SPATIAL STUDIES & GEO-INFORMATION MANAGEMENT

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Dana Klimešová

Abstract
The contribution deals with the contextual design of spatial data for the purposes of the regional development, land management and government. Further development of information technologies, image processing techniques and future using of contextual knowledge based databases together with the geographical networks environment will provide quite new and considerably wider possibilities applying of GIS. The paper describes the role of remote sensing data and contextual modelling of geo-information and tries to give the frame for the object hierarchy and propose the ways of structure and behaviour modelling. GIS architecture is open to incorporate new requirements of knowledge-based analysis and modelling and accept new approaches to data analysis technology, which will be mostly fuzzy oriented.

Anotace
Příspěvek se zabývá kontextovým modelováním prostorových dat pro účely regionálního rozvoje, správy území a řízení. Další rozvoj informačních technologií, pokrok v rozvoji metod zpracování obrazů a budoucí využití kontextově orientovaných znalostních databází, spolu s prostředím geografických sítí, umožní zcela nové a výrazně širší využití geografických informačních systémů. Článek se zaměřuje na roli dat získaných dálkovým průzkumem Země a na možnosti kontextového modelování geoinformací a pokouší se vymezit rámec pro objektovou hierarchii a diskutovat možnosti využití struktury objektů pro modelování v podmínkách neurčitosti. Architektura GIS je dostatečně otevřená, aby přijala požadavky nových přístupů k analýze prostorových dat. Jsou uvedeny příklady studií.

Keywords:
Geographical information management, object oriented classification, contextual modelling, spatial-temporal context, hierarchy, fuzzy rules.

Klíčová slova:
Geografický informační management, objektově orientovaná klasifikace, kontextové modelování, prostorově-časový kontext, hierarchie, neurčitá pravidla.

1. Introduction

Almost everybody can benefit using geography to the competitive advantage. Recent studies show that more than 85% of all business data contains a geographic component. By mapping this aspect of data, it is possible discover trends that have not been yet identify using traditional spreadsheets or tabular data.

The increasing resolution of the sources results in the increasing number of objects of course and moreover the complexity of object structuring hierarchy is rapidly growing too. The huge amount of data asks for automation of the classification and interpretation processes of the spatial data. The digital geographic databases are rapidly growing, also due to mobile GIS technology and the problem has shifted from finding the data to finding meaningful geographic information or better useful knowledge from the large volumes of data. GIS technology is changing to GIM technology (Geographical Information Management).

One of the new aspects will be the temporal context investigation, which can be applied in a range of different thematic areas. It is evident now that the combination of spatial

and temporal components of information and incorporation of computational intelligence into spatial data analysis will bring the new qualitative reasoning of geo-information.

GIS as a basic tool for decision support contain and include the field of Earth observation, new information technologies and related activities. In case of remote sensed data we can take into the consideration the context coming from the surrounding of pixel, context between primitives, context among objects, between spectral channels or image plains and their combinations and moreover the whole image can be understood as the result of all possible contextual relations even around the temporal axis. We are able use the information from very different sources and model or change the requested contextual feature space.

2. Spatial data management

2.1 Contextual design

The information power continually increases. The satellite data with the resolution 1m and less are in disposal for many applications. The fine resolution of data asks for new technology of the processing and evaluation. The main goal of future research initiative is to develop theory, techniques, architectures and systems for filtering of large amounts of raw geographic data (high resolution data) into more user-consumable forms of knowledge to be incorporated into functionally databases. It needs significant advances and integration of many technologies including incorporation of computational intelligence, qualitative reasoning and uncertainty management.

In the field of image analysis the new techniques are applied to support automation of the recognition process. Object-oriented image analysis is based on an object-oriented approach to image analysis. In contrast to the classical image processing method, the basic processing units are image objects or segments. The topological relations of single or adjacent pixels are given by the raster implicitly. The association of adjacent image objects must be explicitly worked out, in order to address neighboured objects.

There are many reasons for the knowledge-based spatial data network establishing and sharing. The pixel-oriented classification can be accepted as the pre-processing phase that is followed by object-oriented contextual classification.

The average resolution of image objects can be adapted to the scale of interest and resulting information can be represented in the scale based on the average size of image objects. This fact is coherent with the hierarchical networking and representation of image objects. In the hierarchical structure each object knows its neighbours, sub-objects and super objects. We distinguish three types of elemental object features:

- *Attribute* (physical properties of objects that follow from real world or image or different information layers related to the object),
- *Topological features* (describe the geometric relationships between the objects or the whole scene) and
- *Context features* (represent the objects' semantic relationships. The gardens are *inside* the urban area; the island is *surrounded by* the water, and so on. It means between class (object) relationships.

The features are the means to assign an object to the certain class. They can be used simultaneously or separately as well as in exactly defined hierarchy and their essence comes from spectral, textural, local, global, temporal, contextual or any other of the available property of image entity. They help, together with the class hierarchy that makes possible to use the inheritance, to create groups of the object and set up the structure, to give additional meaning to the classes of objects. The class hierarchy defines the requirements that an object must meet to be assigned to the certain class – the first step of segmentation.

