Foreword

The Semantic Web offers new options for information processes. Dr. Visser is dealing with two core issues in this area: the integration of data on the semantic level and the problem of spatio-temporal representation and reasoning. He tackles existing research problems within the field of geographic information systems (GIS), the solutions of which are essential for an improved functionality of applications that make use of the Semantic Web (e.g., for heterogeneous digital maps). In addition, they are of fundamental significance for information sciences as such.

In an introductory overview of this field of research, he motivates the necessity for formal metadata for unstructured information in the World Wide Web. Without metadata, an efficient search on a semantic level will turn out to be impossible, above all if it is not only applied to a terminological level but also to spatial-temporal knowledge. In this context, the task of information integration is divided into syntactic, structural, and semantic integration, the last class by far the most difficult, above all with respect to contextual semantic heterogeneities.

A current overview of the state of the art in the field of information integration follows. Emphasis is put particularly on the representation of spatial and temporal aspects including the corresponding inference mechanisms, and also the special requirements on the Open GIS Consortium.

An approach is presented integrating information sources and providing temporal and spatial query mechanisms for GIS, i.e., the BUSTER system developed at the Center for Computing Technologies (TZI) which was defined according to the following requirements:

- Intelligent search
- Integration and/or translation of the data found
- Search and relevance for spatial terms or concepts
- Search and relevance for temporal terms

While distinguishing between the query phase and the acquisition phase, the above serves as the basis for the concept of the systems architecture. The

representation of semantic properties requires descriptions for metadata: this is where the introduced methods of the Dublin Core are considered, and it is demonstrated that the elements defined there do not meet with the requirements and consequently have to be extended.

Furthermore, important problems of terminological representation, terminological reasoning, and semantic translation are treated extensively. Again, the definition of requirements and a literature survey on the existing approaches (ontologies, description logics, inference components, and semantic translation) sets the scope. The chapter concludes with a comprehensive real-world example of semantic translation between GIS catalogue systems using ATKIS (official German catalogue) and CORINE (official European catalogue) illustrating the valuable functions of BUSTER.

Subsequently, the author attacks the core problems of spatial representation and spatial reasoning. The requirements list intuitive spatial denominations, place-names, gazetteers, and footprints, and he concludes that existing results are not expressive enough to enable the desired functionalities. Consequently, an overview of the formalisms of place-name structures is given which is based on tessellations and allows for an elegant solution of the problem through a representation with connection graphs, including an evaluation of spatial relevance. The theoretical background is explained using a well-illustrated example.

Finally, the requirements for temporal representations and the corresponding inference mechanisms are discussed. A qualitative calculus is developed which makes it possible to cover the temporal aspects which are also of importance to Semantic Web applications.

After the discussion of the set of requirements for an intelligent query system, the state of the BUSTER implementation is discussed. In a comprehensive demonstration of the system, terminological, spatial, and temporal queries, and some of their combinations are described.

An outlook on future research questions follows. In the bibliography, a good overview is given on the current state of the research questions dealt with.

This book combines in an exemplary manner the theoretical aspects of a combination of intelligent conceptual and spatio-temporal queries of heterogeneous information systems. Throughout the book, examples are provided using GIS functionality. However, the theoretical concept and the prototypical system are more general. The ideas can be applied to other application domains and have been demonstrated and tested, e.g., in the electronics and tourist domains. This demonstrates well that the approaches worked out are useful for practical applications – a valuable benefit for those readers who are looking for actual research results in the important areas of data transformation, the semantic representation of spatial and/or temporal relations, and for applications of metadata.

Bremen, May 2004 Otthein Herzog

Preface

When I first had the idea about the automatical transformation of data sets, which we now refer to as semantic translation, many of my colleagues were sceptical. I had to convince them, and when I showed up with a real-world example (ATKIS-CORINE) we founded the BUSTER group. This was in early 1999.

Since then, many people were involved in this project who helped with their critical questions, valuable suggestions, and ideas on how to develop the prototype. Two important people behind the early stages of the BUSTER idea are Heiner Stuckenschmidt and Holger Wache. I would like to thank them for their overview, their theoretical contributions, and their cooperation. I really enjoyed working with them and we hopefully will be able to do some joint work in the future again.

Thomas Vögele played an important role in the work that has been done around the spatial part of the system. His contributions in this area are crucial and we had fruitful discussions about the representation and reasoning components of the BUSTER system. At this point, I also would like to thank Christoph Schlieder, who gave me a thorough insight into the qualitative spatial representations and always contributed his ideas to our objectives. Some of them are now implemented in the BUSTER prototype.

The development and implementation of the system would not have been possible without people who are dedicated to programming. Most of the Master's students involved in our project were working on it for quite a long time. Sebastian Hübner, Gerhard Schuster, Ryco Meyer, and Carsten Krüwel were amongst the first "generation". I would like to thank them for their programming skills and patience when I asked them to have something ready as soon as possible. Sebastian Hübner now plays an important role in our project. Without him, the new temporal part of our system would be non-existent.

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