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# The Semantic Web – ISWC 2012

11th International Semantic Web Conference  
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Proceedings, Part I

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# Preface

The Semantic Web has come a long way. What started as a vision of a machine-readable Web over ten years ago now consists of a vibrant community of researchers, practitioners, enthusiasts, companies, and, finally, users. Topics that were once cutting-edge research have now arrived in the mainstream and have even become part of political agendas. The sharing of public information in the form of linked data has become a major argument for the transparency of administrations, and institutions around the globe are putting their data online. Companies from various sectors such as the BBC, Google, IBM, or *The New York Times* release products that are based on Semantic Web technologies. Against all prophecies of failure, the Semantic Web is flourishing.

The International Semantic Web Conference is the premier forum for Semantic Web research, where cutting-edge scientific results and technological innovations are presented, where problems and solutions are discussed, and where the future of this vision is being developed. It brings together specialists in fields such as artificial intelligence, databases, social networks, distributed computing, Web engineering, information systems, human–computer interaction, natural language processing, and the social sciences for tutorials, workshops, presentations, keynotes, and sufficient time to have detailed discussions.

This volume contains the main proceedings of the 11th International Semantic Web Conference (ISWC 2012), which was held in Boston, USA, in November 2012. Even though the economic times are anything but easy we received tremendous response to our calls for papers from a truly international community of both researchers and practitioners. Every paper was thoroughly evaluated following practices appropriate for its track and its evaluation measure. The breadth and scope of the papers finally selected for inclusion in this volume speak to the quality of the conference and to the contributions made by researchers whose work is presented in these proceedings. As such, we were all honored and proud that we were invited to serve the community in the stewardship of this edition of ISWC.

The Research Track of the conference attracted 186 submissions, 41 of which were accepted, resulting in a 22% acceptance rate. Each paper received at least three, and sometimes as many as five, reviews from members of the Program Committee. After the first round of reviews, authors had the opportunity to submit a rebuttal, leading to further discussions among the reviewers, a meta-review and a recommendation from a member of the Senior Program Committee (SPC). The SPC held a 10-hour virtual meeting in order to select the final set of accepted papers, paying special attention to papers that were borderline or had at least one recommendation for acceptance. In many cases, additional last-minute reviews were sought out to better inform the SPC's decision.

As the Semantic Web develops, we find a changing variety of subjects that emerge. This year the keywords of accepted papers were distributed as follows (frequency in parentheses): knowledge representation and reasoning (13), querying the Semantic Web and database technologies (10), ontology engineering (7), machine learning and information extraction (7), data mining and analysis (6), ontology mapping (6), linked data (5), languages, tools and methodologies (4), interacting with Semantic Web data (4), instance mapping (4), evaluation (4), social and emergent semantics (4), cleaning, assurance, and provenance (4), search and information retrieval (3), federated/distributed systems (3), scalable systems (3), Semantic Web services (3), exploiting the social Web (3), knowledge acquisition (2), natural language processing (2), query languages (2), uncertainty (2), modeling users and contexts (2), semantic streams and sensors (2), ontology learning (1), user interfaces (1), mashing up data and processes (1), trust, privacy and security (1), and personalized access (1).

This edition of the International Semantic Web Conference marks the introduction of the Evaluations and Experiments Track. The goal of this track is to consolidate research material and to gain new scientific insights and results by providing a place for in-depth experimental studies of significant scale. It aims at promoting experimental evaluations in Semantic Web/Linked Data domains where availability of experimental datasets and reproducibility of experiments are highly important.

The Evaluations and Experiments track received 35 submissions from all areas of the Semantic Web: including reasoning, querying, searching, matching, and annotating. Papers were of two main categories, namely, evaluation (comparing several approaches to a problem) and corpus analysis. To our surprise, testing a hypothesis through an experiment was not explicitly considered. We also received very few papers aiming at reproducing existing experiments. Eight papers were accepted, corresponding to a 23% acceptance rate. Each paper was reviewed by at least three members of the Program Committee paying special attention to the reproducibility criteria. In spite of the limited number of accepted papers, they address a large range of areas, such as linked stream data, federated query processing, tag recommendation, entity summarization, and OWL reasoning.

