Knowledge Uncertainty and Contextual Modelling

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Abstract: - The paper deals with the relations between knowledge management, uncertainty and the context evaluation on the background of computer science, artificial intelligence and the new possibilities of information technologies that can help us to carry out the knowledge management strategies. Web services architecture makes data acquiring more open and interoperable in using, offers wide range of context information, has a unique ability to integrate diverse data through shared location and offers real potential for meeting the demands of users. Very heterogeneous data available in the combination with multi-criteria conditions evaluation causes increasing of uncertainty we meet in the processes and consequently in results. The paper discuss the problem of wide context (temporal, spatial, local, objective, attribute oriented, relation oriented) as a tool to compensate and to decrease the uncertainty of data, classification and analytical process at all process to increase the information value of decision support.

Key-Words: - Knowledge, uncertainty, knowledge management, contextual modelling, temporal modelling,

1 Introduction

The ways of managing and distributing data and particularly data sources has rapidly changed. Data are collected and processed and during the last couple of years the data flows in and between organizations have extremely increased. In the connection with these facts also the data management tools and techniques are continually changed [10]. It includes the automated knowledge acquiring, proper handling of large volumes of data, new accesses to data interpretation and effective exchange of information between and among various institutions.

The knowledge is an issue changing the society and economy today. Knowledge has become the most important resource. So, knowledge management is an essential process improving competitive advantage.

Knowledge management tries to compensate:

- the loss of stable procedural knowledge
- the loss of customer-related or project-related experiences and know-how
- the loss of the middle management information analysis and routing services

Together with the globalisation of business, an enormous market pressure enforces ever-shorter product life cycles. On the other hand, modern information technology allows worldwide geographically dispersed development teams, virtual enterprises [3] and close cooperation with suppliers, customer companies, and outsourced service providers.

The area in Computer Science that is most influenced by the concept of knowledge is Artificial Intelligence (AI) and Knowledge Based Systems (KBS) [6].

In the early 1980s the development of a KBS was seen as a process of transferring human knowledge to an implemented knowledge base. This transfer was based on the assumption that the knowledge, which is required by the KBS, already exists and only has to be collected and implemented [5].

Since the knowledge is specified independently from the application domain, reuse of the knowledge is enabled for different domains and applications. Besides knowledge modelling and knowledge representation is also an important field of research in computer science and AI.

Some observations can be made about modelling view of the building process of a KBS.

- The model is only an approximation of reality.
- The modelling process is a cyclic process. New observations may lead to a refinement, modification, or completion of the already constructed model. On the other hand, the model may guide further acquisition of knowledge – contextual understanding.
- The modelling process is dependent on the subjective interpretation of the knowledge engineer. Therefore this process is faulty and an evaluation of the model with respect to reality is indispensable for the creation of an adequate model.

2 Uncertainty

The dimensionality of data and the complexity of objects structure hierarchy are rapidly growing and consequently with these aspects increase the uncertainty entering into the processing.

Data uncertainty plays a special role in the environment of Internet and Web Services [3]. It is quite another situation than in case of the closed system, where the user has full control over all steps of processing from data input to presentation of results. In frame of open interoperable system with access to web sources with a great number of existing databases the user control gets completely lost.

A great number of existing databases offer a variety of data sets covering different thematic aspects like topographic information, cadastral data, statistical data, digital maps, aerial and satellite images including temporal data. Data collection is changing from digitising own data to retrieving and transferring from existing databases coming from task processing and result presentation.

To deal with such data sets, the user requires an uncertainty description that has to be added by the producer. User needs an appropriate uncertainty model for this purpose, integrated in GIS [4]. From the philosophical point of view the uncertainty is quite natural part of our life and the surrounding world. Uncertainty might not be a bad thing if you can make better use of it then others, in the sense of competition. We can understand this concept in the frame of description - ordered and chaotic.

