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# KR and model discovery from active DB with predictive logic

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## Abstract

Intelligent multimedia provides a basis as briefed here for designing active databases with agents, multimedia and intelligent business objects. The field of automated learning and discovery has obvious financial and organizational memory applications. Financial companies have begun to analyze their customers' behavior in order to maximize the effectiveness of marketing efforts. There are basic applications to data discovery techniques with intelligence multimedia databases. Management process controls at times calls on warehoused data and relies on organizational memory to reach decision. The computing techniques, the Morph Gentzen deductive system and its models are applied towards an active multimedia database warehousing, model discovery, and customizing interface design. Intelligent visual computing paradigms are applied to define the multimedia computing paradigm and active databases. The Multimedia paradigms can be applied to customize KM database views for financial and organizational memory applications.

## 1 Introduction

The field of automated learning and discovery--often called data mining, machine learning, or advanced data analysis Therun [13] has an obvious financial and organizaitonal memory applications. Financial companies have begun to analyze their customers' behavior in order to maximize the effectiveness of marketing efforts. There are routine applications to data discovery techniques with intelligence databases. Management process control at times calls on warehoused data and relies on organizaional memory to reach deceision. Recent

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research has led to progress, both in the type methods that are available, and in the understanding of their characteristics. The broad topic of automated learning and discovery is inherently cross-disciplinary in nature. As there is increased relience on visual data and active visual databases on presenting and storing orginzational strucures, via the internet and the WWW, the role of data discviery and intelligent mutimedia active databases become essential. Knowledge management- KM *and organizaitonal memory OM are areas where model discovery with active Intelligent Dztabases applying predictive logic* Nourani [3,4,6] *presented here applying Intelligent Multimedia Databases*[14]. Knowledge Management (KM) is one of the key progress factors in organizations. In an organization, know-how may relate to problem solving expertise in functional disciplines, experiences of human resources, and project experiences in terms of project management issues, design technical issues and lessons learned. The coherent integration of this dispersed know-how in a corporation, aimed at enhancing its access and reuse, is called "corporate memory" or "organizational memory" (OM). It is regarded as the central rerequisite for IT support of Knowledge Management and is the means for knowledge conservation, distribution, and reuse. An OM enables organizational learning and continuous process improvement. Identification and analysis of a company's knowledge-intensive work processes (e.g., product design or strategic planning, utilizing KM and OM are datadiscovery and datawarehousing intensive operations. A new computing area is defined with Intelligent Multimedia principles with business applications [4]. The area for which the paper provides a foundation for is where multimedia computing is bound to be applied to at dimensions and computing phenomena unimagined thus far, yet inevitable with the emerging technologies. The principles defined are new practical multimedia artificial intelligence business applications. Multimedia AI systems are proposed with new computing techniques defined. Multimedia Objects, rules, and multimedia programming techniques are presented via a new language Nourani [14, 15]. A preliminary mathematical basis to the Motph Gentzen computing logic is presented in Nourani, for exmaple, [4,14,15,16]. The foundations are a new computing logic with a model theory and formal system. Multimedia AI Systems.

## 2 The Visual multimedia databases

Active databases deploy certain computing which lend themselves naturally to the Inelligent Multimedia principles Nourani [15]. The concept of an active objects are embedded by intelligent objects and "events" are embedded by the computing defined by IM as a basic principle an embedded by intelligent trees, intelligent objects, and hybrid pictures. The characteristics of an Active DMBS, or ADMBS, see for example Bailey et.al [1], supports definition and management of ECA-rules, e.g. Event, Condition, and Action. Hence an ADMBS must have means to define ECA's. An ADBMS must support rule management and rulebase updates. It must carry out actions and evaluate conditions. An ADBMS must represent information in ECA-rules in terms of its

