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The Semantic Web – ISWC 2018

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Preface

Now in its 17th year, the ISWC continues to be a focal point of the Semantic Web community. Year after year, it brings together researchers and practitioners from all over the world to present new approaches and findings, share ideas, and discuss experiences. It features a balanced mix of fundamental research, innovative technology, scientific artefacts such as ontologies or benchmarks, and applications that showcase the power of semantics, data, and the Web.

The Web, and all the ideas, technologies, and values that surround it, are at a crossroads. After several decades of growth and prosperity, it is increasingly seen as a means to lock-in customers and their data, spread misinformation, and increase polarization in society. At the same time, there is a palpable sense of excitement as we witness new voices and developments from the community that are fighting this trend in various ways – from more open and transparent forms of scholarly publishing and peer review in some of the workshops featured at the conference to cutting-edge research and applications on topics such as fake news, semantic coherence, and fact checking. Against this background, this year we decided to revive the Blue Sky Ideas track, chaired by Carolina Fortuna and supported by the Computing Community Consortium, to seek visionary ideas and opportunities for research and innovation, which are outside the mainstream topics of the conference.

A child of its times, the 17th ISWC featured a stellar, all-female keynote lineup: Jennifer Golbeck from the University of Maryland talked about human factors in semantic technologies; Vanessa Evers, University of Twente, introduced us to social robotics, an area with interesting applications for the models and technologies developed in our community; while Natasha Noy of Google discussed how we could use semantics to make structured data on the web more accessible and useful for everyone.

This volume contains the proceedings of ISWC 2018, i.e. papers that were peer reviewed and accepted into the main conference program, which covered three tracks: research, resources, and in-use. Altogether, a total of 254 submissions were received, which were evaluated by 486 reviewers. A total of 62 papers were accepted – 39 for the research track, 17 for the resources track, and six for the in-use track. The substantial number of papers in the resources category attests the commitment of the community to sharing and collaboration and to repeatable, reproducible research.

ISWC has an excellent scientific profile – as such, the research track continues to be the most popular venue for submissions. This year the track received overall 167 valid full-paper submissions, which turned into 39 acceptances, leading to an acceptance rate of 23%. We recruited 272 PC members and 67 sub-reviewers, guided by 17 senior PC members. Each paper received at least four reviews, including one from a senior PC member. The papers were assessed for originality, novelty, relevance, and impact of the research contributions, soundness, rigour and reproducibility, clarity and quality of presentation, and grounding in the literature. Each paper was then discussed by the PC chairs and the senior PC members, who helped us reach a consensus.

The resources track promotes the sharing of high-quality information artifacts that have contributed to the generation of novel scientific work. Resources can be datasets, ontologies, vocabularies, ontology design patterns, benchmarks, crowdsourcing designs, software frameworks, workflows, protocols, metrics, among others. The track is becoming demonstratively more and more important to our community as the sharing of reusable resources is key to allowing other researchers to compare new results, reproduce experimental research, and explore new lines of research, in accordance with the FAIR principles for scientific data management. All published resources must address a set of requirements: persistent URI, canonical citation, license specification, to mention a few. This year the track received 55 submissions, of which 17 were accepted (31% acceptance rate), covering a wide range of resource types such as benchmarks, ontologies, datasets, software frameworks, and crowdsourcing designs; a variety of domains such as music, health, education, drama, and audio; and addressing multiple problems such as RDF querying, ontology alignment, linked data analytics, and recommending systems. The reviewing process involved 70 PC members and 9 subreviewers, supported by 8 senior PC members. The average number of reviews per paper were 3.7 (at least three per paper), plus a meta-review provided by a senior PC member. Papers were evaluated based on the availability of the resource, its design and technical quality, impact, and reusability. The review process also included a rebuttal phase and further discussions among reviewers and senior PC members, who provided recommendations. Final decisions were taken following a detailed analysis and discussion of each paper conducted by the program chairs and the senior PC.

The in-use track at ISWC 2018 continued the tradition of demonstrating and learning from the increasing adoption of Semantic Web technologies outside the boundaries of research institutions, by providing a forum for the community to explore the benefits and challenges of applying these technologies in concrete, practical applications, in contexts ranging from industry to government and science. This year, the 32 submissions were reviewed by at least three PC members each and assessed in terms of novelty of the proposed use case or solution, uptake by the target user group, demonstrated or potential impact, as well as the overall soundness and quality. The PC consisted of 43 members. It helped us select 6 papers for acceptance, covering different domains (e.g., healthcare, cultural heritage, industry) and addressing a multitude of research problems (e.g., data integration, collaborative knowledge management, recommendations).

