Preface to Semantic Web Technologies for Mobile and Pervasive environments

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Abstract. Artificial Intelligence provides a rich set of methods and tools for implementing the Ambient Intelligence vision, i.e. to transform our environments into smart spaces assisting as with our everyday tasks in an intelligent, seamless and non-obtrusive way. Among them, Semantic Web technologies, such as RDF, ontology languages and others, can be used to address several of the challenges that come with this vision, mainly with respect to modelling, sharing and reasoning with context information. This thematic issue demonstrates their capabilities by presenting three different Semantic Web-based solutions for mobile and computing environments.

Keywords. Ambient Intelligence, Pervasive Computing, Mobile Computing, Semantic Web Technologies

1. Introduction to Reflections and Advances in Ambient Intelligence

Pervasive and mobile technologies are among the leading computing paradigms of the future. Transitioning from the world of personal computing, powerful, compact devices are distributed over the user's environment, enabling the contextualized enrichment of business processes with the ability to sense, process and combine data, and transforming the environment into a smart space [1]. This interconnection of devices, machines and users enables the dynamic generation, analysis and communication of multiple data types so that the operational efficiency and effectiveness of existing business processes are increased. However, the integration of devices and services to deliver intelligent solutions, in the so-called Internet of Things (IoT), has only been partially addressed, but yet imposes further challenges, relevant to the heterogeneity of communication protocols and interfaces, context-awareness in a scalable streaming manner, integration, scalability and applicability in various pervasive domains such as health, security, environment and more.

The rapid increase in the number of network-enabled devices and sensors deployed in physical environments, enriched with information processing capabilities, has allowed the interconnection of people, processes, data and devices, offering enormous potentials across many sectors. The large societal and personal impact of pervasive, mobile and interconnected entities in the web, is already apparent in health, security, environmental, agriculture and retail applications [2].

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This thematic issue aims to demonstrate how Semantic Web technologies can be used to address some of the emerging challenges [3], appraising their benefits and limitations in concurrent applications. Three articles are presented, which approach these themes from different angles, including scalability and streaming sensor data, tools for domain experts, ontologies in mobile network analysis, wearable sensors and biomedical applications. The articles are extended versions of selected papers from the 1st international workshop on Semantic Web technologies for Mobile and Pervasive Environments (SEMPER) 2016, which took place in Heraklion, Greece [4].

2. Outline of the Thematic Issue

Following a bottom-up perspective, the issue begins with a paper that focuses on the network infrastructure of a pervasive computing environment. The first paper, entitled **"Combining Ontological Modelling and Probabilistic Reasoning for Network Management**" presents a system for mobile and wireless network management in the context of the Internet of Things. The system incorporates a mobile network simulator, which combines a Markov Logic Network (MLN) model with an OWL2 ontology to describe both domain properties (networks cell) and engine properties (MLN rules). Most importantly, the system provides user-friendly GUI (Graphical User Interface) front-end that enables interactive, visual exploration of the network's properties. Both tabular and graph views are available to examine the MLN reasoning outcomes. Experiments in the paper include a network optimization experiment as well as proof-of-concept scenarios on how the GUI aids problematic cell detection and cell re-configuration outcomes.

The second paper considers a higher-level application, of how domain experts can surf streaming sensor data. Much like the first paper, the paper entitled **"Querying Industrial Stream-Temporal Data: an Ontology-based Visual Approach**", empowers domain experts without prior programming knowledge with a GUI to visually carry out tasks in pervasive environments. Most importantly, this application focuses greatly on industrial applications, bridging the gap between research and practice. The paper acknowledges the rich expressive capabilities of ontologies as semantic rich conceptual domain models and the current inability of domain experts to leverage them. It, therefore, introduces a visual query system (VQS), namely OptiqueVQS, that allows formulating queries using ontological terms. The query is consequently translated into database terms (e.g. SQL) and executed. OptiqueVQS is extended to support the stream-temporal language STARQL, relevant to pervasive applications. An industrial use case scenario extensively demonstrates the usefulness of the proposed language in monitoring appliances at an enterprise scale. User evaluation was carried out in terms of task completion time and written feedback.

Moving on to a high-level application, the third paper demonstrates how Semantic Web technologies can enhance biomedical and e-health applications. The paper entitled **"Semantic Representation and Processing of Hypoglycemic Events Derived from Wearable Sensor Data"** shows how Semantic Web technologies can greatly aid the representation, reasoning and interpretation of complex data for real-life IoT applications. Wearables are employed for non-invasive monitoring of hypoglycemic events in the context of diabetes. To begin with, a wearable sport-bell provides a raw ECG (electrocardiogram), accelerometer (movement) and breathing wave signals which are transformed to physiological symptoms and energy expenditure aspects such

as activities and food/insulin intake via machine learning. However, a second layer of interoperability and intelligence is installed using semantic technologies. The events are represented with a new upper level ontology extending well-known ones, while the semantic information can now interpreted to detect hypoglecemic events via querying the stream of events.

3. Epilogue

The guest editors of this thematic issue would like to thank the authors who contributed articles to the 1st International Workshop on Semantic Web Technologies for Mobile and Pervasive Environments, SEMPER 2016, and to this thematic issue as well as the reviewers. Beyond their individual contributions, the papers highlight emerging trends as they share aspects such as streaming data support capabilities, scalability evaluation and the need for user-friendly visual tools to support domain experts. Most importantly, they prove the importance of Semantic Web technologies playing a crucial role in mobile, pervasive and Ambient Intelligence systems, not only in theoretical, lab-based applications but also in practice, effectively representing streaming sensor data and being integrated in high-level applications such as those in the health and biomedical domains. We believe that such pervasive applications will shape the future of many sectors such as manufacturing, transportation, government and medical care with the Semantic Web technologies at heart, and are looking forward to such developments, through fruitful Ambient Intelligence, mobile and pervasive systems research.

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