The Semantic Web In-Use Track received 77 submissions. At least three members of the In-Use Program Committee provided reviews for each paper. Seventeen papers were accepted – a 22% acceptance rate. The large number of submissions this year demonstrated the increasingly diverse breadth of applications of Semantic Web technologies in practice. The papers demonstrated how semantic technologies are applied in a variety of domains, including eGovernment, smart cities, biomedicine, or question answering. Several papers dealt with applying reasoning for a variety of use cases, while others dealt with streaming data and

processing complex events. A number of infrastructure papers contributed to the state of art for Linked Open Data and for querying large data sets. Very exciting application papers demonstrated how semantic technologies are applied in diverse ways, starting from using linked data in mobile environments to employing full-fledged artificial intelligence methods in real-time use cases.

The Doctoral Consortium is a key event at the ISWC conference. PhD students in the Semantic Web field get an opportunity to present their thesis proposals and to interact with leading academic and industrial scientists in the field, who act as their mentors. Out of 21 submissions to the Doctoral Consortium, six were accepted as for presentation at the conference. For discussion at the special Consortium-only session on 12 November, nine additional proposals were selected. The Doctoral Consortium day is organized as a highly interactive event, in which students present their proposals and receive extensive feedback and comments from the mentors as well as from their peers.

A unique aspect of the ISWC conference is the Semantic Web Challenge, now in its 10th year, with the goal of demonstrating practical progress toward achieving the vision of the Semantic Web. Organized this year by Diana Maynard and Andreas Harth, the competition enables practitioners and scientists to showcase leading-edge real-world applications of Semantic Web technology.

The keynote talks given by leading scientists or practitioners in their field further enriched the ISWC program. Thomas W. Malone, the director of the Center for Collective Intelligence at the Massachusetts Institute of Technology, discussed the phenomenon of collective intelligence and how it interrelates with the Semantic Web. Jeanne Holm, an evangelist for data.gov, discussed the changing global landscape of data sharing and the role the Semantic Web is playing in it. Mark Musen, a professor of medicine of the Stanford Center for Biomedical Informatics Research, discussed how the fundamental challenges of AI are still with us and await embracing to fulfill the vision of the Semantic Web. And last but not least, Nigel Shadbolt, Deputy Head of the School of Electronics and Computer Science at the University of Southampton, gave a lively dinner talk.

As in previous ISWC editions, the conference included an extensive Tutorial and Workshop program. Claudia d'Amato and Thomas Scharrenbach, the Chairs of this track, selected a stellar and diverse collection of 9 tutorials and 18 workshops, where the only problem that the participants faced was which of the many exciting workshops to attend. Workshops and tutorials were chosen on the ground of two different but complementary criteria: maintaining the history of the most promising, challenging, and highly attended workshops such as the Ontology Matching Workshop, the Consuming Linked Data Workshop, the Ontology Patterns Workshop, or the Uncertainty Reasoning for the Semantic Web Workshop and highlighting the attention on new, challenging, and visionary research trends as testified by the Programming the Semantic Web Workshop, the Semantic Sensor Network Workshop, the Web of Linked Entities Workshop, the Semantic Technologies Applied to Biomedical Informatics and Individualized Medicine Workshop, the Web of Data for E-Commerce Tutorial, the Machine Learning for Linked Data Tutorial, the Linked Data for Development Tutorial, or

the Financial Information Management using the Semantic Web Tutorial. Also, particular attention was dedicated to the heterogeneity and scalability issues and related aspects, which explains the choice of the Workshop on Large and Heterogeneous Data and Quantitative Formalization in the Semantic Web, the Tutorial on RDF Query Processing in the Cloud, and the Tutorial on Scalable Semantic Processing of Hodge, Distributed Real-Time Streams.

We would like to thank Birte Glimm and David Huynh for organizing a lively Poster and Demo Session. As in 2011, the Posters and Demos were introduced in a Minute Madness Session, where every presenter got 60 seconds to provide a teaser for their poster or demo.

Ivan Herman, Tom Heath, and Tim Berners-Lee coordinated a top-flight Industry Track where end-users of Semantic Web and Linked Data technologies shared their “warts and all” experiences with the research community. The track attracted presentations from enterprises of all scales, from startups through to software, hardware, and retail giants such as Oracle, Cray, Cisco, EMC, and BestBuy.

