instead of descriptive) approach to the problem of utility (goal) function formulation has been applied. It is based on two-factors utility function concept. The first factor represents the expected return on the invested capital, while the second factor expresses the safety of the chosen development option, which depends on the risk of survival of the worst case (crises) situation. That concept called utility of sustainable development (USD) is consistent with the prospect theory introduced by A. Tversky and D. Kahneman. The decision maker's USD parameters can be identified by the proposed introspection processes. Using the USD concept it is possible to support the management decisions, which involve the market and operational risk, by deriving the optimum strategies for budget allocation among different production branches, services and innovative projects.

The methodology presented enables also to support the sustainable cooperation, which results in fair allocation of duties and rewards among the organization members.

Using that methodology it is also possible to evaluate the disutility of expected losses, such as damage and disasters due to natural forces (fire, floods, tornado etc.) system failure and man-made forces (thefts, terrorism etc.) and find the best preventive or insurance actions, which reduce the risk or eliminate the threats of expected losses.

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Modeling Technology Transitions under Increasing Returns, Uncertainty, and Heterogeneous Agents

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Keywords: technology transitions, increasing returns, uncertainty, agents

Technological change is both costly and highly uncertain. In most of traditional models, technological change has to date largely been treated as exogenous, i.e. technological change, typically in form of improvements in engineering and economic characteristics of individual or aggregate technologies are a free good and also known with perfect foresight within a given scenario of technological "expectations". This is both the case for models developed within the tradition of growth theory and associated production function models (so-called "top-down" models), as well as those developed within a systems engineering perspective (e.g., detailed sectorial "bottom-up" optimization models). In both modeling traditions, technological change is either reduced to an aggregate exogenous trend parameter (the "residual" of the growth accounts), or introduced in form of numerous (exogenous) assumptions on costs and performance of future technologies. Common to both modeling traditions is that the only endogenous mechanism of technological change is that of progressive resource depletion and resulting cost increases, which also explains that the inevitable outcome of imposing additional (e.g. environmental) constraints on the model: rising costs due to the forced adoption of more costly capital vintages that remain unaffected by endogenous policy variables in the model.

Traditional deterministic, social planner models have been criticized (e.g. Grubler and Messner, 1998) for being overly naive and "optimistic" on the feasibility of meeting constraints, as availability and adoption of new technologies will be much slower and discontinuous due to agent heterogeneity and uncertainty than suggested in traditional policy models. Hence the repeated policy conclusion of the need for "earlier experimentation" rather than the traditional "wait and see" implication of conventional models of exogenous technological change. However, traditional models can also be technologically too "pessimistic", as missing out on important spillover effects and adaptive, innovative behavior that arises precisely because of agent heterogeneity and interaction.

Based on earlier, pioneering work done at IIASA (Grubler, Nakicenovic and Victor, 1999; Grisevskyi and Nakicenovic, 2000; and Grubler and Gritsevskyi, 2002), we model endogenous technology transitions under the three most important "stylized facts" governing technological change (cf. Grubler, 1998): (potentially) increasing returns to adoption, uncertainty, and heterogeneous agents following diverse technology development and adoption strategies. In order to illustrate the importance of each of these three "stylized facts" on endogenous technology transitions, we develop a deliberately highly stylized model inspired energy and climate change policy models. We assume one primary resource, whose extraction costs increase over time as a function of resource depletion. The economy demands one homogeneous good whose demand increases (at an exogenously defined rate) over time. There are three kinds of technology, namely "Existing", "Incremental", and "Revolutionary", which can be used to produce the homogeneous good. The "Existing" and "Incremental" technologies require primary resource inputs for production. The "Existing" technology is assumed to be entirely mature, and its costs and efficiency do no longer change over time. The "Incremental" technology has a slight efficiency advantage. With a higher initial cost than that of the "Existing" technology, it has potential for further improvements

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subject to increasing returns to adoption (often also refereed to as "technological learning"). Conversely, the "Revolutionary" technology requires no resource input at all. Its initial cost is much higher than both "Existing" and "Incremental" technologies, but its (uncertain) improvement potentials are also substantially higher. The resulting "learning rates" of the "Incremental" and "Revolutionary" technology are treated as random values in our model. The probabilistic characteristics of these random values can be derived from the (exogenously specified) uncertainty distribution functions of the corresponding learning rates.

Extending earlier work, this paper focuses specifically on the dynamics of endogenous technological transitions under uncertainty and increasing returns under explicit agent heterogeneity. Following the tradition of agent based modeling (Ma, 2003) which is combined here with the modeling field of optimization under uncertainty, actor heterogeneity is represented by different risk attitudes and weights of agents. The interaction between the agents is represented via trade on the homogeneous, resource, and goods respectively, as well as through technology spillovers.

With heterogeneous agents, we run Pareto Optimization, and we use a simultaneous approximation of the random future cost values by N sample functions of the learning rate, where N is the sample size. The model is solved for a sufficiently large sample N, where the size of N has been determined through successive experiments. Several successive model runs with the same sample size N are compared. If no major change in the solution structure and the objective function can be observed then N is considered sufficiently large.

The model presented here is not intended to be by any means a "realistic" model in the sense of technological or sectorial detail. Rather, the main objective of the model is for exploratory modeling purposes and as a heuristic research device to examine in depth the impacts of alternative model formulations on the endogenous technology transition dynamics. As such the model represents an intermediary step towards the final, long-term research objective of developing a multi-layered model of multiple producers and consumers which can be tested with both historical and future scenario data.

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Integrated Modeling Environment

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Keywords: structured modeling, decision support systems, modeling paradigms, model management, object-oriented programming, distributed systems.

The relevance of advanced modeling methodology to the policy issues is justified by the characteristics of models developed for analyzing policy-related problems, and thus supporting the corresponding decision-making processes. Complexity of a decision-making problem is implicitly defined by the knowledge needed for finding rational solutions for the problem. This is turn requires model-based support for decision-making. Models can on one hand integrate interdisciplinary knowledge, and on the other hand can support creation of knowledge through the model analysis. There is a class of problems for which commonly used modeling paradigms and the corresponding general purpose modeling tools do no provide adequate support for the development and analysis of models. Such models have growing complexity and size, and are often developed by integration of models and/or data developed by different teams; they also need to properly treat uncertainty, risks, as well as spatial and temporal distributions.

Moreover, the modeling processes supporting policy making have to meet the strong requirements of: credibility, transparency, replicability of results, integrated model analysis, controllability (modification of model specification and data, and various views on, and interactive analysis of, results), quality assurance, documentation, controllable sharing of modeling resources through the Internet, and efficient use of resources on computational Grids.

Mathematical modeling of a complex problem is actually a network of activities involving interdisciplinary teams collaborating closely with experts in modeling methods and tools; often however new methods and/or software need to be developed, especially in the case of:

1. Models with a complex structure using large amounts of diversified data, possibly from different sources.
2. The need for robust strategies to account for a proper treatment of spatial and temporal distributional aspects, vulnerabilities, inherent uncertainty and endogenous risks affecting large communities and territories.
3. Demand for integrated model analysis, which should combine different methods of model analysis for supporting a comprehensive examination of the underlying problem and its alternative solutions.
4. Stronger requirements for the whole modeling process, including quality assurance, replicability of results of diversified analyses, and automatic documentation of modeling activities.
5. Requirement of a controlled access through the Internet to modeling resources (composed of model specifications, data, documented results of model analysis, and modeling tools).
6. Demand for large computing resources (e.g. large number of computational tasks, or large-scale optimization problems, or large amounts of data).

Use of established modeling methods and general-purpose modeling tools cannot adequately meet requirements of such modeling activities. Thus we need to advance modeling methodology to address these requirements.

The newly created Integrated Modeling Environment (IME) project will develop methods and provide support for modeling activities characterized above. IME will start in January 2006 and is planned for 3 years; it will built on the legacy of the modeling part of the RMS (Risk, Modeling and Society)

Program.

The presentation will have a dual focus. First, it will outline the scope of the IME project; second, it will summarize the recent developments in SMT (Structured Modeling Technology), which will be one of the two core parts of the IME project. Although various elements of SMT have been presented at previous CSM workshops, there are new elements which are worth to be discussed.

Acknowledgment

Several ideas exploited in the SMT 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. The user and DBMS interfaces of SMT were designed and implemented in 2004 by M. Majdan in cooperation with C. Chudzian. C. Chudzian has also been developing parts of the SMT needed for data management, instance definition and analysis. New developments in these parts of SMT will be presented at the CSM/KSS'05 Workshop in a talk by C. Chudzian.

Recent publications relevant to the presentation

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Ontological Modeling in Clinical Decision Support: Radical Prostatectomy Caremap and the MET Environment

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Keywords: ontological modeling, clinical decision support, radical prostatectomy

Ontologies have been used in clinical practice for controlled terminologies, e.g. SNOMED-CT repository of medical terms. However recently, they have been adopted in the design of clinical decision support systems (CDSS), where it is proposed to separate problem domain ontologies from generic solvers [1] (problem domain ontology describes the clinical domain and defines the required knowledge, while the solver is a general problem solving algorithm that uses the domain-specific knowledge in order to arrive at a solution). This separation allows building robust, flexible and reusable systems with shared ontologies and solvers (a single solver can be associated with several problem domain ontologies, and one ontology can be associated with several solvers). This M:N relationship between domain ontologies and solvers extends functionality of CDSS and facilitates creation of new systems from reusable components.

Ontologies not only offer a way of organizing concepts in the domain and support areas, but they can also be used for automatic creation of user interfaces [2]. This allows developing interfaces that are fully specified by the underlying ontology, and that are automatically updated whenever the ontology changes. Although this approach has been initially used for building knowledge acquisition tools, it has been also successfully used in the CDSS design.

