09161 Abstracts Collection
Generalization of spatial information
— Dagstuhl Seminar —

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Abstract. From 13.04. to 17.04.2009, the Dagstuhl Seminar 09161 "Generalization of spatial information " was held in Schloss Dagstuhl – Leibniz Center for Informatics. During the seminar, several participants presented their current research, and ongoing work and open problems were discussed. Abstracts of the presentations given during the seminar as well as abstracts of seminar results and ideas are put together in this paper. The first section describes the seminar topics and goals in general. Links to extended abstracts or full papers are provided, if available.

Keywords. Spatial information, generalization, aggregation, web services, formal semantics, geo-ontology, user context, constraint specification, progressive data transfer, computational geometry, cartography, mobile systems

09161 Summary – Generalization of spatial information

From the early start of handling geo-information in a digital environments, it has been attempted to automate the process of generalization of geographic information. Traditionally for the production of different map scale series, but more and more also in other contexts, such as the desktop/web /mobile use of geo-information, in order to allow to process, handle and understand possibly huge masses of data. Generalization is the process responsible for generating visualizations or geographic databases at coarser levels-of-detail than the original source database, while retaining essential characteristics of the underlying geographic information.

Keywords: Spatial information, generalization, aggregation, web services, formal semantics, geo-ontology, user context, constraint specification, progressive data transfer, computational geometry, cartography, mobile systems

Joint work of: Mustière, Sébastien; Sester, Monika; van Harmelen, Frank; van Oosterom, Peter

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2139

20 years generalization of topographic maps at the Dutch Kadaster. How far are we ?

Nico Bakker (Cadaster - Apeldoorn, NL)

The Topografische Dienst / Kadaster produces already more than 50 years maps in the scales range from 1:10.000 to 1:500.000. Up to the 90s of the previous century this entirely process was manual. Using the maps on a larger scale, which was represented as background at a reduced scale (between the original and target scale), the cartographer draw the map on the target scale, taking into account the generalisation rules which had been prescribed. These generalisation rules have been based on both national and international specifications, partly originating from military map products. Before 1955 the map on the scale 1:25.000 was the basis for the smaller scales. Especially the topographical map 1:50.000 was important for military use. Maps on the scales 1:100.000 and 1:250.000 also belonged to the product assortment. In the 50s the maps on the scale 1:10.000 was introduced, which is considered now still as a basis to the smaller scales. In the eighties digital production came up. Interactive generalisation was carried out with computers. However automatic generalisation was not yet possible.

This presentation shows the early attempts and research to automate the map generalisation. It started in 1990 which the idea to develop an expert system with the rules for generalisation. This should be used for programming in computer language, to speed up the automatic generalisation. In the mid-nineties all the generalisation rules were analyzed and some test were performed with special software. It was not successfully enough and we decided to change the base material TOP10vector to object-oriented database which should better support the automated process. In the last decade much research was done to develop automated generalisation. Until now only some functionalities are available, but there are not yet implemented in the production process. The last development is to harmonize the existing data models of the current product at different scales to one information model and to convert all the vector datasets to object-oriented datasets

Keywords: Automated Generalisation, Topographic Map

"Meaningless" Maps

Claus Brenner (Leibniz Universität Hannover, DE)

This talk intends to stretch our notion of "maps" and "generalization".

An approach to generate a map specifically targeted at the problem of vehicle positioning is presented, where the "map" basically consists of a set of points in a higher dimensional descriptor space. The descriptors are not attached with an interpretation in the usual sense of a (visual representation) of a map, thus are, in a way, "meaningless". Yet, the mapping has typical attributes of a generalized map: it is useful for, and especially targeted at, a certain purpose (positioning), details which are unimportant for this task are removed, and implicit information in the data is made explicit (in form of the descriptors).

Three conclusions are drawn. First, generalization is abstraction, which deals not only with visual representations and may include abstract items which may diverge from our classical notion of meaningful map objects. Second, more and more maps are made for machines and users will only come in touch with them via services. Those maps will use representations which are not necessarily meaningful for us. Third, coming back to visual representations of maps, it would be worth to think about how we could transfer the promising pattern recognition results which are currently obtained in computer vision, using high-dimensional local image descriptors, to (cartographic) generalization.

