

Tutorial on “Context Sensitivity” in Knowledge Rich Systems

Marko Grobelnik, Igor Mozetic (Jozef Stefan Institute)
Michael Witbrock (Cycorp)
Pascal Hitzler, Peter Haase (AIFB, University Karlsruhe)

A brief description of the tutorial

Background

Context sensitivity of applications is an important requirement for modern information and communication systems. The key improvement is adaptivity to the situations in which the system needs to react. This enables more efficient and robust functioning in dynamic environments. Therefore, identification and assignment of a context is a necessary factor to provide services and applications that are tailored to the user and the user's current situation.

Early models of context representation come from Artificial Intelligence, where logic-based formalisms are mostly used. Functions and predicates are defined for each of the aspects (dimensions) of the environment. With the use of mobile devices and current research on ubiquitous computing, the topic of context-awareness is a major issue for upcoming IT applications. Modelling and retrieving context provide means to be integrated in modern knowledge management processes. Intelligent solutions are needed to apply context, e.g., to cope with the fuzziness of context information and, especially because of mobility, rapidly changing environments and unsteady information sources. Advanced methodologies for concluding on or assigning a context to a situation are to be applied, which introduces the main fields of AI mechanisms into context-aware applications.

More on context related topics can be found at the web page “*Context in AI*” (<http://context.umcs.maine.edu/>).

Goals

The main goal of this tutorial is to provide an extensive survey of the past and current work in the area of context related topics. This includes **analysis** of the past work: (1) *defining* the notion of “context”, (2) present *logic-based formalisms* for dealing with contexts, (3) present *probabilistic/fuzzy*

approaches to model context, (4) *demonstrate* “modelling the context” and “reasoning with contexts” in real-life applications.

In addition, the presented work we will provide a **synthesis** of the past work in the light of a *unified categorization* of context-related approaches along several dimensions which appear as relevant from theoretical and practical point of view (see outline for details).

Detailed outline

- (1) Informal introduction to the “context sensitivity” area
- (2) Presenting various definitions of the context appearing in the up-to-date literature from different areas of science with special focus on logic-based and probabilistic approaches from AI
- (3) Positioning of the existing context-related approaches along the following dimensions:
 - Formalism: logic-based vs. probabilistic descriptions
 - Semantics: global model vs. multiple local models
 - Dynamics: static vs. dynamic contexts
 - Cross modal issues: modeling contexts across different data modalities (text, multilinguality, social networks, audio, images, video, sensors, mobile devices)
 - User aspects: context for single user vs. user communities vs. contexts for machine processing
 - Efficiency: expressivity vs. scalability
 - Context acquisition: manual vs. semi-automatic vs. automatic approaches
 - Best practices when dealing with context: economy of different application scenarios
 - Evaluation: how to evaluate the quality of context representation
- (4) Examples/Demonstrations
 - Reasoning with contexts within the Cyc system
 - Modeling “multiple views” ontologies with Support Vector Machines (SVM)
 - Automatic learning of probabilistic contextual mapping rules with Kernel Canonical Correlation Analysis (KCCA)
 - SEKTbar – web browser toolbar for detecting user context during web browsing
- (5) Synthesis of the existing approaches and future trends

Justification of why the tutorial is important

The goal of this tutorial is to connect past and existing work with context with current semantic web activities which move recently towards contextualization (such as networked ontologies, bridge rules, mappings, etc).

Current **importance** of this tutorial is recently increased interest in approaches dealing with contexts within the area of semantic web due to integrative role of SW technology, which acts as a glue between other technologies (such as information retrieval, ubiquitous computing, social networks, cross media, cross language etc). In particular, this can be seen through recent start of several Integrated Projects in the European FP6 programme (such as NEON, NEPOMUK, XMEDIA, etc.) and US projects (such as CALO).

Another aspect of importance of having this tutorial is the fact that “context” is still not well understood and addressed in the semantic web community from the theoretical and practical sides. This tutorial will try to educate part of the community in context-related issues.

Background knowledge required

The required prior knowledge for the tutorial is basic knowledge of logic formalisms (common to most of the ISWC participants) and basics of probability theory and information retrieval (undergrad level knowledge). The tutorial will consist of several independent modules which will not assume complete understanding of previous modules.