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data models. The IM computing paradigm provides a basis for designing multimedia ADBMS's. The IM computing paradigm allows the design for multimedia ADBMS Nourani [14] to apply agent computing to ADBMS, to base an ADBMS on multimedia agent computing, and to carryout metalevel reasoning and KB with multimedia intelligent objects. Let us brief on knowledge representation with G-diagram models Nourani [3,4] and applications to define computable models and relevant world reasoning. G-diagrams are diagrams defined from a minimal set of function symbols that can inductively define a model. G-diagrams are applied to relevance reasoning by model localized representations and a minimal efficient computable way to represent relevant knowledge for localized AI worlds. We show how computable AI world knowledge is representable. G-diagrams are applied towards KR from planning with nondeterminism and planning with free proof trees to partial deduction with predictive diagrams applied in Nourani [4,6,15]. The applications to proof abstraction and explanation-based generalization by abstract functions are alluded to in Nourani [3]. A brief overview to a reasoning grid with diagrams is presented in the above referenced papers. Generalized diagrams are used to build models with a minimal family of generalized Skolem functions. The minimal sets of function symbols are functions with which a model can be built inductively. *The functions can correspond to objects defining shapes and depicting pictures* An ordinary diagram is the set of atomic and negated atomic sentences that are true in a model. Generalized diagrams are diagrams definable by a minimal set of functions such that everything else in the models closure can be inferred, by a minimal set of terms defining the model. Thus providing a minimal characterization of models, and a minimal set of atomic sentences on which all other atomic sentences depend. The compuitng enterprise requires general techniques of model construction and extension, since it has to accommodate dynamically changing world descriptions and theories. The generic diagram,G-diagram for models Nourani [2,3,6] is a diagram in which the elements of the structure are all represented by a minimal family of function symbols and constants. Thus it is sufficient to define the truth of formulas only for the terms generated by the minimal family of functions and constant symbols. Such assignment implicitly defines the diagram. This allows us to define a canonical model of a theory in terms of a minimal function set. The following sections apply KR with visual business objects and section 5 presents the applications to heterogeneous computing and model discovery on busienss data.

## 3 A visual computing logic

The Intelligent Multimedia computing paradigm define multiagent computing with multimedia objects and carry on artificial intelligence computing on boards. The IM Hybrid Multimedia Programming techniques have a computing logic is mathematical logic where a Gentzen[8] and Prawitz's natural deduction systems is defined by taking multimedia objects coded by diagram functions. The deduction rules are a Gentzen system augmented by Intelligent Morphing rules. A set of rules whereby combining hybrid pictures p1,...,pn defines an Event

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{p1,p2,...,pn} with a consequent hybrid picture p. Thus the combination is a morph sequencing initiatiing event. The formal AI and mathematics appear in the first author's mathematical logic publications since 1997 and applied to business areas at [4,15] for example. The intelligent syntax languages are applied with Morph Gentzen [18]. A computational logic for intelligent languages is presented in brief with a soundness and completeness theorem in [4] from Nourani 1994 and applied to intelligent business object computing. A brief overview to context abstraction shows how context free and context sensitive properties might be defined with agents. Agents are in the sense defined in Nourani [18] and the A.I. foundations Genesereth et.al. [5]. The definitions prompted a computational linguistics and model theory for intelligent languages. Models for the languages are defined by our techniques in Nourani[6,18]. Knowledge representation has two significant roles: to define a model for the AI world, and to provide a basis for reasoning techniques to get at implicit knowledge. An ordinary diagram is the set of atomic and negated atomic sentences that are true in a model. Generalized diagrams are diagrams definable by a minimal set of functions such that everything else in the model's closure can be inferred, by a minimal set of terms defining the model. Thus providing a minimal characterization of models, and a minimal set of atomic sentences on which all other atomic sentences depend. To keep the models which need to be considered small and to keep a problem tractable, we have to get a grip on a minimal set of functions to define computable models with. The selector functions are applied to create compound business objects. Visualization and interactive discovery data is a process which involves automated data analysis and control decisions by an expert of the domain. For example, patterns in many large-scale business system databases might be discovered interactively, by a human expert looking at the data, as it is done with medical data. To design intellignt buisness object interfaces the Framework Development System Model (FDSM) is proposed to provide a systematic and realistic approach towards system development Loo[17]. A Reusable Pattern Oriented Framework (REPOF) using Business Objects and Intelligent Agent is presented to facilitate the reuse of architecture, design, concepts, and software components Loo[17]. The banking domain is selected to demonstrate the viability of these concepts. The bridging of the gaps among several emerging techniques and concepts, namely the object-oriented paradigm, business object architecture, pattern, framework and agent computing has been verified to be viable using the FDSM and REPOF in a real world environment: a bank in New Zealand. The software industry has changed significantly over the last two decades, and its evolution has been motivated by the increasing demand of software components. Despite gains, the software industry still faces long development cycles producing software that does not address business problems adequately. In addition, the development and maintenance costs are significant. These limitations have moved the software industry to embrace the object-oriented technology together with the concept of reuse, because of its potential to dramatically improve developer productivity and reduce development cost.

