A Semantic Meta-Modelling Approach for Smart Government: Service Discovery Based on Conceptual Structures

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ABSTRACT

The main objective of many e-government solutions is establishing smart government through developing user oriented, integrated and interoperable services. However, the heterogeneous and distributed nature of public administrations and the limit of traditional service discovery approaches does not enable achieving efficiently this objective. Rather achieving semantic interoperability through the development of shared e-government knowledge can be the key to smart government. As its main contribution, this paper presents a semantic modelling approach of data and public services, and a service discovery approach for building smart government applications. Our approach uses both semantic web services and conceptual structures technologies. Applying these technologies was shown to have an extremely high potential impact in smart government development. They enabled the improvement of the data and services description, of multiple resources, with additional semantic information, which allowed an automatic processing of information and services.

KEYWORDS
Conceptual Graphs, Conceptual Structures, E-government, Knowledge Base, Ontology, Technologies, Smart government

INTRODUCTION

The early objective of e-government is “utilizing the Internet and the world-wide-web for delivering government information and services to citizens” (UN/ASPA, 2001). With the evolution of technologies, this objective has been transformed to the challenge of smart government (Harsh & Ichalkaranje, 2015), which means well defining public services, understanding clearly users requirements, and then helping them to find easily the appropriate services that best matches their interests. However, the Public Administrations (PAs) area is a large, heterogeneous and distributed environment where information, services and processes have been produced without central control or sharing knowledge. These lacks, with the great increase of the number of published services, have generated difficulties for developing smart applications in the context of e-government (Vitvar, Peristera, et al. 2010). For this purpose, the main objective beyond smart government is “the implementation of a set of business processes and underlying information technology capabilities that enable information to flow seamlessly across government agencies ... providing high quality citizen services across all government programs and activity domains”, (Rubel, 2011). Accordingly, implementing Trans-PAs
services, improving information exchange between PAs and enterprises as well as citizens, sharing knowledge, developing flexible and efficient intelligent processing mechanisms (e.g., discovery) and using appropriate technologies, such as semantic technologies (Berners-Lee Hendler et al., 2001) and conceptual structures (CSs) Sowa (1984), are the key to smart government. The main idea of semantic technologies is to enrich data and public services description with semantic information (i.e., meaning of information), which allows an automatic processing of services and an exchange of comprehensive and understandable information between involved parties and thus facilitating service integration and cooperation (Peristeras et al., 2010; Consoli & al., 2015).

Moreover, with linking and structuring the knowledge (data, services, users, etc.), inter/relationships can be quickly understood and service discovery tasks can be more efficient and flexible. In this context, the underlying semantic technologies that we have used are semantic web services (SWS) and ontologies. Indeed, SWS technologies are an extension of the current web service technology by adding a semantic level that improves the automation level of service usage tasks (e.g., flexible integration and discovery) (Cardoso, 2007). Ontology constitutes the cornerstone of SWS development; it “constitutes a domain knowledge that the domain members agree to follow for describing their domain concepts” (Peristeras et al., 2010). In the literature, many SWS ontologies have been developed, such as OWL-S (Ontology Web Languages for services) (Martin et al., 2004) and WSMO (Web service Modelling Ontology) (Fensel et al., 2006). Both ontologies describe services unambiguously by providing meta-data descriptions for web services, including mapping service properties (e.g., input and output) to common concepts. The concepts are defined in ontologies (Gruber, 1993). However, this semantic definition of concepts or services does not entail semantic meaningfulness. This definition focuses principally on defining semantic for machine-processable (Dietze et al., 2009). Therefore, the meaningfulness definition requires the definition of a terminology in terms of a logical structure using symbols and then grounding these symbols to a set of conceptual structures. The aim of this grounding is to structure and organise knowledge according to human understanding, which is mandatory if we want to develop a user-centric services.

In this context, there are only a few works about enriching existing semantic technologies (specifically ontology languages) with CSs representation. CSs provide a means for organising and structuring knowledge for human use. They “can be used to augment human intelligence by facilitating knowledge integration, decision making, the creation of intelligent software systems and the exploration of implicit structures” (Polovina et al., 2007). In our work, we propose an approach of enriching SWS technologies with CSs knowledge representation. We used, in particular, the CSs model of AminePlatform ontology (2009). In this platform, CSs represent, organise and encapsulate knowledge, which can be ontological knowledge that constitutes an ontology or background and common sense knowledge that constitutes a knowledge base. In fact, Amine is a generic model of an ontology, which provides possibilities to manipulate CSs and to construct both ontologies and knowledge base. This genericity of an ontology is reflected in the types of nodes that compose an ontology (Type, RelationType, Individual, Situation, Context, and Rule) and also in the types of links that relate these CSs: specialisation, instantiation and use. Therefore, semantics of CSs and semantics of SWS could complement each other to increase the meaningfulness of knowledge representation.

For e-government domain, several projects applying semantic technologies have been developed. These projects have demonstrated the feasibility of SWS for e-government services, but they still limited towards offering high quality services to citizens. For this purpose, in this paper, we present our approach of e-government services semantic description meta-model (eGov-SSDM) based on CSs and SWS. EGov-SSDM aims; firstly, enriching traditional SWS approaches with a CSs-based knowledge or “service usages knowledge”. This latter is represented using three kind of knowledge: “Service Usage Contexts” (DU, 2009), which defines conceptually the relationships between services
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