Keywords: Generalisation, descriptor space, bag of words, pattern recognition, machine learning

Derivation of cartographic preservation constraints

Dirk Burghardt (TU Dresden, DE)

Cartographic constraints are a formal way of specifying cartographic requirements on generalised topographic maps. Several typologies for the categorisation of cartographic constraints are proposed in the literature, typically with a distinction of two main categories - legibility constraints and preservation of appearance constraints. Legibility constraints are used to specify cartographic requirements of map readability considering limits of visual perception. Preservation constraints are introduced for the conservation of properties such as topology, position, orientation, shape, pattern, distribution/statistic of individual and groups of map objects during the generalisation process.

While legibility constraints can be defined through the introduction of minimal size and distance thresholds, only a part of the preservation constraints can be modelled easily with fixed values for examples constraints on keeping the position or orientation during generalisation. More often preservation constraints have to be specified by considering the property evolution of objects which are presented at different scales. Object properties might be preserved during generalisation for example the width-length ratio of a building or they can change for example the shape complexity described by fractal dimension. A first approach for the description of property evolution was proposed by Bard (2004) with the model of charcaterisation function, which had to be specified by the user.

The approach is further developed through a model of transfer functions which were automatically derived by reverse engineering of manual generalised

maps. Based on the assignment of objects at the different scales a regression analysis can be applied, which provides automatically the parameter values for the transfer function. Thus average property values can be calculated for the generalised objects. The difference between the property value of the generalised object and the average property value can be transformed into the preservation constraint by usage of an interpretation function. The simple case is the application of a linear interpretation function with a tolerance range, which models the bandwidth of allowed variations. Finally the difficulties will be discussed of modelling the property evolution, which arises from m:n-relations of aggregated, split or removed objects.

Keywords: Cartographic constraints, automated generalisation, transfer functions, perservation constraints

Joint work of: Burghardt, Dirk; Schmid, Stefan

Database Enrichment: Automatic identification of Higher order objects in large scale database

Omair Zubair Chaudhry (Ordnance Survey - Southampton, GB)

In the context of map generalisation, the ambition is to store once and then maintain a very detailed geographic database. Using a mix of modelling and cartographic generalisation techniques, the intention is to derive map products at varying levels of detail - from the fine scale to the highly synoptic. We argue that in modelling this process, it is highly advantageous to take a functional perspective on map generalisation - rather than a geometric one. In other words to model the function as it manifests itself in the shapes and patterns of distribution of the phenomenon being mapped whether it be hospitals, airports, or cities. By modelling the functional composition of such features we can create relationships (partonomic, taxonomic and topological) that lend themselves directly to modelling, to analysis and most importantly to the process of generalisation. Borrowing from ideas in robotic vision this paper presents an approach for the automatic identification of functional sites (a collection of topographic features that perform a collective function) and demonstrates their utility in multi scale representation and generalisation.

Keywords: Map generalisation, multiple representations, data modelling, database enrichment

Generalization of Morse complexes in arbitrary dimensions

Leila De Floriani (University of Genova, IT)

The problem of representing morphological information extracted from discrete scalar fields is a relevant issue in several applications, such as terrain modeling and volume data analysis and understanding.

Based on Morse theory, subdivisions of the graph of a scalar field f, called Morse complexes, have been defined as convenient representations for analyzing the behavior of f. In this talk, we define an effective representation for Morse complexes for arbitrary dimensional scalar fields based on encoding their cells and mutual incidence relations. We introduce generalisation operators on Morse complexes, and we describe how these operators affect their incidence-based representation. The important property of such operators is that they are Euler operators on the underlying cell complex and that they form a minimal set of operators for modifying a Morse complex. These generalization operations are also the basis for developing a dimension-independent multi-scale representation for Morse complexes. We show our implementation of a multi-scale morphological terrain model and discuss current and future developments.