### 3.1 Learning from mutimedia data

Many data sets contain more than just a single type of data. The existing algorithms can usually only cope with a single type data. How can we design methods that can take on multimedia data from multiple modalities? Are we to apply separate learning algorithms to each data modality, and combine their results, or are there to be algorithms that can handle multimedia multiple modalities on a feature-level. Learning casual relationships amonst viusal stored data is another imporant area which can benefit from our project. Most existing learning algorithms detect only correlations, but are unable to model causality and hence fail to predict the effect of external controls. Visualization and interactive discovery data mining is a process which involves automated data analysis and control decisions by an expert of the domain. For example, patterns in many large-scale business system databases might be discovered interactively, by a human expert looking at the data, as it is done with medical data. Data visualization is specifically difficult when data is high-dimensional, specifically when it involves non-numerical data such as text. The projects might be a basis for designing interactive business tools. Many current industries still use the conventional information system for managing their administration and production. A propostion is to combine the usage of artificial neural network (ANN), fuzzy logic (FL) and rule-base approach for the design and development of the enhanced deliberation agent in an interactive intelligent business management system Loo et al. [18,19] and Loo et. al. 's paper at *ISMIS' 96*. The intelligent agents are built based on theories, architectures and languages. The usual deliberative agents cannot solve the unanticipated problems in industry. The agent modeling is based on the BID model, for example Brazier et.al. [9] and IM_BID Nourani[16]. Grace Loo's projects experiment applying design enhanced deliberative agents with fuzzy logic, artificial neural network and rulebase to manage stock and quota in the garment manufacturing industry in Hong Kong. The results from our experiments have been verified to be acceptable by the manufacturers and much more efficient than their existing management process for maximizing profit and improving productivity Loo [18].

## 4 Heterogeneous computing and models

### 4.1 KR, KB, and visual model discovery

In Nourani [11] we present new techniques for design by software agents and new concepts entitled Abstract Intelligent Implementation of AI systems (AII). Objects, message passing actions, and implementing agents are defined by syntactic constructs, with agents appearing as functions. The techniques have been applied to design intelligent business objects in Nourani [11]. AII techniques have been applied to Heterogeneous KB Design and implementation. The application areas include support for highly responsive planning. AII techniques are due to be an area of crucial importance as they are applied gradually to the real problems. The applied fields are, for exmaple, intelligent

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business systems, aerospace, AI for robots, and multimedia. Model diagrams allow us to characterize incomplete KR. To key into the incomplete knowledge base we apply generalized predictive diagrams whereby specified diagram functions a search engine can select onto localized data fields. The predictive model diagrams Nourani[3,4] could be minimally represented by the set of functions {f1,...,fn} that inductively define the model. Data discovery from KR on diagrams might be viewed as satisfying a goal by getting at relevant data which instaniates a goal. The goal formula states what relevant data is sought. We propose methods that can be applied to planning Nourani [2] with diagrams to implement discovery planning. In planning with G-diagrams that part of the plan that involves free Skolemized trees is carried along with the proof tree for a plan goal. Computing with diagram functions allows us to key to active visual databases with agents. Minimal prediction is an artificial intelligence technique defined since the author's model-theoretic planning project . It is a cumulative nonmontonic approximation attained with completing model diagrams on what might be true in a model or knowledge base. A *predictive diagram* for a theory T is a diagram D (M), where M is a model for T, and for any formula q in M, either the function f: $q \rightarrow \{0,1\}$ is defined, or there exists a formula p in D(M), such that T U {p} proves q; or that T proves q by minimal prediction. A *generalized predictive diagram*, is a predictive diagram with D (M) defined from a minimal set of functions. The predictive diagram could be minimally represented by a set of functions {f1,...,fn} that inductively define the model. The free trees we had defined by the notion of provability implied by the definition, could consist of some extra Skolem functions {g1,...,gl} that appear at free trees. The f terms and g terms, tree congruences, and predictive diagrams then characterize partial deduction with free trees. The predictive diagrams are applied to discover models to the intelligent game trees. Prediction is applied to plan goal satisfiablity and can be combined with plausabilities Nourani[2], probabilities, and fuzzy logic to obtain, for example, confidence intervals. The first author has applied mimimal predicion to simply encode knowledge with model diagrams to carry on automated deduction as Loveland and Poole's autmated deduction system Nourani [6]. Modeling with virtual tree planning Nourani[12] is applied where uncertainty, including effector and sensor uncertainty, are relegated to agents, where competitive learning on game trees determines a confidence interval. The incomplete knowledge modelling is treated with KR on predictive model diagrams.Model discovery at KB's are with specific techniques defined for trees. Model diagrams allow us to model-theoretically characterize incomplete KR. To key into the incomplete knowledge base we apply generalized predictive diagrams whereby specified diagram functions a search engine can select onto localized data fields. The predictive model diagrams could be minimally represented by the set of functions {f1,...,fn} that inductively define the model. Data discovery from KR on diagrams might be viewed as satisfying a goal by getting at relevant data which instaniates a goal. The goal formula states what relevant data is sought. We propose methods that can be applied to planning Nourani[2] with diagrams to implement discovery planning. In planning with G-diagrams that part of the plan that involves free Skolemized trees is carried along

with the proof tree for a plan goal. Computing with diagram functions allows us to key to active visual databases.