We combined these two uses of ontologies into a uniform ontological framework for building flexible and ubiquitous CDSS and implemented it in the MET decision support environment [3]. In the proposed framework we use ontological models to describe a problem domain and necessary support functionality (domain-specific knowledge, referred to also as a decision model, and solvers), and to define a logical user interface that can be rendered on various access platforms (e.g., handhelds, tablets, or notebooks). A CDSS build by such ontological models is characterized by complete de-coupling of its logical and physical components allowing it to be rendered when and where required, and used by end-users with different skills and support requirements.

The proposed ontological framework for building a ubiquitous CDSS is presented in Figure 3 using management of radical prostatectomy patients in a hospital as an example of clinical problem domain. This framework includes general concepts related to the CDSS development and specific concepts related to the clinical domain (radical prostatectomy caremap for hospitalized patients). It consists of three main parts describing logical models of different system components:

- Clinical domain (patient, episode, presentation),
- Support functionality (decision model, solver, attribute mapper),
- System (user interface, system module).

The ontological model of a domain is build using the following assumptions:

1. A single patient can have several episodes (e.g., visits in the Emergency Department or hospitalizations),

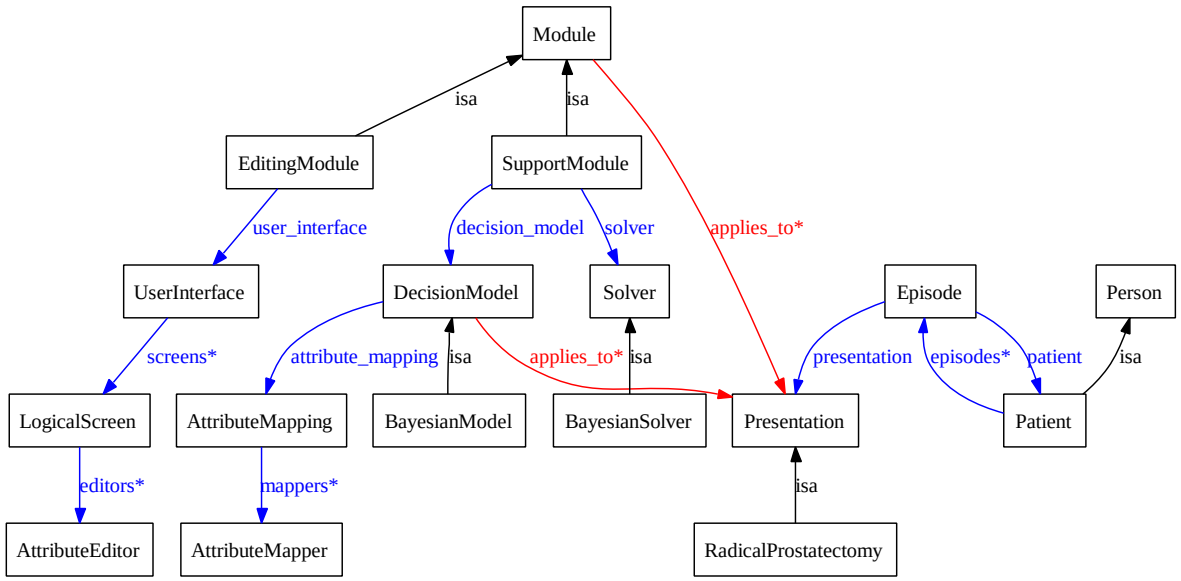

Figure 3: Ontological modeling framework for a ubiquitous CDSS and radical prostatectomy caremap

2. Each episode is bound to a single clinical presentation (e.g., prostate cancer requiring radical prostatectomy).

The ontological model of support functionality is described by the following basic concepts:
1. Decision model that contains knowledge necessary to support a clinical presentation,
2. Solver that employs a decision model using data to arrive at a solution,
3. Attribute mapper to pre-process values of attributes according to the requirements of a decision model.

The ontological model of a system involves the following basic concepts:
1. Editing module that manages a user interface for presenting and modifying patient's data,
2. Support module that provides support functionality for clinical presentation,
3. User interface that renders, lays out and manages logical screens (specific instances of the interface for various computing platforms),
4. Logical screen that groups and manages several attribute editors,
5. Attribute editor that binds specific widgets (editing tools) to a specific attribute.

This general framework has been specialized for various clinical presentations. The majority of them are emergent acute pain clinical problems; however, to demonstrate the flexibility of the framework we also extended it to support a caremap for radical prostatectomy and to estimate the length of stay in hospital after the surgery. As the general framework includes all the necessary concepts, the specialization was relatively easy and required the following steps:
1. Defining the concept of radical prostatectomy, derived from the concept of an episode, that established all the required clinical attributes considered in this presentation,
2. Defining the decision model for supporting the analysis of a caremap (Bayesian belief network model derived from the concept of a decision model) with all necessary attribute mappers,
3. Defining the solver (Bayesian inference solver derived from the concept of a solver) for Bayesian decision model,
4. Defining the specialized logical user interface for entering values of the clinical attributes and presenting results of applying the Bayesian inference solver to the Bayesian belief network model.

The created system MET-MCM (Mobile Caremap Monitor) has been verified in a limited retrospective chart study. Positive results proved the validity of the proposed ontological modeling framework.

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Design and Evaluation of Technology Creation "Ba" in Academia

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Keywords: knowledge creation, technology

One key issue for the 21st century COE (Center of Excellence) program "Technology Creation Based on Knowledge Science: Theory and Practice" sponsored by MEXT (the Ministry of Education, Culture, Sports, Science and Technology, Japan) at JAIST is the design, consolidation and evaluation of graduate school research facilities and the surrounding environment as a "Ba" (a Japanese term meaning: place, center, environment, space, etc.) for creating science and technology. What we mean here by "Ba" is not a physical space, but rather the entire system which makes mastery and embodiment of knowledge possible, including factors like time, place and context (Nonaka et al., 2000).

At the foundation of this program for knowledge bases, there is an academic field called "knowledge science", which models the knowledge creation process and conducts research on knowledge management, and JAIST is the only institution in the world where a School of Knowledge Science has been established as a research department. This school has produced many research results relating to management of knowledge, including knowledge conversion theory, methods of knowledge systematization, and methods of developing creativity, in the area of management studies.

However, future "knowledge science" will transcend not only management studies, but also the barriers between areas of study, and in Japan in particular, "knowledge science" must be accepted and practiced by researchers in key scientific fields (bio, nanotech, environment, information), so that creative results can be theoretically brought into being. To achieve this, it is necessary to have a "Ba" for developing and practicing knowledge creation theory (socialization, externalization, combination, and internalization) in science and technology research. Awareness of this problem is what led to the proposal of the COE program.

We begin this paper by considering what distinguishes knowledge and information. This clarifies the necessity of having two approaches toward knowledge science, one from management science and one from information science. We shall introduce the history of how the "School of Knowledge Science" was established, in addition to systems science, as a methodology for unifying these two. Next, we shall introduce research and education goals in the COE program, and explain system methodologies which are under development for promoting the program.

Toyama and Nonaka (2000) defined a "knowledge creation Ba" as a "dynamic context which is shared and redefined in the knowledge creation process". This paper considers the advantages and disadvantages deriving from the vagueness, depth, diversity and freedom of this definition, and stresses the need to design "knowledge creation Ba" using systems concepts. A conceptual framework for systematization is proposed by introducing a holistic perspective to knowledge management. Finally, we discuss evaluation of "knowledge creation Ba" using systems concepts, and report on a preliminary survey.

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Application of EDGE Software and Simulation Methods to Problems of Catastrophe Bonds Turnover

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Keywords: catastrophe bonds, neutral martingale measure, simulations, financial instruments

The catastrophe bonds (in abbreviation *cat bonds*) are relatively new kind of financial instruments. Their development is connected with enormous losses caused by natural and human–made catastrophes, which during last decades increased significantly (see e.g. [4], [12]). For example, between 1989 and 1995 total insured losses were 50 % higher than in the preceding 38 years (see [8]). For many countries, even developed ones, losses caused by these events considerably affected insurance industries, national economy and governmental budgets.

The catastrophes bonds are very similar to other bonds issued by a government or an enterprise (see e.g. [11]). The main difference between cat bond and the standard bond is that structure of payments of the first one depends also on the occurrence of specified type of natural catastrophe in the precisely described region and time interval. This event defines so called *triggering point*, which changes the schedule of future payments of the cat bond (see [8], [10], [14], [15]). Examples of such catastrophes may be floods, earthquakes, hurricanes, tsunamis, etc. Additionally, as usual, the structure of payments is connected with some basic financial instrument, like rates, shares, etc.

The catastrophe bonds may be a very important new financial instruments for insurers and governments. Especially in the developing countries these instruments may stabilize economic growth. In developed countries they may be also significant for national economy and private sector (see e.g. [3], [5], [14]). These instruments transfer *risk* from *insurance markets* or *governmental budgets* to *financial markets*, which are more *liquid* and have more *capacity* than other markets or budgets (see e.g. [7], [8], [10]).

The issuing of catastrophe bonds is a source of important questions for financial mathematics. Such problems, as a present value of future cash flows, the size of necessary and sufficient volume of issued bonds, analysis of possible issuing costs may be solved by using simulations and special software. As the answer for the mentioned above questions, we present generalization of the methodology known in financial mathematics, i.e. neutral martingale measure, Monte Carlo simulations and procedures originated from EDGE software (see e.g. [19]). This work is continuation of papers [16], [17]. Other approaches to these problems may be found in e.g. [2], [13].

The software package EDGE, an Earthquake and Damage Generator / Estimator for Toscana, was developed at IIASA (see [1], [18]). This software integrates two main parts (modules). The first part is a generator of catastrophes (earthquakes), and the second is an estimator of damages arising from generated catastrophes. The generator of catastrophes simulates earthquakes. From input calibrated to specified region it generates scenarios of possible earthquakes for this region. These scenarios include a variety of important data, e.g. locations of earthquake occurrences, their magnitudes, affected areas, etc. (see [1]). These scenarios are then used in the second part of the software. Using additional input,

the estimator creates distributions of possible losses and samples of losses for different locations in the whole region.