Keywords: Morphological models, terrains, multi-dimensional scalar fields, Morse complexes

An Automated Formalization Method for the Use of Interchange Generalization

Ahmet Ozgur Dogru (Istanbul Technical University, TR)

In this study an automated approach for formalizing road interchanges was proposed. The aim of this proposal is to support interchange classification process executed to generalize them for reducing the visual complexity of the small scaled road maps. In this context, interchanges were first derived from the road network data by using semiautomated method then they were formalized as matrix and tree structures. These structures were then used to classify interchanges depending on their common characteristics. Classification results were proposed to be used for automated symbolization of interchanges on small scaled road maps.

Keywords: Road interchanges, formalization, classification, generalization

Use of agents in generalisation

Cecile Duchene (Institut Géographique National - Saint-Mandé, FR)

In this presentation, we deal with the use of agent modelling for generalisation. We mainly try to identify why this paradigm is well suited for the generalisation problem, and present a quick overview of related works done at COGIT Laboratory.

An agent is a computational entity with a goal, capacities of perception, deliberation, action and possibly communication, and a pro-active (autonomous) behaviour. Multi-agent systems, i.e. systems composed of a set of interacting agents, are commonly used for complex phenomena simulation and for problem resolution. The principles of agent modelling are to model simple behaviours on

the agents, based on a partial knowledge and/or perception of their world. The strength of the system lies in the interactions between the agents, that enable to progress towards a solution (when used for problem resolution) or to make collective behaviours emerge (when used for simulation).

Automating the generalisation process enters in the category of (spatial, complex) problem resolution. Multi-agent based models have been used for generalisation in several works, like [Baeijs 98; Ruas 99; Barrault et al. 2001; Galanda 03; Duchêne 04; Jabeur 06; Gaffuri 08; Taillandier et al. 08]. As a general principle, in these models the objects appearing on the map are modelled as agents, an the generalisation is the result of their interactions. Some of these works are now used or about to be used in NMAs for production. It also appears that the multi-agent research community considers the generalisation problem as a very interesting application field. According to us, four main characteristics of the multi-agents paradigm make it well adapted to generalisation as soon as it is very contextual (i.e. for scale transitions that imply lots of interactions between the map objects):

(1) The distributed modelling aspect: each agent knows a part of the problem and a part of the solution

(2) The dissociation between the facts base, the knowledge, and a generic behaviour that matches them in order to act , which enables to improve each part of the modelling separately.

(3) The hierarchical multi-level modelling, which enables groups or organisations of agents to have collective, dedicated, pre-identified behaviours.

(4) The possibility to model direct, transversal interactions between agents through forces or dialog.

At COGIT lab., three complementary multi-agent models have been designed, respectively relying on hierarchical interactions [Ruas 1999], transversal interactions [Duchêne 2004], and low-level influences [Gaffuri 2008]. We are now working on how to combine them together and with other generalisation models, to make a step forward to automatically generalising complete multi-theme datasets. We are also moving to studying the design of generalisation processes able to adapt to much more various data and user needs.

Joint work of: Duchene, Cecile; Gaffuri, Julien

Why Is Cartographic Generalization So Hard?

Andrew U. Frank (TU Wien, AT)

I remember first presentations about cartographic generalizations (Spiess 1971), where tools for generalization were shown, but the conclusions stated, more or less clearly, that fully automated cartographic generalization was not possible. There has been an impressive stream of research documenting methods to generalize maps. The consensus today seems to be that automated tools under control of a cartographer are the most effective means (Buttenfield et al. 1991; Weibel 1995).

In this contribution some fundamental aspects of map making, including generalizations are analyzed. Map generalization is studied by most map producers, especially the National Mapping Agencies, because they have to maintain maps at different scale and it appears economical to derive a map at smaller from a map of a larger scale by an automated process. Equally important is the production of maps at arbitrary scales for the illustration of web pages. These tasks are the backdrop for the following abstract analysis.