Potential attendees

Potential attendees are students and researchers working in the area of theory and practice of semantic web. Theorists will gain insight into how to define and deal with contextual information in different theoretical frameworks. Practitioners will see how contextual information functions in practice through demonstration of several systems and by getting a solid overview of the existing work.

In particular, an interested group of attendees will come from the running projects (e.g. European FP6 and US DARPA) where “context sensitivity” plays a prominent role. Addressing relation to the areas such as ubiquitous computing, sensor networks, social networks, information retrieval, machine learning, etc. might attract researchers from the areas which are not traditionally a part of ISWC.

Information about the tutorial speakers

Marko Grobelnik / Igor Mozetic

Address: J. Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia

E-mail: Marko.Grobelnik@ijs.si / Igor.Mozetic@ijs.si

Phone: +386 1 4773 778

Fax: +386 1 4773 315

Michael Witbrock

Address: Cycorp, Inc. Suite 100, 3721 Executive Center Drive, Austin, TX 78731, US

E-Mail: witbrock@cyc.com

Phone: +1 512 342-4000

Fax: +1 512 342-4040

Peter Haase / Pascal Hitzler

Address: Universität Karlsruhe (TH), Institut AIFB, D-76128 Karlsruhe, Germany

E-Mail: pha@aifb.uni-karlsruhe.de / hitzler@aifb.uni-karlsruhe.de

Phone: +49 721 6083923

Fax: +49 721 693717

A Short CV of the presenters

Marko Grobelnik works at the Department of Intelligent Systems of the J. Stefan Institute since 1984 as a researcher and project manager. He participated in several European, national, and industrial projects. Currently, he and his group are involved in research projects with Microsoft Research, FP6 European projects SEKT (Semantically Enabled Knowledge Technologies), NEON (Lifecycle Support for Networked Ontologies), ALVIS (Next Generation Information Search), PASCAL (Pattern Recognition, Statistical Modeling, and Computational Learning), TAO & SWING (Semantic Web Services). Most of his research work is connected with the study and development of Machine Learning and Data Mining techniques and their application to real-life problems. His current research focuses on Machine Learning for rich knowledge representations. He has published several papers in refereed conferences and journals. He has served in the program committees of different international conferences; he co-organized several international conferences, workshops and tutorials. Related to this tutorial, he is coordinating activities on “**Context Sensitivity**” within the NEON Integrated Project on “Networked Ontologies”. He presented tutorials at the following events:

- 5th European Conference on Principles and Practice of Knowledge Discovery in Databases (PKDD'01), Freiburg, Germany 2001 with the title: “**Tutorial on Text Mining: What if your data is made of words?**” (http://www.afia.polytechnique.fr/CAFE/ECML01/text_mining.html).
- PASCAL Network of Excellence Workshop on Text Classification (Grenoble January 2004): **Tutorial on Text Mining** (<http://www.pascal-network.org/Reports/Workshops/129/>)
- WWW2004 – ACM Conference on World Wide Web (NYC 2004) : **Tutorial on Text Mining approaches for Web Data** (<http://www2004.org/tutorial.htm>)
- ESWS2004 – European Conference on Semantic Web (Heraklion, Crete 2004): **Tutorial on Knowledge Discovery & the Semantic Web** (<http://www.esws2004.org/sub/tutorials.htm>)
- Workshop on Complex Object Visualizations (Koper 2005): **Tutorial on Text Visualization** (<http://www.iip.si/cov/>)
- ECML/PKDD 2005 – European Conference on Machine Learning (Porto 2005): **Tutorial on Ontology Learning from Text** (<http://ecmlpkdd05.liacc.up.pt/tutorials.html>)
- IJCAI2007 – International Joint Conference on Artificial Intelligence (Hyderabad 2007): **Tutorial on Text Mining and Link Analysis for Web and Semantic Web** (<http://www.ijcai2007.org/>)

Igor Mozetic is a senior associate at the Jozef Stefan Institute, Department of Knowledge Technologies. He has extensive international research and teaching experience (Fulbright scholar at the University of Illinois at Urbana-Champaign, visiting professor at George Mason University and at Technical University of Vienna, senior research fellow at Austrian Research Institute for Artificial Intelligence). His main research interests are in machine learning, logic-based knowledge representation and automated reasoning. He is currently working on context formalization and contextual mappings between ontologies, and is in the W3C Rule Interchange Format working group.