Usually we meet uncertainty in the sense of valuation. Uncertainty is a real and universal phenomenon in valuation and the sources of uncertainty are rational and can be identified. Valuation is the process of estimating the value and estimation will be affected by uncertainties. The input uncertainties will translate into an uncertainty of the valuation.

Actually – the uncertainty arises from imperfect understanding of the events and processes in the world around. From another point of view the fact of uncertainty is very stimulating for the research on the field of *defining*, *measuring*, *modelling* and *visualizing* uncertainty and data quality analysis. The uncertainty opens the space for further questions like: *where, why and when* and the answers to this question can help us to do better decisions [7].

To gain the relevant answer it is necessary incorporate the various contexts into the analysis of objects, phenomena, events and processes and connect up uncertainty into the knowledge-construction and decision-making process through context cognition.

Open systems are using frequently various models but the model is only an approximation of reality and the modelling process is dependent on the subjective interpretation of the knowledge. It means that new observations may lead to a further refinement, modification, or completion of the already constructed model. And the model may guide further acquisition of knowledge and the knowledge is the base for decision support. Moreover, besides knowledge modelling also knowledge representation is very important field of research.

2.1 Uncertainty Management

Data are not perfect from many reasons:

- Incomplete data
- Precision of measurements
- Discreet description of connective phenomena
- Inherent part reflecting our understanding of things [11]

On the other hand the current top level of GIS usage, it is control GIS, where the large ability is aided to implement knowledge models from different branches of scientific investigation, wide context implementation including less evident connections, models of trends, objects and expected or predicted relations.

To reduce uncertainty of data it is mainly the question of the proof of recognized quality assurance. Some users often take the pragmatic approach to the cost versus accuracy. Sometimes, without the relevance testing, the resolution of data is used for the whole set of different task. Then the problem of over-defined and under-defined objects brings the difficulties [8].

Especially uncertainty of a geographic object can be modelled through uncertainty of its geospatial, temporal and thematical attributes. Uncertainty of relations takes into consideration spatial, temporal and spatio-temporal relations.

To add suitable attribute or to spread the net of relations reduce the uncertainty of the object. The special case is to model objects uncertainty using spatial-temporal approach to the objects and incorporate spatial-temporal relationships. The dynamics of object is very powerful tool to obtain exact results about the object and phenomenon behaviour to support further decision [16].

The decision making process is always associated with some level of uncertainty which can rise from:

- Definition of the problem
- Data used
- Sequence of operations used to obtain result
- Understanding of result

GIS is shifting very fast from desktop GIS to network GIS. Great advantage of network GIS is ability to provide GIS services in a networked environment, typically through the Internet.

With this technology, all GIS components, data components and functional objects, can be distributed across the network. In this component-oriented framework the user has no problem with the increasing complexity of information structures and quality demands and is able understand objects and phenomena and theirs expressions in various context and provide richer analysis with different aspects of modelling.

2.2 Context Understanding

The contextual modelling deals with different types of context information. It is possible consider context as follows.

Context as the reflection of object or phenomena using different interpretation through the system of cognition: *perception, conception, interpretation.*

Context as the reflection of selected facts is concerned with validity of statements and the system of argumentation: *identification, analysis- coordination, synthesis – decision.*

Context as the reflection when hypothesis stays instead of experience in the system of abduction – instinct based context: *recognition of patterns, coordination by intuition, judgement due to synthetic inference.*

Context as the reflection concerning validity of statement using knowledge generating system – knowledge based context: *abduction – iconic analogy to experience, deduction – model of ideal world, induction.*

Using context it is possible to derive new quality of information that can be used to support decision.

3 Temporal Data Modelling

The integral part of control GIS [9] is the modelling where the information layers from real, artificial and virtual world are composed together to select optimal scenario or verify given hypothesis or assumptions.

The contextual design of spatial data and further development of geo-information technologies, image processing techniques and the possibilities of object history modelling together with the geographical networks environment will provide quite new and considerably wider possibilities of using GIS.