Keywords: Cartographic Generalization, AI-Hard, NP-Hard

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2009/2136

See also: Achatschitz, C. (2008). Preference-Based Visual Interaction Spatial Decision Support in Tourist Information Systems. Vienna, Technical University Vienna. Doctor.

Generalisation problems sample to test generalisation

Julien Gaffuri (Institut Géographique National - Saint-Mandé, FR)

The Cornell box is a simple scene used by people working in 3D computer graphics to compare different lighting models. It is composed of a box, with colored sides, containing several simple 3D objects. The characteristics of that box are available for each researcher in light modelling (http://www.graphics.cornell.edu/online/box/).

The use of this scene allows: - to give an overview of a lighting model on simple objects, - to easily compare different lighting models, by comparing their effect on the Cornell box.

In generalisation research, several kinds of components (generalisation models, algorithms, spa- tial analysis methods, etc.) have been designed to tackle many different generalisation problems.

In order to better show these research results and compare them, we propose to attempt to build a kind of "generalisation Cornell box".

Keywords: Generalization, sample, benchmark, geographic data

Optimization and Pattern Identification for Generalization

Paul Hardy (ESRI Europe - Cambridge, GB)

This presentation reviews generalization research and development within the framework of a commodity GIS (ESRI ArcGIS).

ESRI has been developing a research prototype of an 'Optimizer' engine, focused on contextual generalization [Monnot, Hardy, Lee 2007]. It uses Simulated Annealing, but with intelligent rather than random actions.

The presentation covers the database-centered framework into which to fit generalization tools, and in particular the mechanisms for storing cartographic

overrides to representation rules. It shows early example outputs from initial experimental tools using this optimization engine, for road network thinning (pruning); road displacement to avoid symbology conflicts; displacement propagation; and building displacement/exaggeration.

Finally it mentions other ESRI research on detection of patterns of multiple urban buildings for enrichment prior to generalization, plus new tools (non-Optimizer) for collapse of polygon to skeletal centerline.

Keywords: Optimization, Patterns, Generalization

Methods to Measure Map Readability

Lars Harrie (Lund University, SE)

Creation of maps in real-time web services introduces challenges concerning map readability. Therefore we must introduce analytical measures controlling the readability. The aim of this study is to develop and evaluate analytical readability measures with the help of user tests.

Keywords: Map readability, generalization, web map services

Generalisation by Combinatorial Optimisation: Handling Multiple Constraints and Objectives

Jan-Henrik Haunert (Leibniz Universität Hannover, DE)

Map generalisation is often approached by combinatorial optimisation. Mainly two techniques are applied: deterministic methods or iterative meta-heuristics. In this talk I present typical generalisation problems and formalise them in terms of constraints and objectives.

Optimisation approaches to the problems are discussed.

Finally, I highlight three challenges that need to be addressed by future research:

(1) We need deterministic methods that allow for a higher variability of the output maps than the existing deterministic methods do.

(2) Methods based on meta-heuristic need to be improved with respect to their capability of handling hard constraints.

(3) Methods for integrating multiple (potentially contradicting) generalisation objectives are needed.

Keywords: Building Simplification, Aggregation, Optimisation

Generalization of Geographic Information as an Ontological Problem

Werner Kuhn (Universität Münster, DE)

Map generalization still lacks a sound formal theory. As a consequence, its automation remains hampered, and tool support haphazard. While it is widely recognized that the generalization of models has to underpin that of maps, this insight has not yet led to an ontological theory of generalization which would be suitable for cartographic applications. As an outsider to map generalization, engaged in model generalization and spatio-temporal ontology, I argue in a short talk that

1. map generalization is a conceptual problem, before being a graphical one
2. ontology is, therefore, a necessary underpinning for generalization
3. formal ontology provides (early) theories of granularity that help.

The need for a much more broadly conceived, ontological theory of generalizing spatio-temporal information would have been illustrated by case studies in hierarchical navigation and sensor abstraction (if time permitted).