Monte Carlo methods are used to simulate the set of possible trajectories of underlying asset behaviour $S_t = \{S_t^1, S_t^2, \ldots, S_t^m\}$. To generate these trajectories we use adequate iterative stochastic equation, e.g. Euler scheme for geometrical Brownian motion with constant drift (see eg. [9], [19]).

Using EDGE software we acquire the set of possible scenarios of catastrophe $X_t = \{X_t^1, X_t^2, \ldots, X_t^m\}$, e.g. values of earthquake magnitudes. Joining these two sets S_t and X_t we may prepare adequate analysis as answer for many problems arising from catastrophe bonds turnover.

We illustrate the general methodology with appropriate algorithms in pseudocode with simulation results. Moreover, we discuss application of methods for accelerating and simplifying calculations known for other types of financial instruments (see eg. [9]) to the case of the presented problems.

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A method of Reorganizing the Knowledge in Government Documents for Quick Response of Emergencies

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Keywords: quick response, knowledge management, knowledge reorganization, knowledge map

To face the emergencies, the decision makers need to know what to do, how to do, who does, where the resource is as soon as possible. The knowledge about know what, know who, know how, know where and know when plays an important role for making right decision. The knowledge is usually distributed in many files including laws, regulations, emergency plans, principles, technical criterions and so on. Because these files are published by different governmental departments, the knowledge that decision makers needed is not organized according to the situation of an emergency. So it is difficult for the decision makers to make quick response when an emergency occurred.

In this paper, a method of reorganizing the knowledge in government documents for quick response of emergencies is presented. The method consists of five parts.

Firstly, a common flow of emergency control is built up based on the sufficient analysis of some different types of emergencies, such as severe acute respiratory syndrome (SARS), earthquake and nuclear radicalization and so on. Using this flow, the knowledge needed for emergency control is obtained and then classified into several types. Secondly, the departments related to emergency control are classified into two types: commanding department and functional department. The function of each department is defined, and then the knowledge requirement of them is ascertained. Thirdly, the relationship between a certain situation of emergency and the classified knowledge is established. Based on these work, the reorganized knowledge for commanding department and functional department is obtained, respectively.

Next, the knowledge map is applied to express the knowledge after reorganization. Knowledge map expresses the knowledge in graph format instead of text format. It has many advantages such as visible, heuristic and guidable and so on. Two kinds of knowledge map, the knowledge structure map and the knowledge application map are built up to express the knowledge for commanding department and functional department, respectively. Finally, the knowledge map system is designed and realized. The system provides a visible framework for knowledge reorganization and a platform for knowledge map creation.

Using the proposed method, the knowledge distributed in the files published by different governmental departments is reorganized as knowledge map system, in which the knowledge related to the certain situation can be obtained directly. And then the decision maker can make quick and right decisions when an emergency occurred.

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Human-Machine Collaborative Knowledge Creation: Capturing Tacit Knowledge by Observing Expert's Demonstration of Load Allocation

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Keywords: knowledge creation, machine learning, explanation-based learning, container loading, interactive learning.

In our real world there are so many hard problems in which multiple restrictions are contained and multiple objectives are to be achieved. Encountering such hard problems, human experts are handling such complex problems just in focusing some critical aspects and in neglecting others at most times. Selecting restrictions as well as prioritizing objectives are essentially based on their experiences of problem solving, but know-hows utilized wherein are difficult to be captured, while an expert could demonstrate problem solving without any difficulty. Container loading problem is one of such complicated problems and there has been no program developed that can automate the loading like a human expert.

With the advancement of current computer technologies, it becomes to be possible to utilize advantages of the computer's high-speed computation and huge storage capabilities to assist people to solve the real hard problems. Actually many researchers are resorting to many kinds of optimization algorithms guided by heuristic control rules as feasible approaches. However, the results obtained so far do not always stratify the user's requirements, since the heuristic algorithm cannot always fully implement an expert's flexibility that are revealed when he/she encounters a variety of dynamic or complex situations.

In general once an algorithm is determined, a problem solving based on that algorithm may become fixed, i.e., get to lose flexibility like a human's problem solving. The most fundamental characteristics of human experts exist in their interactive aspects that reveal when he encounters a novel problem. The problem may stimulate the experts to perform their potential skills using their expertise, which is not always recognized by the experts themselves explicitly. The human being would start to react when he/she is put in particular circumstances. An older methodology like expert systems concentrated its attention to enlist all the knowledge apart from such particular problem solving circumstances, but such an approach was not successful. Preferably, we think opportunities for the expert to apply his/her knowledge should be offered by the system and the methodology should assist the knowledge elicitation process by stimulating the expert's proactive and voluntary problem solving efforts to be exerted. In this way, a platform should help the expert to derive and transform his/her tacit knowledge into explicit one is the most important. So the abstraction of the knowledge but the most optimization should be pay attention greatly.

The general optimization algorithm has many weaknesses. In the first reason, new aspects needed to consider are not easy to be added into the approach after the design having been finished. In the second reason, achievements based on better methods are also not easy to be alternated later. Last but not the

least reason, it is difficult to be decided when to relax parameters existing among constraint conditions or evaluation functions which always is needed to adjust to dynamic environment.

At the same time it is hard to make full use of the expert's knowledge directly though the expert has rich experience and can deal with concrete problems flexibly. Generally speaking useful knowledge from the expert is tacit. According to Polanyi's [1] definition, it is highly personal, context-specific, and hard to formalize and communicate.

Then, the core point to us is how to combine the heuristic algorithm with the expert's knowledge, i.e. how to abstract the expert's practice into knowledge and apply it into the heuristic algorithm to improve the flexibility of the general algorithm. Aiming for this we propose a method named Interaction-based Knowledge Acquiring Framework (IKAF) and we introduce explanation-based learning (EBL) as a core leaning function embedded within the system that interacts with a human expert and acquires his/her tacit knowledge.

Explanation based learning (EBL) is one of the deductive machine leaning methods taking use of domain theory as domain specific knowledge (see e.g., [2, 3]). EBL can generalize a specific explanation formed for a particular training example and can derive generalized knowledge from that by analyzing why that example is an instance of an instance of a concept to be learned. The methodology of EBL gives a feasible and flexible way to abstract the expert's knowledge. In our framework the expert is allowed to revise the result calculated by the conventional optimization techniques and taking this revision as an example for EBL. And through the analysis of this training example, the expert's tacit control knowledge is leaned and can be used in the next calculation based on the revised knowledge base, to which the acquired fragment of an expert's tacit knowledge is added incrementally.

As a matter of fact, our framework is also interactive in a sense that the expert is allowed to commit in the problem solving by criticizing the solution provided by the system, and the system accepts the revised solution provided by the human expert (i.e., system learns from an expert user). A user may not be restricted to a human expert but may be a novice user; in this case a user may interact with the system recognizing what is better solution comparing with his/her expecting solution (i.e., a novice user learns from the system).

The paper is organized as follows. In the next section, we present IKAF architecture in details. Then, we apply it to solve a container-loading problem so as to illustrate how our framework does work. Both the problem definition and the concrete solution will be presented in section 3. In section 4 a real solving process of container loading problem is demonstrated as the validation of the application. In the last section, conclusions and future work are discussed.

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Testing ontological support for multidisciplinary model-based problem-solving for water management

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Keywords: model-based water management, ontological modelling support, knowledge base, verification, validation

Introduction

Mathematical models have been applied for several decades to support model-based problem solving for decision-making, including water management. Recent developments, e.g. an integrated problem-solving approach with awareness of socio-economics aspects in water management and environmental modelling, set higher demands to quality assurance for model-based problem solving. This growing interest for quality assurance is further fuelled by a multitude of reasons, including ambiguous terminology, a lack of mutual understanding between key-players, malpractice in regard to input data, inadequate model set-up, insufficient calibration/validation, model use outside of its intended scope, insufficient knowledge on some processes, miscommunication of the modeler to the end-user, overselling of model capabilities, confusion on how to use model results in decision making and a lack of documentation and transparency of modelling processes.

The responses of the modelling community to these problems consist mainly of guidelines, but these are usually nationally based and focused on single domains (disciplines). Resulting model outcomes and decisions based on them are often non-transparent, irreproducible, non-auditable and not fully and easily comparable among different countries.

An additional complicating factor is related to the changing character of model-based problem projects from monodisciplinary, single person and academic oriented research model studies into multidisciplinary, decision support oriented projects, in which teams consisting of members with different background and different roles co-operate to complete the complex job. Modelling in multidisciplinary modelling teams is a necessity in such problem contexts and facilitates exploring more complex questions. On the other hand it also makes co-operation in teams more difficult. Team members with different scientific backgrounds encounter more communication problems, which makes managing multidisciplinary model-based water management projects a cumbersome affair. In an EC funded project, HarmoniQuA, a modelling support tool has been developed to lower many of the hurdles encountered in present simulation modelling.

The support tool MoST (**Mo**delling **S**upport **T**ool) consists of a knowledge base with guidelines for multidisciplinary model-based water management, which can be changed with the Knowledge Editor by authorised persons. Modelling projects have to be seen as a *process*. This process has been decomposed into *steps*, which each consists of a series of *tasks*. Tasks have to be executed by doing *activities* using *methods* (if available). These guidelines are provided to teams, which members have different backgrounds (e.g. groundwater, hydrodynamics, surface water quality, ecological modelling, precipitation-runoff, flood forecasting, socio-economics) and play different roles (water manager, modeller, auditor, stakeholder, public) in water management projects. These teams set-up such projects and define subprojects related to the domains relevant for the study at hand. Team members get roles, tasks to

do and authorise members to read and edit the work of others and take decisions on how to continue the project. After the set-up phase MoST facilitates in the next phase managing the project (what has been done, what is skipped, what is presently done), time slots at the project level and at task and activity level, resources used and the responsibilities of all team members. This information of a project is stored in an ontological model journal with more or less the same structure as the knowledge base. Finally, MoST helps producing reports based on the model journal, customised to different purposes and audiences.