The industry track provides an opportunity for industry adopters to highlight and share the key learnings and new research challenges posed by real-world implementations. This year we had many exciting submissions from small to large companies that are making revealing leaps forward in science and engineering by using and adopting semantic technologies, web of data sources, and knowledge graphs. Each short submission was reviewed by at least three PC members. We accepted 14 out 27 abstracts that showcased a wide range of real-world industrial strength applications. The submissions were assessed in terms of the impact of semantics as a competitive differentiator in industry and discussions on the business value, experiences, insights, as well obstacles that stand in the way of large-scale adoption of semantic technologies.

The main conference program was complemented by presentations from the journal, industry, and posters and demos tracks, as well as the Semantic Web Challenge and a panel on future trends in knowledge graphs.

The conference included a variety of events appreciated by the community, which created more opportunities to present and discuss emerging ideas, network, learn, and mentor. Thanks to Amrapali Zaveri and Elena Demidova, the workshops and tutorials program includes a mix of established topics such as ontology matching and ontology design patterns alongside newer ones that reflect the commitment of the community to innovate and help create systems and technologies that people want and deserve, including re-decentralizing the Semantic Web, augmenting intelligence with humans in the loop, and a perspective workshop discussing open issues and trends. Application-centric workshops range from statistics to science to healthcare. The tutorials covered topics such as ontology modeling, crowdsourcing methods and metrics, RDF data validation and visualization, as well as knowledge graph machine learning and applications.

The conference also included a Doctoral Consortium track, which was chaired by Lalana Kagal and Sabrina Kirrane. The DC afforded PhD students from the Semantic Web community the opportunity to share their research ideas in a critical but supportive environment, where they received feedback from senior members of the community. This year the Program Committee accepted 12 papers for presentation at the event, while a total of 18 students were selected to participate in the DC poster and demo session. All student participants were paired with mentors from the PC who provided guidance on improving their research, producing slides, and giving presentations.

The program was complemented by activities put together by Bo Fu and Anisa Rula as student coordinators, who secured funding for travel grants, managed the grant application process, and organized the mentoring lunch alongside other informal opportunities for students and other newcomers to get to know the community.

Posters and demos are one of the most vibrant parts of every ISWC. This year, the track was chaired by Marieke van Erp and Medha Atre. It included 40 demos and 39 posters selected from a total of 95 submissions. A minute madness session offered time to those who wanted to take to the stage to present a brief preview of their poster or demo to generate interest in the work.

The Semantic Web Challenge has now been a part of ISWC for 15 years. Started as an open challenge to provide a forum for new and prestigious applications of Semantic Web technologies, and seconded by a challenge for scalability with the Billion Triple Challenge since 2003, the challenge was reanimated in 2017 with a new direction, with fixed datasets, and objective measures allowing for direct comparison of challenge entries. The 2018 challenge used a partly public, partly private knowledge graph about company networks owned by Thomson Reuters, and participants were asked to predict supply chain relations between those companies, using both knowledge in the graph itself as well as external sources. The best solutions were presented and discussed at the conference, both in a dedicated plenary session as well as during the poster session.

Delivering a conference is so much more than assembling a program. An event of the scale and complexity of ISWC requires the help, resources, and time of hundreds of people, organizers of satellite events, reviewers, volunteers, and sponsors. We are very grateful to our local team at Stanford University, who have expertly managed

conference facilities, accommodation, registrations, the website, and countless other details. They made the conference a place we want to be every year and helped us grow this exciting scientific community.

Our thanks also go to Maribel Acosta, our tireless publicity chair – she played a critical role in ensuring that all conference activities and updates were communicated and promoted across mailing lists and on social media. Oana Inel was the metadata chair this year – her work made sure that all relevant information about the conference was available in a format that could be used across applications, continuing a tradition established at this conference many years ago. We are especially thankful to our proceedings chair, Lucie-Aimée Kaffee, who oversaw the publication of this volume alongside a number of CEUR proceedings for other tracks.

Sponsorship is crucial to the realization of the conference in its current form. We had a highly committed trio of sponsorship chairs, Annalisa Gentile, Maria Maleshkova, and Laura Koesten, who went above and beyond to find new ways to engage with sponsors and promote the conference to them. Thanks to them, the conference now features a social program that is almost as exciting as the scientific one – including a jam session accompanying the posters and demos presented on the second day of the conference and a bike ride from San Jose to Asilomar, the venue of the conference. Our special thanks go to the Semantic Web Science Association (SWSA) for their continuing support and guidance and to the organizers of the conference from 2017 and 2016, who were a constant inspiration, role model, and source of practical knowledge.