Keywords: Granularity transformations, map vs model generalization, homomorphism between the two, sensor abstractions, hierarchical navigation

An ontology-modelling approach to urban spatial data enrichment

Patrick Luescher (Universität Zürich, CH)

There is a gap between individual, discrete objects represented in current cartographic databases and the higher order geographic concepts that humans use to reason about space, specifically in an urban environment. While higher level concepts are not explicitly coded in current cartographic databases, they are nevertheless implicitly contained, owing to the fact that there often exists a relationship between the form (i.e. geometry) and function (i.e. semantics) of real-world phenomena. Spatial data enrichment makes explicit the semantics that is implicitly contained in spatial databases.

In my talk I presented an approach that uses ontologies to model higher level concepts and drive the pattern recognition process. I showed how the ontologies are formalised as a set of rules. Special emphasis was put on fuzzy reasoning in order to account for vagueness of geographic concepts. The reasoner is linked to spatial data processing capabilities through a service oriented architecture. This makes possible to integrate custom algorithms for spatial data processing. The approach was illustrated and open issues were discussed through classification of building types in English urban areas.

Keywords: Cartographic databases, ontologies, cartographic pattern recognition, supervised classification, building types

Partonomic modelling to support context and reasoning in map generalisation

William Mackaness (University of Edinburgh, GB)

The visual communication of (spatial) information is a design problem. We argue that solutions depend on us being able to reason about space. The core aim of data enrichment is to make explicit the linkages between concepts in order to provide a context to the analysis and display of geographic phenomena. A variety of classification techniques compliment the data enrichment process and offer a more intuitive understanding of the objectives of map generalisation. In particular this paper explores mereology as a basis for model and cartographic generalisation. The paper illustrates various benefits of this approach.

Keywords: Mereology, reasoning, design, abstraction

Joint work of: Mackaness, William; Chaudhry, Omair

Partonomic Modelling and Reasoning

William Mackaness (University of Edinburgh, GB)

The attached powerpoint includes written comments in the note section of each slide which helps convey the story behind this presentation. In essence the presentation argued that:

1. Generalisation process needs to be task oriented.
2. We have taken the 'concept/ linkages' paradigm and mapped to 'functional sites/ partonomic relationship'.
3. We've illustrated first order logic as a simple way of reasoning about concepts as a basis for selecting map content, and thus scale.

Keywords: Partonomies, mereology, reasoning, map generalisation

Challenges in Map Generalisation

William Mackaness (University of Edinburgh, GB)

The ppt reviews successes in generalisation research and attempts to focus on core research activities and challenges.

Keywords: Map generalisation challenges future research

Line Generalization in the context of a Variable Scale Vector Data Server

Martijn Meijers (TU Delft, NL)

The talk I gave dealt with an open problem in my PhD research. It deals with line generalization in a variable scale data server. This server works on data structures implemented in a Database Management System. It stores the result of an offline gradual generalization process in which each time two objects are merged. After each object merge, also related edges will be merged. These edges will be simplified simultaneously. This however leads to topological problems. The presentation presented ideas on a modified Visvalingham Whyatt algorithm that tries to prevent those topological problems.

Keywords: Line Generalization, Variable Scale, Vector Data

Comparing points of view underlying databases

Sebastien Mustiere (Institut Géographique National - Saint-Mandé, FR)

Each geographic database reflect a certain point of view that can be somehow modeled as an ontology or, more easily, reflected by a taxonomy of terms used to depict its content.

In this presentation we argue that tools are needed to globally compare two or more taxonomies, and that this is a key issue for answering some key questions like: in which extent two databases are similar / different? can two databases be reasonably merged? which database best fits to a certain need?....

Keywords: Multiple representation, integration, taxonomy, geonto project

Use cases for Generalisation Web Services

Nicolas Regnauld (Ordnance Survey - Southampton, GB)

During the past few years, the need for an open platform for research on automatic generalisation has become clear. This triggered the development in Zurich of a prototype open platform based on Web services (client - server architecture).