GIS architecture is open to incorporate new requirements of knowledge-based analysis and modelling, namely in connection with web designed spatial databases and temporal oriented approaches. This type of geo-information processing it is the resource, tool and means. It is modelling in most common sense.

If the standard geographical database is understand as a digital model of the real world than control GIS handles the DB, which is the result of temporal interface of standard DB with virtual and artificial models of real world.

Temporal or dynamical analysis of spatial data is needed in various fields such as mainly known environmental systems analysis. Dealing with this approach we are facing the difficulties in generating spatial-temporal space of quality data for analysis, the necessity of interpolation or integration of observational data [11].

The great advantage is to mix spatial topological relations with temporal topological relations and generate and extract new spatial-temporal relationships from the spatial-temporal objects. The uncertainty of objects is projected to the uncertainty of relationships between objects.

Context sensitive object recognition is a successful strategy to reduce uncertainty geographical objects and primarily it holds in temporal context application.

The time is considered to be continual valuable, $\boldsymbol{T}$ is the set of measured times that corresponds to the set of real numbers and $\boldsymbol{I}$ is the set of temporal intervals.

Let $\boldsymbol{i}$ is the temporal interval from $\boldsymbol{I}$,

$$i = \lfloor t_1, t_2 \rfloor, \quad \text{where}$$

$$t_1 , t_2 \in T \quad a \quad t_1 < t_2 . \qquad (1)$$

The selected relations between the temporal intervals of type: *before, meets, overlaps, equal* are considered and in the similar way it is possible to introduce the spatial relations in two-dimensional space like: *disjoint, touch, inside, overlap, covered* between two objects p_1 , p_2. Than it will be useful to define the interior and the border of the object (phenomenon) p and the concept of temporal and complex object as a reflection of combination and temporal decomposition of the object.

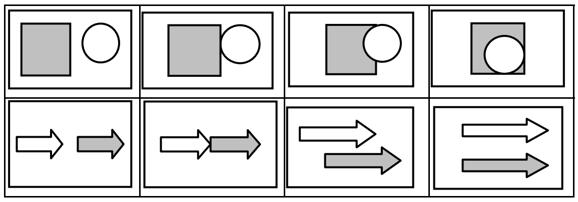

Table 1 Selected spatial and temporal relations.

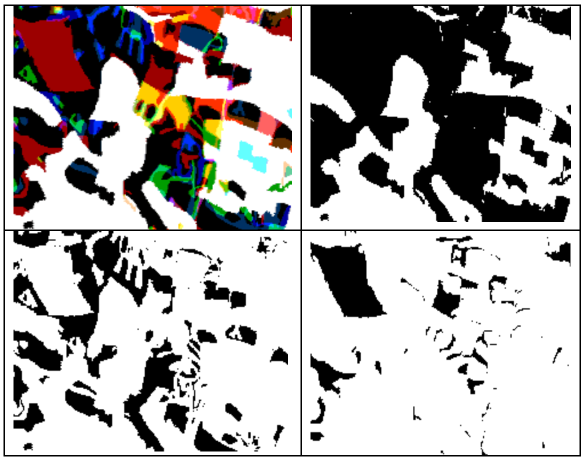

Table 2 Complex and temporal objects.

On the base of these considerations it is possible to create temporal space, to define objects type and propose the concept of interior and border of the interval. Than the algebra can be built. It is of course far from our exciting imagination to build real temporal database.

4 Conclusion

The contribution deals with more abstract level for reflection and understanding of the various modelling processes. In this paper, the problem of wide spatial and temporal context is discussed. Our decisions are becoming increasingly dependent on understanding of complex relations and phenomena in the world around and context modelling is able to incorporate new requirements and produce more valuable results. The main goal has been to show selected aspects of this process and compare the increasing possibilities of the sources with the difficulties of data contextual structuring and the object dynamics implementation.

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