MoST is a complex tool and novice users need training before they can benefit from its features to support modelling teams in their daily routine. Therefore, comprehensive training material has been developed for students and professional modelers in water management. This training material consists of written material, presentations, exercises that encourage using MoST in a test case project and many screen-recording movies on MoST, its knowledge base, a case study and some background information. The movies are the core part of the training material and aim at helping users to work with MoST and act as a sort of animated help facility.

In the remainder of this paper, we will use 'the knowledge based system' (KBS) as a container term for MoST, plus its KB filled with modelling knowledge for water management, plus a model journal archive, plus the Knowledge Editor. As a side product of the KBS we also realized a technology that allows developing systems for guidance and support of teams working in a complex, techno-scientific context, further referred to as the 'the knowledge based technology' (KBT).

Validation tests

Verification of a knowledge-based system (KBS) is the task of determining that the system is built according to its specifications. *Validation* is the process of determining that the system actually fulfills the purpose for which it was intended. Do the intended end users adopt it and evaluate its performance positively. Verification is showing the system is built right and validation is showing the right system was built. The term *testing* will be used to refer to verification and validation. Testing to increase the confidence of users - sometimes called validation - is a continuous process: each test aims at proving something is not 'good'; there more tests that are passed, the more confidence one can have. Knowledge based systems are hard to test, as several aspects of these systems have to be validated, depending of their objectives. Before discussing which tests are needed, we have to outline some basic concepts. First there is the *mental model* of how we look at multidisciplinary model-based problem solving. This mental model can be summarized as follows.

- There is a **problem**,
- Owned by some **problem owner**,
- Who organizes a **multidisciplinary team**,
- Consisting of **team members**, who:
  * Have different disciplinary backgrounds;
  * Fulfil different **roles** in that team.
- What the multidisciplinary teams have to do to support to 'solve' the problem at hand is called a **process**. This process should be a role model of the best practices of professional modellers in the field.
- The process is carried out in a modelling **project**;
- The modelling project consists of one or more **subprojects**, belonging to one or more domains/disciplines;
- Subprojects are called:
  * **Single domain subproject**, if they run with a different speed than other subprojects;
  * **Multidomain subproject**, if they have to be synchronized with other subprojects;
- A subproject consists of **steps**.
- A step consists of **tasks**.
- A task consists of **activities**.
- Tasks and activities can use **methods**and **tools**.
- What teams have to do can be made explicit in a **knowledge base**.

To use this mental model for this KBS (MoST and the rest) the problem, the team and the process

are particularized for water management (i.e. the knowledge base is filled with modelling knowledge for water management). So we have a knowledge base with process knowledge (here for water management) and the rest of the mental model is used as blueprint for system specifications (reported elsewhere) and based on these, a design for MoST.

Subsequently, we can use the following **test criteria**, which are a mix of verification tests and validation activities:

The knowledge based system (1) :

- The KB structure, i.e. its ontology (11):
  * Correctness. *Capturing intuitions of domain experts?* (111)
  * Completeness. *Can everything be represented?* (112)
  * Consistency. *Is it a correct ontology?* (113)
  * Granularity. *Not too detailed, not too abstract, but fitting the knowledge level required to do the job.* (114)
- The KB content related to water management (12):
  * The process decomposition (121):
    – Correctness. *Do the decomposition and the flowchart capture intuitions of domain experts and their mental model of modelling processes?* (1211)
    – Completeness. *No gaps (steps, tasks, activities, methods)?* (1212)
    – Redundancy. *No unintended duplications in steps, tasks, activities, methods?* (1213)
    – Consistency. *Does the decomposition contain contradictions?* (1214)
    – Transparency. *Does the flowchart and the rest of the decomposition offer a transparent view on the structure of the process?* (1215)
    – Granularity. *Not too detailed, not too abstract, but fitting the knowledge level required to do the job.* (1216)
  * The content of the decomposition elements (122):
    – Correctness. *Capturing intuitions of domain experts?* (1221)
    – Completeness. *No gaps (steps, tasks, activities, methods and tools)?* (1222)
    – Redundancy. *No unintended synonyms?* (1223)
    – Consistency. *Different ways of treating the same concept? And does the content of the KB include contradictions?* (1224)
    – Meaningfulness. *Intended users should be able to understand.* (1225)
- The tool MoST (13):
  * Correct functioning without error and software bugs? (131)
  * Reliable? *Is the system functioning, available and accessible by a project team when needed?* (132)
  * Functioning according to requirements? (133)
  * Supporting adequately daily practice of professionals? (134)
  * Appropriate for teaching novel model users (students)? (135)
- Training material (14):
  * Correctness (141)
  * Usefulness professionals (142)
  * Usefulness students (143)

The knowledge base technology (2) :

- Is the KB ontological structure reusable? (21)
- Is the tool MoST useful for other processes? (22)

This list of criteria is consistent with the presented mental model of how multidisciplinary team function

in modelling projects, but many of the criteria are difficult to test, as there are no tools or general applicable methods. Nevertheless we tried to assess all at a feasible level. MoST and its modelling knowledge base for water management have been developed in a prototyping process, starting with providing just guidelines and next adding functionality to monitor and store what team members do in so called model journals. This version with a limited (still complex) functionality was then tested in 10 test cases of normal commercial modelling projects. Based on the results of these tests, the functionality of MoST has been extended to assist multidisciplinary teams co-operating online (internet) in multidomain modelling projects for water management. This has been tested in a second series of 10 test cases, which results are used for final improvements.

The ontological structure of the KB (11) and the process decomposition (121) are discussed by all partners at project meetings and commented by various (internal) testers and (external) reviewers. Reading and using the KB were the methods that the testers used to evaluate it. In this way the content of the decomposition elements (122) have been tested according to the following criteria (see above): 1221, 1222, 1223, 1224 and 1225. These tests were conducted at three levels: (1) internally reviewed by experts (modelers for water management) not involved in developing the KB, (2) used in two series of test cases by professional modellers, where MoST has been used in normal, commercial projects and (3) commented by external reviewers (Pasky Pascual from EPA, USA, Nils Ferrand from CEMAGREF, France and Hugh Middlemis from Aquaterra, Australia).

MoST (software) was tested at four levels: (1) on criteria 131, 132 and 133 by an project partner not involved in the design and implementation of the software, (2) at a functional level (criterion 134) in both test series, (3) by the external reviewers on criteria 131, 132 and 134 and (4) by professionals attending workshops (134) and students attending master degree courses (135). All testers of the software (and impolitely of the KB) were asked to fill in an online questionnaire. In the workshops and courses the training material has been used, which is a test on criteria 141 and 142 (workshops) and criteria 141 and 143 (courses). Testing of training material by using it was further evaluated with the online questionnaires. Applying this technology to support another process will test the knowledge base technology (criteria 21 and 22). Within the EC-funded project AquaStress the HarmoniQuA technology will be applied to define the process in which multidisciplinary teams try to mitigate water stress issues throughout Europe and also for supporting teams in their daily practice.

A final test is scientific publishing. Many aspects have been published (Refsgaard and Henriksen, 2004, Refsgaard *et al.*, 2005, Olsson *et al.*, 2004) or are accepted for publication (Scholten *et al.*, 2005 or 2006). Furthermore, the KBS is presented at many conferences and workshops.

Results and conclusion

From the variety of test results, we will highlight here only a few remarkable:

- Not many comments on the ontological structure of the KB (11) have been received. Ontologies are for domain experts without knowledge engineering experience hard to understand. Useful indications on how to change the ontology emerged indirectly when putting the pieces of modelling knowledge into instances of the ontology.
- Several times we received demands for changing the structure of the modelling process (121). These demands came from project partners and from the 'wider modelling society'. All remarks were carefully evaluated and several have been used to improve the decomposition of the modelling process in **tasks** and of **tasks** into **activities**. These changes were mainly related to the order of the tasks, their dependencies, but also to the decomposition in tasks and the activities associated with the tasks. Implementing of these changes were quite easy and not time consuming, because of the flexibility provided by the ontological approach. Typically, substantial changes required a few hours to a single day work to incorporate the changes in MoST and in its KB.
- Feedbacks on the content of the decomposition elements (122) included long lists of errors, wishes and comments (1221 to 1225). But all respondents so far appreciated the guidance provided by the KB and found it useful, especially for novice users of MoST.

- The results of the first test series for criterion 134 were promising and directed the redesign of MoST to a more powerful level. These tests led to a long series of small suggestions that have been discussed and partly implemented. The first test series also identified more important shortcomings. The modelling support provided by MoST was insufficient in two aspects. The version used for these tests was too much focused on single users and on monodisciplinary projects. Extra functionality for modelling teams and for multidisciplinary projects has been implemented in the full version of MoST. The second test series with the full version of MoST provided other needs for change. Applying MoST and its KB in university courses resulted in a similar request. Many testers and students wanted MoST to enable working at a higher level: not only fulfilling tasks by doing activities, but also detailing what team members do at a task level only. In the latter case the activities are just headings in the model journal contribution on that task.
- Testing the training material (14) led to many relatively small changes. Many of the national workshops for professionals are scheduled for this year, so answers on criterion 142 (usefulness for professionals) are not available yet. But using the training material in student course (143) showed very promising results. Students learn very quickly (a few hours) how to use MoST in a training case study and apply it in their problem oriented education projects, in which small groups of s tudent have to solve environmental problems with a model. The guidance provided by the KB directed them effectively through the network of tasks, of which modelling projects usually consist. This approach also approved more efficient than the textbook approach with the GMP Handbook (Scholten, 1999) used in the same courses in the past.