We now want to promote the use of this platform by the generalisation community. We have identified a set of use cases that demonstrate the benefits and costs/risks associated with using this platform, for different types of users (researchers, National Mapping Agencies, GIS companies). The potential benefits (reuse, interoperability, transparency) are potentially very high and should largely outweigh the costs/risks (overhead to publish tools as services, data security, copyrights, cost of maintaining servers, supporting users...).

We now need to start enriching that platform by publishing tools as services. We also need to consider the semantic description of these services to allow automatic discovery of relevant services to perform a particular generalisation task

Keywords: Web Services, open platform, interoperability, software reuse, automatic generalisation

Use cases for Generalisation Web Services

Nicolas Regnauld (Ordnance Survey - Southampton, GB)

Description of use cases to illustrate the potential benefits and costs associated with the publication of generalisation tools as Web Services.

Keywords: Web Services, Use cases, interoperability, Software reuse

Joint work of: Regnauld, Nicolas; Duchene, Cecile; Weibel, Robert

Building Generalization in highly redundant data

Monika Sester (Leibniz Universität Hannover, DE)

Laser scanner data are a powerful data source for acquisition and update of high resolution topographic information. Current airborne laser scanning systems are able to acquire densities of up to 40 points per square meter. With this information topographic objects like buildings, trees, electricity lines, and the relief can be determined. The main problem is the classification and identification of these objects in the point cloud and their precise reconstruction.

In this presentation the problem of delineating building ground plans from laser scanner point clouds is tackled. Starting point is a pre-processing step that distinguishes terrain and off-terrain points. Then, all connected off-terrain points are aggregated in a region growing process. These regions represent potential buildings. For them, in a third step, the outline is simplified. This is a generalization task, which has to take the characteristics of buildings into account to produce a meaningful 2D building shape. Due to the high redundancy of the data (as opposed to typical building generalization problem), classical building generalization solutions do not work. A solution is proposed that firstly extracts straight lines from the building outline, then these lines are combined using building characteristics (rectangularity, parallelism) in a least squares adjustment optimization.

Keywords: Lidar Data, Building outlines, RANSAC algog., Least Squres Adjustment

An Automated Approach to Compare Generalized Hydrographic Network Features to a Benchmark Dataset

Lawrence Stanislawski (USGS - Rolla, US)

Two primary levels of detail of the United States National Hydrography Dataset (NHD) are available for all areas of the country: the high-resolution and 1:100,000-scale layers.

Additional resolutions are required to support the automated cartographic mapping and web services desired by the United States Geological Survey (USGS). Automated methods are being developed and tested to prune the high-resolution NHD to a consistent level of detail, where necessary, and to prune it to other levels of detail that are appropriate for mapping at smaller scales. An automated process is presented that summarizes omission and commissions errors of pruned network lines when compared to a benchmark dataset. The index is known as the coefficient of linear correspondence (CLC). The CLC is estimated for each 0.5 degree by 0.5 degree cell covering a 48 subbasin area in the central United States, where the high-resolution NHD network features were pruned to the 1:100,000-scale level of detail and compared to a benchmark, which is the 1:100,000-scale NHD network features. The CLC ranges from 0.40 to 0.92 in the 110 cells covering the study area, with an average of 0.75. The automated process of estimating the CLC and associated values is a reasonably fast method to compare pruned, or otherwise generalized, linear features to a set of benchmark lines. This repeatable, consistent process provides spatially distributed indices that isolate areas with relatively poor matching to the benchmark lines.

Keywords: Drainage network pruning, benchmark, coefficient of linear correspondence

Formalising generalisation requirements in a multi-scale model topography using OCL expressions

Jantien Stoter (ITC - Enschede, NL)

An important step towards automated generalisation within NMAs is to formally specify how the content and meaning of the datasets representing different scales relate to each other in a multi-scale information model topography. This presentation presents modelling principles for a multi-scale Information Model TOPography, called IMTOP (studied in collaboration with TU Delft and Dutch Kadaster). The Unified Modelling Language (UML), including the Object Constraint Language (OCL), is used for formalisation. The modelling principles are a result of two steps. Firstly we conducted a requirement analysis using the needs for a multi-scale information model of the NetherlandsŠ Kadaster as case study. Secondly we designed, implemented and evaluated several alternatives to meet the identified requirements. The model covers two main aspects of a multi-scale data model. Firstly it integrates the data states at the different scales in a UML class diagram. Secondly it formalises requirements for automated generalisation by means of OCL expressions. These requirements cover both legibility conditions regarding the output of generalisation (can be defined within the target scale) and preservation conditions (have to be defined in correspondence with the source scale using inter-scale relationships).