### 4.2 Discovery computation from warehoused data

Data discovery from KR on diagrams might be viewed as satisfying a goal by getting at relevant data which instaniates a goal. The goal formula states what relevant data is sought. We have presented planning techniques which can be applied to implement discovery planning. In planning with G-diagrams that part of the plan that involves free Skolemized trees is carried along with the proof tree for a plan goal. Diagrams allow us to model-theoretically characterize incomplete KR. To key into the incomplete knowledge base. Selector functions Nourani [4] Fi from an abstract view grid interfaced via an inference engine to a knowledge base and in turn onto a database. Generalized predictive diagrams are defined, whereby specified diagram functions and search engine can select onto localized data fields. A *Generalized Predictive Diagram*, is a predictive diagram where D (M) is defined from a minimal set of functions. The predictive diagram could be minimally represented by a set of functions {f1,…,fn} that inductively define the model. The functions are keyed onto the inference and knowledge base to select via the areas keyed to, designated as Si's in figure 1 and data is retrieved Nourani [20]. Visual object views to active databases might be designed with the above. The trees defined by the notion of provability implied by the definition might consist of some extra Skolem functions {g1,...,gn}, that appear at free trees. The f terms and g terms, tree congruences, and predictive diagrams then characterize deduction with virtual trees Nourani [12] as intelligent predictive interfaces. Data discovery from KR on diagrams might be viewed as satisfying a goal by getting at relevant data which instantiates a goal. The goal formula states what relevant data is sought. We have presented planning techniques, which can be applied to implement discovery planning.

### 4.3 KR and data warehousing with keyed functions

Let us see what predictive diagrams do for knowledge discovery knowledge management. Diagrams allow us to model-theoretically characterize incomplete KR. To key into the incomplete knowledge base. Practical AI systems are designed by modelling AI with facts, rules, goals, strategies, knowledge bases. Patterns, schemas, AI frames and viewpoints are the micro to aggregate glimpses onto the database and knowledge bases were masses of data and their relashionships-representations, respectively, are stored. Schemas and frames are what might be defined with objects, the object classes, the object class inheritances, user-defined inheritance relations, and specific restrictions on the object, class, or frame slot types and behaviors. From Nourani [14] the schema might be:

Intelligent Forecasting
IS-A Stock Forecasting Technique
Portfolios Stock, bonds, corporate assets
Member Management Science Techniques

Schemas allow brief descriptions on object surface properties with which high level inference and reasoning with incomplete knowledge can be carried out applying facts and the defined relationships amongst objects. Relationships: Visual Objects have mutual agent visual message correspondence. Looking for patterns is a way some practical AI is a carried on with to recognize important features, situations, and applicable rules. From the proofs standpoint patterns are analogies to features as being leaves on computing trees Goals are objects for which there is automatic goal generation of missing data at the goal by recursion backward chaining on the missing objects as sub-goals. Data unavailability implies search for new goal discovery. Goal Directed Planning is carried out while planning with diagrams. The part of the plan that involves free Skolemized trees is carried along with the proof tree for a plan goal. If the free proof tree is constructed then the plan has an initial model in which the goals are satisfied. IM's basis for forecasting is put forth at preliminary stages in Nourani[4]. The Morph-Gentzen logic with predictive model diagrams has been applied as a basis for intelligent forecasting Nourani [4,14]. The are graphics sequents for predicting the quarter earnings from the second and third combined with a market condition graph. The way a market condition graph is designed is a propriety issue. It is obtained by Morph Gentzen sequents from known stock market parameters. Data discovery from KR on diagrams might be viewed as satisfying a goal by getting at relevant data which instantiates a goal. The goal formula states what relevant data is sought. The fast track to real media content management is a media asset management environment that allows vendors and customers media applications to interoperate seamlessly within the IBM DB2 Digital Library infrastructure. Asset management is an important area to the efficient intelligent multimedia computing. Cost-effective management of digital content is expected to be another frequent topic. IBM's Grand Central Media provides media asset management that enables a company to manage, secure, share, locate and reuse digital media files. The academia for example, the University of California, Berkeley's BMRC has designed a video on demand system with asset management. Garlic Proceedings IFIP 2.6 offers the ability to interrelate data from multiple sources with a broad range of querying capabilities, in a single, cross-source query. A significant focus of the project is the provision of support for data sources that provide type-specific indexing and query capabilities. Garlic's "wrapper architecture", see e.g., Wiederhold [7] and the appplications at Nourani [10].

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