August 2018

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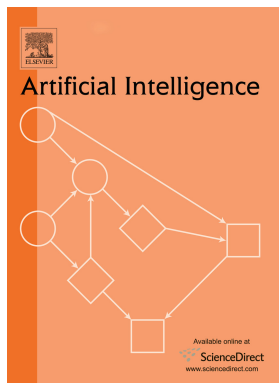
Tutorials

ISWC 2018 Workshop
and Tutorial Chairs' Welcome

Besides the main technical program, ISWC 2018 hosts a selection of workshops and tutorials on a range of emerging and established topics. The key areas addressed by the workshop and tutorial programme include core Semantic Web technologies such as knowledge graphs and scalable knowledge base systems, ontology design and modelling, semantic deep learning and statistics, and well as novel applications of semantic technologies to audio and music, IoT, robotics, healthcare, social media and social good topics. Furthermore, several events address the topics on the interface of Semantic Web technologies and humans, including visualization and interaction paradigms for Web Data as well as crowdsourcing applications. The workshops and tutorials provide a setting for focused, intensive scientific exchange among researchers and practitioners in a variety of formats.

The decision on acceptance of workshops and tutorial proposals was made on the basis of their overall quality and their appeal to a reasonable fraction of the Semantic Web community while also targeting diversity of the programme. Overall, we received 31 workshop and tutorial proposals, of which 8 were accepted as full-day events and 17 as half-day events. The full workshop and tutorials programme is available at: http://iswc2018.semanticweb.org/workshops-tutorials.

We would like to take this opportunity to thank the workshop and tutorial organizers for their invaluable and inspiring contributions to the ISWC 2018 programme. We look forward to seeing you in Monterey!

March 2018

Elena Demidova
Amrapali Zaveri
Workshop & Tutorial Chairs

Methods and Tools for Modular Ontology Modeling

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Ontology design patterns and other methods for modular ontology engineering have recently experienced a revival, and several new promising tools and techniques have been presented. The use of methods for modular ontology development and these newly developed tools and technologies promise simpler ontology development and management, in turn furthering increased adoption of ontologies and ontology-based tech, both within and outside of the semantic web academic environment. This workshop intends to spread the word about these method and tooling improvements beyond "the usual crowd"of pattern developers and researchers, for the benefit of the Semantic Web research community as a whole.

This full-day tutorial targets ontology designers, data publishers, and software developers interested in employing semantic technologies and ontologies. We present the state-of-the-art in terms of methods and tools, exemplifying their usage in several real-world cases. We then tutor the attendees on the use of three sets of related tooling for modular ontology development, allowing them to try out leading-edge software that they might otherwise have missed, under the supervision of the tools' main developers. We expect that at the end of the day, the attendees will have developed the ability to independently and with confidence develop ontologies in a modular fashion, using the tools and techniques showcased in this tutorial.

Validating RDF Data Tutorial

Jose Emilio Labra Gayo[1] and Iovka Boneva[2]

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RDF promises a distributed database of repurposable, machine-readable data. Although the benefits of RDF for data representation and integration are indisputable, it has not been embraced by everyday programmers and software architects who care about safely creating and accessing well-structured data. Semantic web projects still lack some common tools and methodologies that are available in more conventional settings to describe and validate data. In particular, relational databases and XML have popular technologies for defining data schemas and validating data which had no analog in RDF.

Two technologies have been proposed for RDF validation: Shape Expressions (ShEx) and Shapes Constraint Language (SHACL).

ShEx was designed as an intuitive and human-friendly high level language for RDF validation in 2014 [4]. ShEx 2.0 has recently been proposed by the W3C ShEx community group [3].

SHACL was proposed by the Data Shapes Working Group and accepted as a W3C Recommendation in July 2017 [1].

In this tutorial we will present both ShEx and SHACL using examples, presenting the rationales for their designs, a comparison of the two, and some example applications. The contents of the tutorial will be complemented by the *Validating RDF Data* book [2] written by the presenters.

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Hybrid Techniques for Knowledge-Based NLP - Knowledge Graphs Meet Machine Learning and All Their Friends

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Many different artificial intelligence techniques can be used to explore and exploit large document corpora that are available inside organizations and on the Web. While natural language is symbolic in nature and the first approaches in the field were based on symbolic and rule-based methods, like ontologies, semantic networks and knowledge bases, many of the most widely used methods are currently based on statistical approaches. Each of these two main schools of thought in natural language processing, knowledge-based and statistical, have their limitations and strengths and there is an increasing trend that seeks to combine them in complementary ways to get the best of both worlds. This tutorial covers the foundations and modern practical applications of knowledge-based and statistical methods and techniques as well as their combination for the exploitation of large document corpora. Following a practical and hands-on approach, the tutorial tries to address a number of fundamental questions to achieve this goal, including: (i) how can machine learning extend previously captured knowledge explicitly represented as knowledge graphs in cost-efficient and practical ways, (ii) what are the main building blocks and techniques enabling such hybrid approach to natural language processing, (iii) how can structured and statistical knowledge representations be seamlessly integrated, (iv) how can the quality of the resulting hybrid representations be inspected and evaluated, and (v) how can this improve the overall quality and coverage of our knowledge graphs. The tutorial will first focus on the foundations that can be used to this purpose, including knowledge graphs and word embeddings, and will then show how these techniques can be effectively combined in NLP tasks (and other data modalities in addition text) related to research and commercial projects where the instructors currently participate.