Related publication:

Mozetic, I., Bojadzic, D. Reasoning with temporal context in news analysis. Contexts and Ontologies workshop, ECAI-06, Aug. 2006.

Michael Witbrock serves as the Vice President for Research at Cycorp, Inc. He holds a PhD in Computer Science from Carnegie Mellon. At Cycorp, he has overall responsibility for corporate research, and is particularly interested in automating the process of knowledge acquisition and elaboration, extending the range of knowledge representation and reasoning to mixed logical and probabilistic representations, and in validating and elaborating knowledge in the context of task performance, particularly in tasks that involve understanding text and communicating with users. Prior to joining Cycorp, he was Principal Scientist at Terra Lycos, working on integrating statistical and knowledge based approaches to understanding web user behaviour; a research scientist at Just Systems Pittsburgh Research Center, working on statistical text summarization; and a systems scientist at Carnegie Mellon on the Informedia spoken and video document information retrieval project, where he was also involved in the planning of the Experience on Demand Project. He has held overall responsibility for the DARPA RKF Project (Acquiring knowledge from end users), the ARDA AQUAINT project (Question answering via natural language processing and inference), the ARDA NIMD project (improving performance on analytical tasks by modelling and recognizing analytical tasks, and proactively providing task related assistance), the DARPA BUTLER Project (learning rules for improved task performance from base cases in a large, diverse KB) the Vulcan Capital funded HALO project (deep inference for question answering) and the NIST funded StreamSage project (conceptual annotation of text) among others.

Peter Haase is a senior researcher at the Institute of Applied Informatics and Formal Description Methods (AIFB) at the University of Karlsruhe. Before joining the AIFB, he worked in the Silicon Valley Labs of IBM in the development of DB2 until 2003. His research interests include ontology management and evolution, decentralized information systems and Semantic Web. At the AIFB, he previously worked in the EU IST project SWAP (Semantic Web and Peer-to-Peer) and SEKT (Semantically Enabled Knowledge Technologies) and is now working as a project leader for the EU IST project NeOn (Lifecycle Support for Networked Ontologies). He was co-organizer of the Workshop on Ontologies in Peer-to-Peer Communities (OntoP2P) at ESWC 2005, Heraklion, and has held **prior tutorials** on reasoning in the Semantic Web,

including the latest ESWC2006 tutorial on "Practical Reasoning with OWL and DL-Safe Rules".

Pascal Hitzler is assistant professor and project leader at the Institute for Applied Informatics and Formal Description Methods (AIFB) at the University of Karlsruhe in Germany. His research record lists over 80 publications in such diverse areas as semantic web, neural-symbolic integration, knowledge representation and reasoning, lattice and domain theory, denotational semantics, and set-theoretic topology. He is currently writing a German textbook on Foundations of Semantic Web (jointly with York Sure). He leads AIFB's activities in the SmartWeb project funded by the German Ministry for Education and Research (BMBF), leads the ReaSem project funded by the German Research Council (DFG), contributes to several workpackages in the EU IST projects NeOn and X-Media, and in the EU Network of Excellence KnowledgeWeb. He has jointly **teaching** a number of well-received courses at summer-schools, including courses at the European Summer School on Logic, Language, and Information, ESSLLI-05 and ESSLLI-06, the Summer School on Computational Logic Dresden 2006, and the Interdisciplinary College IK2006 at G nnen. He has given/will **give joint tutorials** on Connectionist Knowledge Representation and Reasoning at the German Conference in Artificial Intelligence KI2005, on Reasoning with OWL and DL-safe Rules at ESWC06, and on Knowledge Technologies, Hybrid Approaches and Neural Networks at ICANN06. He has also been an organizer of and teacher at international enhancement programmes for highly skilled students in Mathematics and Computer Science, and has served as an editor for several books in this area. He serves as a reviewer for international journals, conferences, and research project applications.

A list of the support material to be given to tutorial attendees

All the participants will be given:

- Tutorial slides (paper version & electronic version)
- Technical Report on "*State-of-the-art in 'context' representations*" – NEON Project (<http://www.neon-project.org/>) deliverable, work in progress, will be finished by September 2006

A list of audio-visual or technical requirements

No special equipment needed. We expect: overhead projector, network connection.