Keywords: Semantic rich mulit-scale data model

Spatial Reasoning for the (Semantic) Web - Use Cases and Technological Challenges

Heiner Stuckenschmidt (Universität Mannheim, DE)

The goal of semantic web research is to turn the World-Wide Web into a Web of Data that can be processed automatically to a much larger extend than possible with traditional web technology. Important features of the solution currently being developed is the ability to link data from from different sources and to provide formal definitions of the intended meaning of the terminology used in different sources as a basis for deriving implicit information and for conflict detection. Both requires the ability to reason about the definition of terms. With the development of OWL as the standard language for representing terminological knowledge, reasoning in description logics has been determined as the major technique for performing this reasoning [**?**]. More recently, rule languages have gained more importance as well as they have been shown to be more suited for efficient reasoning about terminology and data at the same time.

So far little attention has been paid to the problem of representing and reasoning about space and time on the semantic web. In particular, existing semantic web languages are not well suited for representing these aspects as they require to operate over metric spaces that behave fundamentally different from the abstract interpretation domains description logics are based on. Nevertheless, there is a strong need to integrate reasoning about space and time into existing semantic web technologies especially because more and more data available on the web has a references to space and time. Images taken by digital cameras are a good example of such data as they come with a time stamp and geographic coordinates.

In this paper, we concentrate on spatial aspects and discuss different use case for reasoning about spatial aspects on the (semantic) web and possible technological solutions for these use cases. Based on these discussions we conclude that the actual open problem is not existing technologies for terminological or spatial reasoning, but the lack of an established mechanism for combining the two.

Keywords: Semantic Web, Spatial reasoning

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2009/2138

Cartographic and semantic aspects on web services

Heiner Stuckenschmidt (Universität Mannheim, DE)

Several countries are currently working on setting up geoportals as part of their national spatial data infrastructure (SDI) (and this is also a requirement of the Inspire initiative).

A key ability of these geoportals is that the user should be able to view (and download) data from several sources from one access point. This will certainly make the access to geospatial data easier. However, there are also cartographic and semantic challenges that have to be solved. In this discussion group we discussed some topics concerning both download services and view services and some possible solutions.

Keywords: Geopertals, integration, semantic technologies

Joint work of: Harrie, Lars; Stuckenschmidt, Heiner

Extended Abstract: http://drops.dagstuhl.de/opus/volltexte/2009/2134

Map generalization: A SWOT analysis

Robert Weibel (Universität Zürich, CH)

I provide a survey of achievements of past research and discuss new opportunities that have recently come about and that map generalization research could and should take advantage of. The talk takes the format of a SWOT analysis, but the main objective is really to advocate a shift to new problems and a re-definition of map generalization, as well as a better linkage to other research domains that are rapidly gaining importance.

Over the past couple of years, new opportunities have evolved that all involve some level of map generalization or visualization-oriented abstraction, such as LBS, Web 2.0 and volunteered geographic information, geographic information retrieval (GIR), spatio- temporal data mining, visual analytics, and maps mash-ups. However, I argue that much of current research is still focusing on automating paper map production (with few exceptions, such as mobile and web mapping applications). I present an overview of new challenges, as well as selected examples of what I believe are successful solutions to these, including integration with GIR on Web 2.0 content to extract concepts of vernacular geography from Flickr tags.