As said earlier, testing is a continuous process, leading to improvements in all aspects of the system and the technology. Until now tests have been encouraging and support the idea that our approach is a successful one.

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Strategic Planning of Distribution Networks for Letter and Parcel Mail using Optimization Models

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Distribution Networks for Letter and Parcel Mail consist of several subnetworks (subsystems), such as:

- Network for collecting mail at customer sites, mailboxes and filials (transportation networks, also called feeding networks)
- Sorting Centers SCA (exit to long haul transportation) performing sorting processes for the long haul transportation
- Long Haul Transportation Network (combined transportation mode between the sorting centers),
- Sorting Centers SCE (entrance from long haul transportation) performing sorting processes for the distribution and delivery (last mile)
- Networks for distributing mail to the delivery stations (transportation networks)
- Delivery to business customers and private households (last mile).

The listing of these subnetworks shows the sequence in which a letter or parcel flows through the network from origins (source locations) to destinations. It is assumed that a Sorting Center is split into two parts SCA and SCE which chair one and the same location. Also, we assume that the quantity of letter or parcel mail (measured in a certain unit) which has to be transported per day from an origin to a destination location is known.

Planning a distribution network of this type means both design of a new network or reengineering (replanning) of an already used network. Letter and parcel mail are special categories of freight. Therefore, we start to consider more general network design problems in freight transportation, and focus later on the postal logistics cases.

Network Design in Freight Transportation means in the most general case: Designing of the physical network which performs the task "shipping goods from origin to destination locations under service quality (performance) rquirements". This includes:

- creation or reengineering of the infrastructure at the locations (terminals, depots, hubs)
- selection of services to be offered
- assigning the resources (vehicles, human resources) to the services and
- scheduling of the services.

This problem is too complex in order to become solved in one step as a whole. Therefore, planning phases have been introduced which are determined by the time horizon and the importance of the respective decisions. These planning phases are mostly called the strategic, the tactical and the operational phase.They overlap and are depending on each other. In particular, in the strategic phase longterm decisions are made concerning the network infrastructure:

- quantity and quality of the main resources locations, facilities, fleets, human resources and the methods of acquisition of these resources
- selection of the services to be offered

The tactical planning phase contains mainly the design of the service network (Service Network Design). This means the selection of routes on which services will be offered, traffic distribution, terminal

policies (sorting, storing, picking) and the empty balancing strategies. High quality strategic decisions require to make strategic and tactical network design simultaneously. However, this results in very complex optimization models, which are almost impossible to solve for realistic problem instances. Therefore, the models, we will explain later in this paper, represent a compromise: The strategic network optimization model includes the Service Network Design (SND) problem approximately.

Let's now consider the postal logistics application in more detail:

The most important objects are

- origins (sources) for letter /parcel mail: mail boxes, filials, business customers, zip-code areas
- destinations: private households, business customers, zip-code areas (depending on the level of aggregation)
- locations: point-locations (usable for mailboxes, sorting centers, delivery stations, airport locations) area-locations (zip-code areas, delivery districts, areas allocated to the sorting centers)
- facilities: sorting centers (number, size, type, layout), hubs (candidate hubs are the sorting centers, air hubs), delivery stations (number, size, type and layout)
- fleets :
  - heterogeneous fleet of aircrafts for the longhaul transportation network,
  - heterogeneous fleet of road vehicles for the longhaul transportation network, the distribution and the feeding networks.

The selection of services depends mainly on the selected service quality levels, which are e.g. next-day delivery, 2nd-day delivery etc. The service levels may be different for the different products (goods), e.g. types of letters, types of parcels. After selecting service levels for each product, the services have to be selected. The usual way to do this is to assign time windows or 'latest times' to the subnetworks which correspond to selected service levels. For example, there is a time window for the longhaul transportation network which ensures overnight (next day) delivery. The latest times and the time windows determine the services which are needed, e.g. :

- combined transportation mode 'air-road' within the longhaul transportation network
- direct links vs. consolidation using hubs within the longhaul transportation network
- routes within the feeding and distribution networks
- to-house delivery by the postman in the last -mile networks

The approach briefly described above predetermined a certain type of thinking about optimality of a distribution network. It consists of two phases:

1. Definition of service quality level of the whole network
2. Minimization of costs under the precondition that the service quality level is met.

This means, service-quality measures are set as constraints (hard requirements) which must be fulfilled. The costs are considered to be soft constraints. The idea is, make the costs as small as possible, where what possible means is defined by the service quality constraints. Of course, other scenarios are also interesting. In particular one can ask, how much costs can be reduced by relaxation of certain service quality levels. Also, the whole problem can be considered as multi criteria decision analysis problem. During the presentation we will focus on 3 classes of optimization problems:

PS1(Facility Location Problems): We assume a service network to be given which guarantees that the required service levels will be fulfilled. "To be given" means that such a network can be constructed. The models use simplified service networks in order to compute approximate costs of the transportation part of the network.The problem is to find facilities, their numbers, types, sizes and locations in order to minimize overall costs.

PS2 (SND-Service Network Design): There are given the facilities by number, size, type, location etc. The problem is to find the service network (SND) which fulfills the required service levels and, under this condition, minimizes costs.

PS3 (Location Routing Problems): The problem is to determine locations and routes simultaneously in a way that service quality requirements are met and, under this condition, costs are minimized.

The class PS3 of problems is well recognized in the literature, the class PS2 was intensively studied by our group for the DP World Net letter mail application from 1995 until today. In this paper, we will mainly focus on three models of the class PS3 of optimization problems:

- Delivery Station Location Optimization ,
- Sorting Center Location and Area Assignement Optimization ,
- Optimal allocation of sources to Sorting Centers.

We will present generic models and will discuss optimization methods to solve these models.

Model Theory Approach to Development of an Intelligent Management Information System: Liquor Wholesaler System Problem

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Keywords: model theory, set theory, formal systems development methodology

Our group is working for application of systems theory to management information system (MIS) development. Although an MIS is customarily treated as a synonym of a transaction processing system (TPS), it should be correctly recognized as a system composed of a problem solving (DSS) component as well as a transaction (data) processing component. Our research proposes model theory approach as a new system development methodology. It is completely different from the traditional software engineering approach. The model theory approach can cover problem solving system development as well as TPS development. It is a formal systems theory approach in the sense that an information system model is constructed in set theory based on a formal structure of an MIS. The formal structure is composed of two components, a standardized component and a problem dependent component. The latter is called a user model. An executable system is generated from the user model by automatic system generation. On translation the standardized component is attached to the user model such that effort required for system development is drastically reduced. The approach, consequently, facilitates rapid system development.

This presentation discusses a liquor wholesaler system which has been used as a standard problem to compare system development methods in Japan. It has been treated as a TPS, although it involves an inventory control function. We develop the system as combination of problem solving and transaction processing functions. The combined system is called an intelligent MIS. Figure 4 (on the next page) shows its used for development.

The user interface (UI) is constructed in PHP. Interactive activities between a user and system are, therefore, performed on the browser. A regular user command is executed by the transaction processing (TP) component. On the other hand, if a command requires a problem solving function, it is first sent to the TP component, which calls the problem solving component. It solves the problem formulated as PSE (problem specification environment) and sends a solution to the UI through the TP component.

The presentation will show development of the liquor wholesaler problem as an intelligent MIS and discuss comparison between our approach and a Z formulation of the problem, which is another notable formal method.

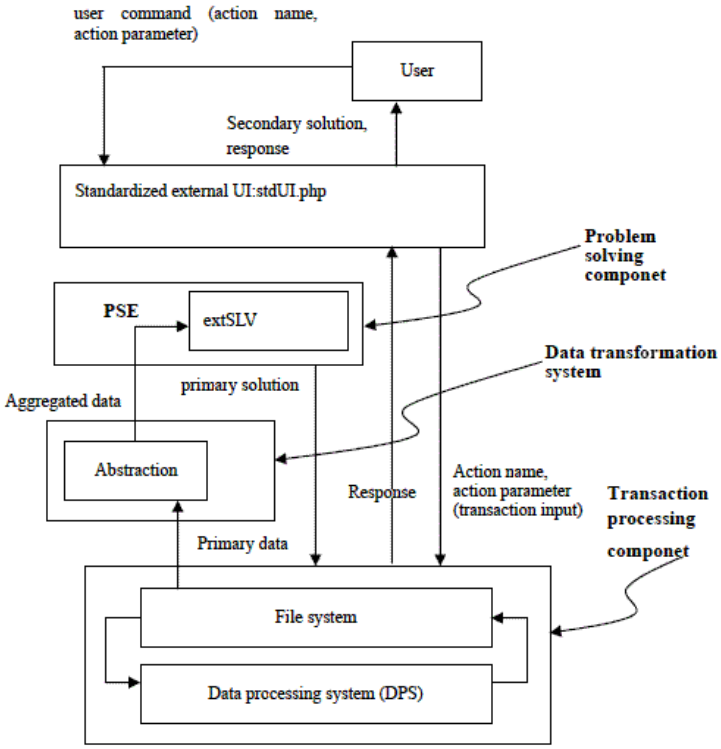

Fig.1

Figure 4: The structure of the intelligent MIS

Model-based Evaluation of Psychological Sense of Security for Moving Humanoid Robots Based on Analytic Hierarchy Process

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Keywords: model-based evaluation, psychological sense of security, coexisting humanoid robots, SSR (Safe, Secure and Reliable) society, AHP (Analytic Hierarchy Process)

The experiment [1] was conducted at Osaka University to evaluate human sense of security for a coexisting humanoid robot with people in a virtual reality. One of the authors of this work (K.K.) joined the experiment as an examinee. In this experiment a virtual humanoid robot is virtually presented to the examinee through a projection-based virtual reality environments named CAVE [2] and a humanoid robot passing nearby a human examinee in a corridor is evaluated by the examinee. The initial distance between the robot and the examinee is 5[m]. The robot is approaching to the examinee with various motion patterns. The examinee pushes a button when he/she wants to avoid the robot and the location of the robot at this moment is recorded. The examinee is also asked to answer the questionnaire on his impressions he feels on the robot motions.