Building Enterprise-Ready Knowledge Graph Applications in the Cloud

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Knowledge Graphs are a powerful tool that changes the way we do data integration, search, analytics, and context-sensitive recommendations. Consisting of large networks of entities and their semantic relationships, they have been successfully utilized by the large tech companies, with prominent examples like the Google Knowledge Graph and Wikidata, which makes community-created knowledge freely accessible. Cloud computing has fundamentally changed the way that organizations build and consume IT resources, enabling services to be provisioned on-demand in a pay-as-you-go model. Building Knowledge Graphs in the cloud makes it easy to leverage their powerful capabilities quickly and cost effectively.

In this tutorial, we cover the fundamentals of building Knowledge Graphs in the cloud. In comprehensive hands-on exercises we will cover the end-to-end process of building and utilizing an open Knowledge Graph based on high-quality Linked Open Data sets, covering all aspects of the Knowledge Graph life cycle including enterprise-ready data management, integration and interlinking of sources, authoring, exploration, querying, and search. The hands-on examples will be performed using prepared individual student accounts set up in the AWS cloud, backed by an RDF/SPARQL graph database service with an enterprise Knowledge Graph application platform deployed on top.

Crowdsourcing with CrowdTruth
Harnessing Disagreement in Human Interpretation for Ambiguity-Aware Machine Intelligence

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In this tutorial, we introduce the *CrowdTruth methodology* for crowdsourcing ground truth by harnessing and interpreting inter-annotator disagreement. CrowdTruth is a widely used crowdsourcing methodology[1] adopted by industrial partners and public organizations, e.g. Google, IBM, New York Times, The Cleveland Clinic, Crowdynews, The Netherlands Institute for Sound and Vision, Rijksmuseum, and in a multitude of domains, e.g. AI, news, medicine, social media, cultural heritage, social sciences. The central characteristic of CrowdTruth is *harnessing the diversity in human interpretation* to capture the wide range of opinions and perspectives, and thus, provide more reliable and realistic real-world annotated data for training and evaluating machine learning components. Unlike other methods, we do not discard dissenting votes, but incorporate them into a *richer and more continuous representation of truth*. The goal of this tutorial is to introduce the Semantic Web audience to a *novel approach to crowdsourcing* that takes advantage of the diversity of opinions (human semantics) inherent to the Web. We believe it is quite timely, as methods that deal with disagreement and diversity in crowdsourcing have become increasingly popular. Creating this more *complex notion of truth* contributes directly to the larger discussion on *how to make the Web more reliable, diverse and inclusive*.

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[1] http://crowdtruth.org.

Challenges and Opportunities with Big Linked Data Visualization

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The Linked Data Principles defined by Tim-Berners Lee promise that a large portion of Web Data will be usable as one Big interlinked RDF database. Today, we are assisting at a staggering growth in the production and consumption of Linked Open Data (LOD). In this scenario, it is crucial to provide intuitive tools for researchers, domain experts, but also businessmen and citizens to view and interact with increasingly large datasets. Visual analytics integrates the analytic capabilities of the computer and the abilities of the human analyst, allowing novel discoveries and empowering individuals to take control of the analytical process.

This tutorial aims to identify the challenges and opportunities in the representation of Big Linked Data by reviewing some current approaches for exploring and visualizing LOD sources. First, we introduce the problem of finding relevant sources in catalogues of thousands of datasets, we present the issues related to the understanding and exploration of unknown sources. We list the difficulties to visualize large datasets in static or dynamic form. We focus on the practical use of LOD/ RDF browsers and visualization toolkits and examine the support at big scale. In particular, we experience the exploration of some LOD datasets by performing searches of growing complexity. At last, we sketch the main open research challenges with Big Linked Data visualization. By the end of the tutorial, the audience will be able to get started with their own experiments on the LOD Cloud, to select the most appropriate tool for a defined type of analysis and they will be aware of the open issues that remain unsolved in the scenario of the exploration of Big Linked Data.

Contents–Part I

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In-Use Track