We are indebted to Eva Blomqvist, our Proceedings Chair, who provided invaluable support in compiling the volume that you now hold in your hands (or see on your screen) and exhibited superhuman patience in allowing the other Chairs to stretch deadlines to the absolute limits. Many thanks to Jen Golbeck, the Fellowship Chair, for securing and managing the distribution of student travel grants and thus helping students who might not have otherwise attended the conference to come to Boston. Peter Mika and David Wood were tireless in their work as Sponsorship Chairs, knocking on every conceivable virtual “door” and ensuring an unprecedented level of sponsorship this year. We are especially grateful to all the sponsors for their generosity.

As has been the case in the past, ISWC 2012 also contributed to the linked data cloud by providing semantically annotated data about many aspects of the conference. This contribution would not have been possible without the efforts of Li Ding our Metadata Chair. Oshani Seneviratne, our Publicity Chair, was tirelessly twittering and sending old-fashioned (and highly appreciated) announcements on the mailing lists, creating far more lively “buzz” than ISWC ever had.

Our very special thanks go to the Local Organization Team, led by Lalana Kagal. She did an outstanding job of handling local arrangements, thinking of every potential complication way before it arose, often doing things when members of the Organizing Committee were only beginning to think about asking for them. We managed to juggle so many balls, that some of us were dizzy just looking at it. Special thanks go to the staff of MIT conference services – Cathi Di Iulio Levine, Nicole Silva, Lynne Alyson Lenker, and Eva Cabone – for their enormous resourcefulness, foresight, and anticipation of the conference needs and requirements. Also many thanks for the designers at the University of Zurich Multimedia and e-Learning Services, who provided all the design work often going beyond the call of any duty.

Finally, we would like to thank all members of the ISWC Organizing Committee not only for handling their tracks superbly, but also for their wider contribution to the collaborative decision-making process in organizing the conference.

September 2012

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# Driving Innovation with Open Data and Interoperability

## (Keynote Talk)

Jeanne Holm

Data.gov, U.S. General Services Administration  
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### **Abstract**

Data.gov, a flagship open government project from the US government, opens and shares data to improve government efficiency and drive innovation. Sharing such data allows us to make rich comparisons that could never be made before and helps us to better understand the data and support decision making. The adoption of open linked data, vocabularies and ontologies, the work of the W3C, and semantic technologies is helping to drive Data.gov and US data forward. This session will help us to better understand the changing global landscape of data sharing and the role the semantic web is playing in it.

This session highlights specific data sharing examples of solving mission problems from NASA, the White House, and many other governments agencies and citizen innovators.

# The Semantic Web and Collective Intelligence

## (Keynote Talk)

Thomas Malone

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### **Abstract**

The original vision of the Semantic Web was to encode semantic content on the web in a form with which machines can reason. But in the last few years, we've seen many new Internet-based applications (such as Wikipedia, Linux, and prediction markets) where the key reasoning is done, not by machines, but by large groups of people.

This talk will show how a relatively small set of design patterns can help understand a wide variety of these examples. Each design pattern is useful in different conditions, and the patterns can be combined in different ways to create different kinds of collective intelligence. Building on this foundation, the talk will consider how the Semantic Web might contribute to—and benefit from—these more human-intensive forms of collective intelligence.

# Tackling Climate Change: Unfinished Business from the Last “Winter” (Keynote Talk)

Mark A. Musen

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## Abstract

In the 1990s, as the World Wide Web became not only world wide but also dense and ubiquitous, workers in the artificial intelligence community were drawn to the possibility that the Web could provide the foundation for a new kind of AI. Having survived the AI Winter of the 1980s, the opportunities that they saw in the largest, most interconnected computing platform imaginable were obviously compelling. With the subsequent success of the Semantic Web, however, our community seems to have stopped talking about many of the issues that researchers believe led to the AI Winter in the first place: the cognitive challenges in debugging and maintaining complex systems, the drift in the meanings ascribed to symbols, the situated nature of knowledge, the fundamental difficulty of creating robust models. These challenges are still with us; we cannot wish them away with appeals to the open-world assumption or to the law of large numbers. Embracing these challenges will allow us to expand the scope of our science and our practice, and will help to bring us closer to the ultimate vision of the Semantic Web.

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