In this research we try to analyze the experimental data and the data obtained by the questionnaire and then we try to model the examinees' psychological sense of security using the systems methodology called Analytic Hierarchy Process (AHP) which has been used for value judgement of alternatives under multi-objective evaluation. Ekman and Friesen [3] pointed out that basic emotions of human are "happiness", "surprise", "angry", "disgust", "fear" and "sadness". In this research we pick up "fear" and "unpleasantness" as the two main factors of "uneasiness" affected by the humanoid robot motion. The factor of "fear" is divided into two elements and the factor of "unpleasantness" is divided into seven elements. We describe a three-level hierarchical structure of uneasiness. We analyze 17 kinds of robot motions to find which kind of motion would let people feel morel uneasy and which kind of motion would be more friendly from the viewpoint of psychological sense of security.

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System Intuition and its Role in Knowledge Creation

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Keywords: knowledge creation, system intuition, collective system intuition, imagery thinking

The knowledge conversion and creation process are closely related to the way of thinking. In the process of conversion and creation, intuition plays important role. The model of knowledge creation suggested by I. Nonaka and H. Takeuchi describes the process of creation only at the macroscopic level. In the model the conversion and creation processes are directly from tacit knowledge to explicit and from individual to organizational without intermediate steps in detail. According to the opinion of the author of this paper, the knowledge possessed by individual or organization is a continuum from tacit to explicit. There are many intermediate steps between different levels, e.g. knowledge integration, data and text mining, summarization, oral exchange of experience, etc. In these steps beside the rational thinking processes, the intuition is always employed.

Intuition is one of the greatest powers latent in all human beings and has been called "straight knowledge", but is often underrated and unrecognized. The essence of intuition is: holistic thinking, feeling of pattern or relationships, - understanding without rationale. Intuition can be considered both as a mode of thinking and as a kind of knowledge. It is closely related to tacit knowledge. The existing research on intuition is limited in theoretical area by psychologists and only a few in application. Since intuition is a powerful thinking mode for knowledge creation, it is necessary to investigate its role in knowledge working processes. For the creation of new knowledge, the experience and insight that experts hone over years are crucial. The intuition consists the ability of accessing the cumulative experience and expertise developed a period of years and distilling out of a response or choose without being able to understand consciously how to get it. Many years of preparation and work provide material for incubation of ideas in the subconscious. This is just the first step of creative activity.

Some of the Western people feel there are more myths about intuition and it is opposite of logic. They do not consider the intuition is one of the thinking style. But for ancient Eastern people they put more emphasis on intuitive thinking style than analytical. From Confucius to Zen Sect (the product of the indigenous Buddhism of China) it is a tradition from ancient China to employ the intuitive approach in academic and real life. The analytic thinking is based on the concept and the intuitive thinking is based on the imagery or pattern. Now in China a new discipline covering both the analytic and imagery thinking named Noetic Science in underdeveloping.

A famous Physicist, F.Capra pointed out, *Chinese were not deeply interested in causal relation but rather in the synchronic patterning of things and events*. This means more relying on the intuitive thinking. For the Eastern system thinking, all things and events perceived by the sense are interrelated, connected, and are but different aspects or manifestations of the same ultimate reality. So it pays more attention to the relations of parts than the essence of each part. The Chinese fashion of the creation of intuition is

Experience—Nurtured—Enlightenment—Sublimated

The knowledge creation needs synthetic process rather than analytic. Intuition is a synthetic psychological function which allows us to synthesize isolated experience and information into an integrated picture. This leads the author of this paper to define a new thinking style, *System Intuitive Thinking* or simply

System Intuition. The system intuition or system intuitive thinking is characterized by both holistic and intuitive view. The main features of system intuition or system intuitive thinking are:
1. Emphasizing on the entirety, or *Seeing the whole first.* From the totality to see the system.
2. Emphasizing the unity, pay more attentions to the interrelations of parts and environment.
3. Top down approach.
4. More relying on tacit knowledge.
5. Context orientation

It is not opposed with analytic system thinking, but as a complementary thinking style, integrated with analytic thinking, to formulate a brand new system thinking style.

Another concept the author of this paper would put forward is *collective system intuition*. The collective intuition is defined as *The collective capability amongst a team's member to recognize issues especially in fast changing environment*. The collective system intuition can be defined as the collective capability to system intuitive approach. In the case of organizational learning and knowledge creation, collective system intuition is necessary as the basis for the same feeling.

If the individual intuitive ability can be enhanced through subconscious learning and understanding, the collective intuitive ability can be got by raising intuition to a more or less explicit level. Collective system intuition, as well as collective intuition in general, may be considered as cultural gene. To this point, perhaps the collective unconsciousness (after C.G.Jung) may be the influencing factor. The system intuition is based on the tacit knowledge, It is a precursor and bridge to the new knowledge creation. Similarly the collective system intuition is based on organizational tacit knowledge and is a precursor and bridge to the new organizational knowledge creation.

Just like the intuitive is not opposed to rational, the system intuition is not opposed to the analytical system thinking, which is the core of modern systems sciences. In the recent stage when we have the methodology, methods, and tools of analytical approach, we can use the system intuition complementally in the knowledge conversion and creation process.

Trust regions for estimated models

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Keywords: support vector machines, regression, confidence intervals, machine learning

In process industry huge amounts of data become available through measurements. These data are used in particular to estimate the actual values of other quantities, for which measurements are more complicated or costly or time consuming (soft sensoring is preferred above hard sensoring). Soft sensors are essentially models for the relationships between quantities. Estimation of such relationships is the field of statistical regression. However, the traditional methods for statistical regression do not always satisfy practical needs: the sets of available functions may not be sufficiently rich or the quick adaptation to changing circumstances may not be adequate. This may be particularly true for the large numbers of data in practical cases. Therefore, new methods (largely stemming from the areas of artificial intelligence and machine learning) have been explored recently. Two relevant new methods are "support vector machines for regression"(see e.g. Vapnik [1]) and "symbolic regression through genetic programming"(see e.g. Goldberg [2]).

The presentation will focus on the first approach: regression with support vector machines. A neglected topic for these new approaches is the preciseness of the estimates. In the presentation, this topic will be investigated in some detail for regression with support vector machines.

In the literature, essentially two methods are available for constructing interval estimates rather than point estimates with support vector machines for regression. Both methods will be reviewed and their weak points wll be indicated. Based on this analysis, a new method will be constructed. The performance of the two existing methods and of the new method will be illustrated by examples. One of the existing methods is Bayesian (see e.g. [3]) and the other is data-analytic (see e.g. [4]). The new method is also data-analytic and remedies several of the weak points of the existing methods. The core-element of the data-analytic approach is the definition of a strangeness- measure for potential outcomes. By proper adaptation of this strangeness-measure, a much more satifying interval estimate may be obtained.

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Models of Knowledge Creation Processes

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Keywords: creative space, spirals of knowledge creation, systemic models of knowledge integration, support of creative processes

The paper presents conclusions from an investigation of the concept of *Creative Space*, performed by the authors when preparing a book on knowledge creation and integration theories. *Creative Space* starts with a generalization of *SECI Spiral* (Nonaka and Takeuchi), obtained by considering not the binary logic *tacit - explicit* and *individual - group*, but a rough (three-valued) logic *emotive - intuitive - rational* and *individual - group - humanity*. Thus, instead of four nodes of two-by two matrix, we can consider nine *nodes of Creative Space* and diverse *transitions between these nodes.* However, these are only two basic dimensions of *Creative Space;* further investigation shows that *Creative Space* has at least ten dimensions: *epistemological (Intelligence), social (Involvement), creative (Imagination), motivational (Intervention), systemic (Integration), abstractive (Abstraction), veridical (Objectivity), hermeneutic (Reflection), cross-cultural, organizational.* We could thus consider at least 31059,049 nodes and 59,049x59,048 = 3,486,725,352 possible transitions in the *Creative Space;* these numbers illustrate only that creative processes can be extremely diversified and the spiral models of them are only rough ideal approximations. Nevertheless, it is useful at least to list the typical spirals of knowledge creation and other knowledge creation processes identified and discussed as the result of our investigations:

1. Three spirals of organizational knowledge creation, typical for market-oriented organizations: *Oriental SECI Spiral* (Nonaka and Takeuchi), *Occidental OPEC Spiral* (Gasson), and *Brainstorming DCCV Spiral* (Kunifuji);

2. Three spirals of normal academic knowledge creation, typical for normal scientific activities at universities and research institutes: *Hermeneutic AIRE Spiral*, *Experimental EEIS Spiral*, *Intersubjective EDIS Spiral*, that can be represented together in the *Triple Helix of Normal Knowledge Creation*, all proposed as results of our investigations;

3. One spiral of revolutionary scientific creation processes: *ARME Spiral* (Motycka);

4. Two general systemic models of knowledge creation and integration: *Shinayakana Systems Approach* (Sawaragi and Nakamori) and I^5 *(Pentagram) System* (Nakamori).

These models give a background for further work on *Creative Environments* - software systems supporting diverse aspects of creative processes, such as *Web knowledge acquisition, debating, experiment design and virtual laboratories, road-mapping for scientific research, brainstorming, gaming, distant learning and teaching;* the last denotes a special software environment for creating electronic versions of distant teaching courses.