2.2 Fuzzy design

The class hierarchy, which can be continually changed during the processing, it is the base of knowledge for the image object classification. In many applications the desired geo-information and the objects of interest are than extracted step by step, by iterative process of classifying and processing. It is very similar to human image understanding processes. This kind of circular processing results in a sequence of partial states, with an increasing differentiation of the classification result and the increasing abstraction of the original image information.

On the each step of the abstraction new information and new knowledge is generated and can be used beneficial for the next analysis step. High beneficial is the fact, that after successful analysis, a lot of interesting, additional information can be derived. The hierarchical structure represents and contains the information of the image data at different resolutions simultaneously. Fine objects are sub-objects of the coarser structures. It means, that each object knows its context, its neighbourhood and its sub-objects.

We use the term *the object*, but very often it is in fact *the phenomenon.* The phenomenon *form* is more or less stabile in contrast to the traditional material object and exact proposition and reasoning become problematical. We understand the occurrence of some phenomenon in the measure sense. This is the reason why the framework of fuzzy object and related theories is proposed.

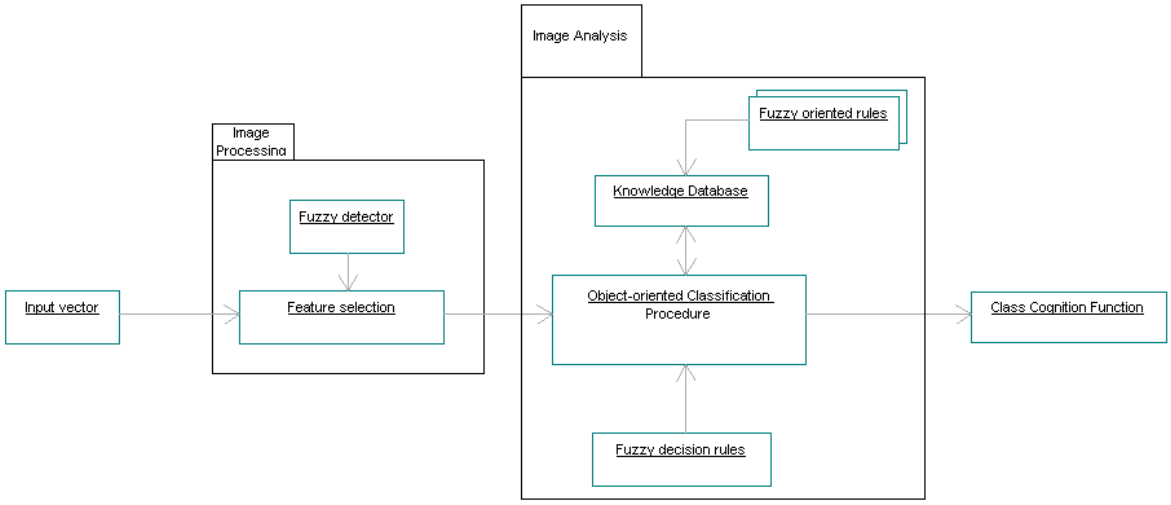

Fig. 1. Block diagram of the fuzzy analysis process

Instead of classical approach a fuzzy concept allows the decision about membership or non-membership to definite class provide as the function defining the degree of cognisance to the definite class or in another words the degree of membership. Application of fuzzy techniques can be done in many ways and the results of analysis are than more precise as traditional methods furnish.

3. Spatial studies

Relevant geographical information can help us map out different activities in requested context and discover hidden opportunities. By mapping more aspects of data, including history components or more complex temporal sets of data, we can discover trends we did not yet identify using traditional approaches. Spatial data processing has a large opportunities in the controlling and checking processes, namely in connection with mobile GIS.

In frame of university GIS courses it is difficult systematically provide the large geographical database but with about mentioned tools the students are able to solve very interesting for practice and significant for learning thematic studies. Selected spatial studies will be shown and discussed on the session.
Several examples follow:

- Identification of swimming pools from aerial data for the purposes of the schedule of building permission proceedings evaluation.
- Detection of forest area where cut occurred for the purposes of control.
- The garbage handling and ash cans arrangement.
- The study devoted to urban green areas planning and caring.
- Deep demographical studies are in disposal.

4. Conclusion

In this paper, the problem of the context oriented classification and modelling is addressed where the contextual information is used. The combination of spatial and temporal components of information and incorporation of computational intelligence and fuzzy design into spatial data analysis is discussed and the fact is pointed out that it will bring the new qualitative reasoning of geo-information. Our decisions are becoming increasingly dependent on understanding of complex relations and phenomena in the world. 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 results understanding.

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Adresa autora:

Dana Klimešová, Czech University of Agriculture, Prague, Faculty of Economics and Management, Dept. of Information Engineering, Kamýcká 129, 165 21 Praha 6 – Suchdol, Czech Republic, klimesova@pef.czu.cz
and
Czech Academy of Sciences, Institute of Information Theory and Automation, Dept. of Image Processing, Pod vodárenskou věží 4, 182 00 Prague 8, Czech Republic,klimes@utia.cas.cz