Keywords: Map generalization, research opportunities, web 2.0, SWOT

Optimal Simplification of Building Ground Plans

Alexander Wolff (TU Eindhoven, NL)

We present an optimization approach to simplify building ground plans given by two-dimensional polygons. We define a simplified building as a subsequence of the original building edges; its vertices are defined by intersections of consecutive (and possibly extended) edges in the selected sequence. Our aim is to minimize the number of edges subject to a user-defined error tolerance. We prove that this problem is NP-hard when requiring that the output consists of non-intersecting

simple polygons. Thus we cannot hope for an efficient, exact algorithm. Instead, we propose a heuristic and an integer programming formulation that can be used to solve the problem with existing optimization software.

We discuss results of our algorithms and how to incorporate more sophisticated objective functions into our model.

Keywords: Cartography, Scale, Generalization, Optimization, Building simplification, NP-hard, Integer Programming

Joint work of: Haunert, Jan-Henrik; Wolff, Alexander

Full Paper:
http://www.isprs.org/congresses/beijing2008/proceedings/2_pdf/3_WG-II-3/01.pdf

See also: Proc. 21st Congress Internat. Society Photogrammetry Remote Sensing (ISPRS'08), Technical Commision II/3, pages 373-378, volume XXXVII, Part B2 of Internat. Archives of Photogrammetry, Remote Sensing and Spatial Informat. Sci., 2008

Semantic Technologies for Mobile Communications: User-generated Policies and Services

Anna Zhdanova (FZ Telekommunikation Wien, AT)

Nowadays, Web, mobile, physical and virtual environments converge in one shared communication sphere, where end-users are playing an increasingly important role (e.g., becoming "prosumers" instead of consumers). Technologies stemming from such fields as Semantic Web and Telecommunications get combined to achieve this convergence and end-user empowerment on the Internet of the Future. In practice, the end-users increasingly demonstrate the capability to successfully generate and exploit such ontology items as classes, subclasses, properties, instances, ontology mappings and rules. I present ongoing efforts towards user-driven construction, sharing and maintenance of semantic policies and (micro-)services.

Full Paper:
http://userver.ftw.at/~zhdanova/papers/policy_editor.pdf

Space, Time, and Semantics

Willem van Hage (VU University Amsterdam, NL)

This presentation is about my current work on extending SWI-Prolog with a spatial indexing package. This package allows a tight integration between RDF(S) and OWL reasoning and spatial reasoning (e.g. incremental nearest neighbor, containment, intersection).

Keywords: Prolog, RDF, OWL, spatial indexing, R*-tree, incremental nearest neighbor, semantic web

Bluffers Guide to the Semantic Web

Frank van Harmelen (VU University Amsterdam, NL)

We present the overal vision of the Semantic Web (why the world would be a better place if we had it), we outline what technology is necessary to get there, and we describe the current state of play. All along, we try to find out how this is relevan for Geo-data.

Keywords: Semantic web

Trajectory Simplification

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Trajectory simplification is different from line simplification, because trajectories have a temporal component that captures when the object was where, and how fast it traveled. We will review the Imai-Iri optimal line simplification algorithm and show that it can be adapted to trajectory simplification. Depending on the exact formulation of the requirements of the simplification, a trajectory with n vertices can be simplified in $O(n^2)$ or $O(n^2 \log^2 n)$ time.

Keywords: Trajectories, simplification, speed

Applying DLM and DCM concepts in a multi-scale environment

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Although the separation between Digital Landscape Model (DLM) and Digital Cartographic Model (DCM) is considered as state of the art, data producers, like national mapping agencies, still wrestle with the question what to store explicitly in order to efficiently maintain their geographic databases and maps. In this discussion/presentation we will try to show that explicit storage of both models, up to the data instance level, leads to more redundancy in multi-scale data models and makes it more difficult to manage geographic databases. To streamline the process of data production for both analysis and map making purposes, we propose to maintain only the data instances of the DLM, including minor 'distortions' to apply visualization rules easier, and to investigate variable scale data storage.

Keywords: DCM (Digital Cartographic Model), DLM (Digital Landscape Model), multi-scale, vario-scale, data management

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