More general conclusions are as follows. Philosophy of the 20th Century concentrated on language and human communication. We have now compelling rational and empirical reasons to consider also

more powerful, older, *preverbal aspects of human cognition*, represented e.g. by hermeneutic reflection. Together with the change from *reduction principle* to *emergence principle*, characteristic for proper understanding of the concept of *complexity*, this has profound ontological and epistemological consequences. For example, this would indicate that all the dichotomy of *logical empiricism versus humanistic rationalism*, the dichotomy of *reason versus being*, called sometimes in other terms *technical versus practical*, that was so pronounced in the history of philosophy of the industrial age, can be explained in the knowledge age in a different but simpler way, in terms of the dichotomy *verbal versus preverbal*.

A Framework for Ontology-Based Knowledge Management System Modeling

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Keywords: knowledge management system, ontology, semantic similarity, matching

Knowledge management is a crucial activity in organizations since knowledge is considered the most important asset that enables sustainable competitive advantage in very dynamic and competitive markets. The development of effective knowledge management system (KMS) has become an important issue in applied domains.

The goal of a general KMS is to provide the right knowledge to the right people at the right time and in the right format. Through KMSs, users can access and utilize the rich sources of data, information and knowledge stored in different forms. Furthermore KMSs facilitate people sharing knowledge and hence creating new knowledge. Traditional KMSs are based on the existing data repositories and users needs. For knowledge discovering, users submit queries to the system and receive knowledge by keyword match. But keyword-based systems cannot understand the meaning of data. They are inflexible and stifle for knowledge creation.

Fortunately, the emerging ontology-based KMSs can find the content-oriented knowledge that people really want due to the fact that the domain ontology is powerful in knowledge representation and associated inference. An ontology is a vocabulary of entities, classes, properties, functions and their relationships. Ontologies are meant to provide an understanding of the static domain knowledge that facilitates knowledge retrieval, store, sharing, and dissemination. For KMSs, ontology can be regarded as the classification of knowledge [1]. That is to say, ontology defines shared vocabulary for facilitating knowledge communication, storing, searching and sharing in knowledge management systems[2].

In this paper, we propose a framework of ontology-based KMS that mainly focuses on performing the activity for projects and domain experts matching. In project management, it is not easy to choose an appropriate domain expert for a certain project if experts research areas and the contents of the projects are not known ahead very well. It is also a hard work when the number of projects is much high. So there is a great need for the effective technology that can capture the knowledge involved in both domain experts and projects. The proposed ontology-based KMS tries to solve this problem.

Our KMS encompasses four main modules, they are: Ontologies Building, Documents Formalization, Similarity Calculation and User Interface:

Ontology Building: We adopt Protg, developed by Stanford University, to build our domain ontologies. After that the ontologies are transformed into OWL formats.

Document Formalization: Benefiting from the ontologies that we have built, we can use the concepts to formalize the documents that contain information about experts and projects. The input data of this module can be various kinds of files, including Doc, HTML, XML, and so on, while the output data is a list of concepts derived from the ontologies. We can also specify appropriate concepts for experts and projects manually.

Similarity Calculation: Considering the requirements of a certain project, we develop an algorithm to find the experts who meet the requirements well. The algorithm computes the similarities between

experts and projects by integrating node-based approach and edge-based approach and then ranks experts according to the obtained similarity values.

User Interface: The proposed KMS implements a typical client-server paradigm. End users can access and query the system from the Internet, while domain experts or system administrators can manipulate the document formalization and ontology building process.

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Federated Application Integration with Web Services: Case of Multi-Participant Cargo Transportation

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Keywords: Web service, federated application integration, shipments tracking

Information exchange and application integration across organizational boundaries is a key challenge confronting business-to-business (B2B) electronic commerce, owing to the intrinsic heterogeneity of the information systems between different organizations, as well as the organizations' policies of privacy protection. Various distributed computing technologies have been studied to overcome this difficulty, and to bridge the "information islands" of the different organizations. However, none of these technologies has been widely adopted in reality. In recent years, a newly-developed technology called Web Services has gained great attention in both academia and industry because:

- Web Services are developed upon the technological stack of the widespread World Wide Web so that they seem easier to be accepted by the public;
- using the XML-based messaging (e.g. SOAP) and interfacing (e.g. WSDL) mechanisms, Web Services emphasize the "loose coupling" of distributed computing services so that heterogeneous systems may be seamlessly interconnected and inter- operated over a public network while the internal information of each system can at the same time be well-hided and -protected.

However, although many technological progresses have been made, reports on successful application of the Web Services technology in the real world are still rare. More discussions on the underlying mechanisms of how the Web Services influence interactions between businesses are also helpful for promoting successful applications of this technology, and for the businesses to exchange information more smoothly and to collaborate more effectively.

In this work, we contend that the power of Web Services in the business world lies in that this technology brings the opportunity for the collaborating companies to form a "virtual enterprise" in a more flexible and dynamic manner. The "loose-coupling" characteristic of Web Services may dramatically mitigate the inter-operation difficulty between heterogeneous information systems of the different companies. That means, with its internal part remaining relatively stable and internal data being protected, a company's information system may be smoothly connected to different external information systems by creating different Web-Service-enabled interfaces and configuring different XML-based messaging profiles to the respective external systems. Such XML-based messaging and interfacing method encourages a means of "federated" information exchange and application integration. On one hand, each information system remains an independent system that works on its own right. On the other hand, it can be connected to other systems to form an integrated system so as to solve a particular problem in a specific context of b2b e-commerce; and it can participate in different integrated systems by using different interfaces

that are wrapped in the form of Web Services. Consequently, in the case of a "virtual enterprise" being comprised of multiple collaborating companies, the information systems of the participating companies may also be virtually integrated so that the customers of the overall "virtual enterprise" interact with this virtually integrated system through a uniform interface that hides the heterogeneity of the underlying individual information systems.

To test the feasibility of such "federated" application integration, in this paper we further study a case of shipments tracking in cargo transportation by multiple collaborating companies. We consider a scenario that a cargo owner asks a 3rd party logistics agent to plan and execute cargo transportation. The logistics agent, then, signs contracts with multiple logistics service suppliers, namely, transportation companies and inventory providers, to execute the actual cargo transportation. In this case of transportation by multiple logistics service supplier, traditionally it is not so convenient for the owner to keep trace of the cargo status during transportation, since the information flow between the participating companies are not always smooth. To realize real-time sharing of information of the cargo status, in particular information sharing between the logistics agent and the contracted logistics service suppliers, we implement a shipments tracking system with the Web Service technology, which is actually comprised of the shipments tracking systems of all the participating companies in a mode of aforementioned "federated" application integration. In this "federated" shipments tracking system, each participant company keeps trace of the cargo status by using its internal shipment tracking system during the period that the cargo is within the specific company's service. When any status change is tracked, a report about the cargo-status-change is generated by the internal shipments tracking system and sent to a Web Service called "Cargo Status-Change Listener" that is located at the logistics agent side. The "Cargo Status-Change Listener" in turn activates some other program resident inside the logistical agent's internal information system so as to update a database that records cargo status information. The customer, or the cargo owner, can then retrieve that database to get the cargo status report at anytime, using a query-interface provided by the logistics agent. In this process, on one hand, each participant company (the logistics agent and the logistics service suppliers) uses a relatively independent information system; one the other hand, these independent information systems are connected to organized a "federated" information system in a loosely-coupled manner. From the viewpoint of the customer (i.e. the cargo owner), the actual logistic service suppliers can be transparent and he or she just faces a virtually single transportation company (i.e. the logistics agent), and get the cargo status information by retrieving a virtually uniform shipments tracking system.

The paper also introduces the solving of key technological issues about the implementation of the prior federated shipments tracking system, for example, the "Cargo Status-Change Listener" implemented with document-style Web Services. With a primitive prototype being implemented, we give out some discussion about the technological and managerial implications of the proposed "federated" information exchange and application integration scheme.

GABEK. A Qualitative Method for the Analysis of Interviews and for their Systematic Use for Problem Solving

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Keywords: qualitative method, knowledge organization, interviews, text analysis, problem solving, evaluation, causal networks, relevance analysis

How can we improve problem solving in complex situations? GABEK is a PC-supported procedure designed for the analysis, processing and representation of normal language texts. Complex problems are generally unstructured and difficult to define. Frequently they are tied to dynamic situations affecting a large number of individuals. On the other hand, the experiences gained by those affected, e.g. the employees of an institution, contain creative problem solving potential. The GABEK method (Ganzheitliche Bewltigung von Komplexitt - Holistic Processing of Complexity - Josef Zelger, Innsbruck) suggests itself when trying to make systematic use of this potential. The integration of experiences, knowledge, and attitudes of many individuals normally takes place in the form of conversations. If, however, the organisation is large, or its products are complex, then the normal informal or formal means of communication no longer suffice to ensure coordinated cooperation. Methods of knowledge organisation then have to be employed. For this purpose the qualitative method GABEK and the respective software WinRelan have been developed. Thus on the basis of interviews decisions can be prepared, aims clarified and appropriate measures suggested.

How can we navigate in the conceptual landscape of opinions? The jumbled answers of the respondents are represented by the PC-program WinRelan as a conceptual network. The nodes of this network are concepts which are connected by associations between them. This conceptual network acts like a map providing orientation in the landscape of opinions. Frequently used concepts can be compared to conurbations, in which many individuals meet - rarely used concepts are villages, in which neighbours meet only occasionally. Frequent associations can be compared to heavily used roads - rare ones to paths. We use the network provided by a group of interviewees to gain an overview of their opinions, to clarify terms used, to identify contradictions or to select texts on specific themes.

How can the opinions of many individuals be represented in a systematic form? The "Gestalten tree" orders the utterances of all those involved in a hierarchical way. The contents on the top of the Gestalten tree are particularly important because they correspond to a large number of opinions and experiences of individuals interviewed. Structuring the verbal data in the form of a Gestalten tree permits us to view the results either in a greatly abstracted form or in great detail. Every level represents the situation as a whole, but in greater or lesser detail. Brief summaries at higher levels are always based on, or justified by groups of texts on lower levels. To gain an overall impression one reads the texts on the higher level; for implementation of results we look at the lower levels.

How are evaluations represented? In normal language texts value judgements are also expressed: properties, objects, qualities, situations or processes are not only described by the persons affected but also assessed. These assessments are collected in different lists (exclusively positive evaluations, exclusively netagive evaluations etc.). Lists of evaluations referring to the state as it is can be used to the evaluation of products, processes and real situations. On the other hand there are also evaluation lists describing a desired and not yet realized end state. These provide basic values and higher goals of the respondents. In a similar fashion emotionally laden expressions, symbols, metaphors, and other expres-

sions can be singled out. This aims to describe the emotional situation or mood. How can we identify causal assumptions of the respondents? Normal language texts do not only express descriptions and evaluations, but also assumptions concerning causes and effects. They express attitudes concerning causal connections that have been gained on the basis of empirical experience gathered over longer periodes of time or through personal exchanges with other individuals. Such causal assumptions can be used for the construction of models and as arguments to provide a basis for rational decision making. The causal network drawn by PC-support is used to identify possible aims and measures and to assess positive effects and negative side effects. This is a necessary step in preparation for the implementation of appropriate measures.

Which topics are the most relevant ones from the respondents' point of view ? In order to be able to answer this question we suggest three criteria:

- Properties or relationships that occur on the highest level of the Gestalten tree are more significant than those that only occur on a lower level because the contents on the highest level of the Gestalten tree are applicable in a greater number of situations.
- If in the lists of evaluations a large number of individuals attribute a positive value to one characteristic, then this is an indicator of its significance.
- The third path toward weighting is conducted via causal assumptions. The original answers of the interviewees not only contain descriptions and valuations, but also theoretical everyday knowledge. This knowledge is expressed often by assumptions concerning cause-effect relationships. When a property as a causal factor has a large number of effects then this parameter is significant.

Are there applications of the method GABEK and its software WinRelan? As GABEK applications are both concerned with the use of everyday knowledge, and expert experience the method is used for widely different purposes. Thus, by including the opinions of those affected conflicts are resolved, possible co-operations between business partners established, products evaluated, and safety factors assessed. GABEK is also used in market and customer satisfaction research. Both organisational and staff development, Customer Relationship Management and evaluation projects belong to the standard applications. Models have been developed; projects for urban and regional development were conducted. Innovation research, quality management, intercultural management, migration research are also preferred applications of GABEK. So far more than 200 GABEK projects have been conducted. Among them there are more than 100 diploma theses or dissertations, 7 EU-projects and a large number of other funded projects. Applications on 5 continents have proven both their need and their practical applicability. Every two years GABEK users meet for an international GABEK Symposion to discuss the results of projects and to develop new fields of application.

Morfe information is available at: `http://www.GABEK.com`

A Motivation Mechanism in Knowledge Sharing of Knowledge -Intensive Organizations

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Keywords: knowledge sharing, motivation mechanism, game theory, principle-agent theory

Knowledge-intensive organizations are based on their capability of making use of intangible, intellectual knowledge. Have the same character with currency, the value of knowledge only can be shown in its transference and employment (that is knowledge is useful only when it is shared by social members). Therefore, the transfer process from tacit individual knowledge to explicit company knowledge becomes the most important problem in knowledge management. However, company employees, especially those keymen, are usually reluctant to share knowledge with others, they afraid that sharing knowledge will make them lose advantage in colleagues or in company By using Game Theory and Principle-agent Theory, this paper will attempt to analyze and explain the above-mentioned phenomena. Supposing these employees are rational, they have a motivation to keep his knowledge, thus forming a prisoners dilemma. It is a contradiction of individual rational and group rational. In this paper, it is considered that one of the key factors that prevent knowledge sharing is hitchhike. As for the solution, this paper will attempt to study how to make a motivation mechanism to change payoff of players to avoid hitchhike behavior, and accordingly to promote knowledge sharing in a company. The argument is supported by a case of knowledge share in a consulting company.

Knowledge Construction as Evolutionary Gaming

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Keywords: knowledge construction, evolutionary game, structure, agency, action

Introduction

In our pervious effort in exploring a sociological underpinning for the i systems of knowledge construction, we proposed an Eastern structurationist view (ESV) which conceives knowledge construction as emergent social accomplishments during which actors, constrained and enabled by structures which may or may not be their making, mobilize and exercise the agency of themselves as well as of others, to initiate, improvise and institutionalize innovations. Structure is conceptualised as constituted by a scientific-actual, a cognitive-mental and a socio-relational front, agency is understood as consisting of intelligence, imagination and involvement clusters, while actions are differentiated along a rational-inertial, a postrational-projective and a practical-evaluative dimension. Seen via ESV, structure complexity provides dynamic opportunities for knowing, agency complexity allows actors to exploit opportunities in different ways, whereas action complexity brings structure and agency complexities into interplay in continuing structuration and agentisation processes from which knowledge is emerging and embodied, over time, back into structures and agency (Nakamori and Zhu 2004).

In this paper, we continue our sociological exploration with an extended focus at complementing the above panorama narrative with an interactive, processual foundation, conceptualizing, particularly, how action brings structure and agency into interplay. We do this by incorporating into the field of knowledge management an evolutionary game theoretic approach.

The significance of an evolutionary game theoretic approach

Social action and phenomena, e.g., organizations, projects, collective events, can be thought as on-going games, linked, multiple, played at and across various levels and domains (Aoki 2003, Mouzelis 1995), by players with diverse interests to advance their various courses. Following the sociologist Crozier (Crozier and Friedberg 1980), we submit that the game concept is not merely a matter of a new vocabulary, but of a change of logic, of the way we understand and conduct social action. In this approach, the game is not a nature given to adapt to, to engage in, to withdraw from, but a human construct to negotiate for and live with.

An evolutionary game is sociological in nature since, to play well, a player must learn, from past experiences, to discern and take into account the others strategies, and to follow the rules of the game that are shared and agreed among players. The success and failure of ones own strategy, i.e., the realized

payoffs, will depend upon the strategies adopted by other players and how the rules are created, maintained and modified. The game concept reconciles freedom of human agency and constraints of social structure. Players remain free, always possess a zone of uncertainty and liberty, but must, if they want to advance their courses, adopt rational strategies which conform to the nature of the game. The constraints generated and imposed by the game do not automatically determine actions, but rather authorizes a range of possible strategies among which the players choose. The consequences, intended or otherwise, of such choices can bring modifications of the game itself, and hence induces transformations in both structure and agency. An evolutionary game concept thus links structure and agency in a non-reductionist, non-conflating way, preserves duality within both structure and agency as well as dualism between them, transcends structure determinism and actor voluntarism.

Key concepts in the evolutionary game theoretic approach

Among the core concepts in this approach are game configuration and game model. Structure does not directly or automatically constrain players via social positions, class status, etc. Rather, it applies to the games in which actors have to play. Not all components of the surrounding structure are equally critical, indispensable or powerful to a focal game. It is a matter of time-space-purpose specific. Constituencies of structure become operationalised and relevant to a particular game in a contingent manner. By the same token, clusters of an actors agency are not always equally relevant, useful or effective across games. Actors need to transpose their respective agency into the contingency of games.

Configuration of a game contains more than merely game rules. Other, perhaps more crucial, elements include, e.g., the composition of players: who are allowed or willing to play and why. Whereas conventional game approaches take such issues as given, e.g., the prisoners dilemma simply assumes the two players already in, our approach takes the issue as the focus of analysis. Other considerations in this regard, in our evolutionary perspective as compared to conventional game approaches, are legitimacy, power, trust, reputation, learning competence, etc.

A game model denotes to a players understanding of and knowledge about the game configuration. It is based on such a subjective game model a player derives her/his strategy. Where is the game model from then? It is an outcome molded by the players own agency (disposition and position capacity) and the contingent game configuration. Due to bounded rationality (Simon 1957), bounded memory (Young 1998) and bounded legitimacy (the players position and role in the game) (Crozier and Friedberg 1980), a game model is more or less accurate (Archer 2004), resulting in more or less appropriate strategies, and in turn payoffs more or less intended (Aoki 2003). The relationship between the game configuration and game models are a 'dialectical' one: game models are subjective constructs about game configuration, whilst they constitute a part of that same-one configuration (Stone 2005). It is the objective configuration and subjective game models (via strategies) together, we posit, that shape realized payoffs and outcomes which in turn modify both game configuration and game models (as well as related strategies) and, in the long run, transform both the wider structure and private agency.

Evolutionary gaming and knowledge construction

The evolutionary game theoretic approach puts knowledge at the centre of its conceptualization and analysis. To generate strategies and tack action, actors need knowledge. Due to incompleteness of information and asymmetric distribution of information (because of bounded rationality and power relations respectively), actors knowledge and hence game models and strategies are unavoidably limited, plural, provisional, fragile, and more or less untheorised, resulting in a zone of uncertainty with which actors find themselves confronted and confronting. Actors have no choice but play the game always within such zones of uncertainties. Put it positively, zones of uncertainty permit freedom to actors to strategise and innovate. It is such uncertainty that eliminates undue determinism and excessive voluntarism.

But actors, with their transposed agency, continuously learn from playing the game, from their own success and failure, from other players moves, in the context of realized payoffs and consequences which

are, usually, by no means optimal. Such learning is always messy, mixed with various kinds of mis-learning. Through such learning, actors continuously re-construct their knowledge, revise their game models, adjust their strategies, in short, increase their competence and transform their agency a process we call agentialisation. Such a process at the mean time changes power distributions and hence disrupts and re-constellates game configurations. When new knowledge become shared by a critical mass among actors, albeit unequally and with diverse meanings, and when the modification/constellation of game configurations obtains momentum, the wider, containing structure gets transformed - a process we call structuraion.

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