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*Original Citation:*

*Availability:*

This version is available <http://hdl.handle.net/2318/143937> since 2015-12-08T11:34:22Z

*Publisher:*

ACM - Association for Computing Machinery

*Published version:*

DOI:10.1145/2539150.2539218

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# How Semantic Knowledge can Enhance the Access to PA Online Services

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## ABSTRACT

Current e-government initiatives are offering a huge amount of information about available services, which tends to overload citizens, who are often “lost”. Intelligent Web-based portals represent a possible solution to this problem, by providing an effective and user-friendly access to online information and service descriptions. In particular, this paper proposes an approach based on formal ontologies and shows how they can provide a great enhancement in this direction. Formal semantic knowledge, in fact, enables the exploitation of reasoning mechanisms to understand users goals and provide them with information and services satisfying their needs. The proposed approach has been tested on a set of services provided by a local Italian Public Administration and results are encouraging.

## Categories and Subject Descriptors

H.3.5 [Information Storage and Retrieval]: Online Information Services Web-based services - H.3.4 Semantic Web

## General Terms

Design, Experimentation, Human Factors, Languages.

## Keywords

e-Government, Semantic Web, ontology, online services, Public Administration.

## 1. INTRODUCTION

People working at e-government initiatives are aware of the major role played in this field by semantic technologies (see, for instance, [1]; [8]; [18]; [6]), which represent the main tool “for the vision of a knowledge-based, citizen-centric [...] integrated e-Government” [21], p.1. Local governments and Public Administrations (PA) are the main providers/integrators of services for citizens, and this makes integration and interoperability particularly relevant and urgent issues for them.

Data and service integration and interoperability can be considered as key challenges from two main different viewpoints, i.e., a machine perspective and a user point of view. In particular,

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iiWAS'13, 2–4 December, 2013, Vienna, Austria.

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the goal can be the support to: (a) the integration of heterogeneous service execution, within shared business processes; (b) the provision of a simple, user-friendly access to heterogeneous information and services.

As far as the first issue is concerned (point (a) above), enabling technologies are - among others - Service Oriented Architectures (SOA) [2], and Semantic Web Services [19]. In this case, the central idea is to exploit semantic knowledge to enhance the descriptions of services operational functionality, and the representation of the processes composing and orchestrating such services (see, for instance, [4], [11], [20]). As far as the second issue is concerned (point (b) above), enabling technologies are (again, among others) NLP-based approaches [10], ontologies [5], and semantic search engines [12], together with methodologies for the design of accessible and usable User Interfaces [13]. In this paper, we will focus on this second point of view, and in particular, on the exploitation of *ontologies* within Web-based e-government systems offering heterogeneous information and services to citizens. This means that we are not concerned with the (semantic) representation of service programming interfaces, but, instead, with a formal (semantic) representation of a *description* of the offered services (which are not necessarily online services).

The current trend of e-government is to offer a growing amount of information about services, accessible from Web browsers or mobile apps. This trend poses a great challenge to citizens, often overloading them with too many information items and too complex ways to find services. As a solution to this problem, “intelligent” Web-based portals should enable users to easily express their goals and, on the basis of them, filter information in order to provide users with services satisfying their needs.

The main contribution of this paper is to show how formal semantic representations, such as computational ontologies, can enhance the provision of information and services, mainly in terms of their accessibility. The paper shows how formal semantic knowledge supports the design and development of “intelligent” Web-based service portals, providing citizens with a user-friendly access to PA services. In particular, one of the most important aspects of the presented approach is to be user-centered. The information and service accessibility is enhanced on the basis of strategies grounded into real users needs.

The rest of the paper is organized as follows: in Section 2 we briefly overview the most relevant projects about e-government and, in particular, about service access, with a special focus on the Italian reality; Section 3 is devoted to the presentation of our project, by describing its goal, an informal usage scenario, and an explanation of how the described system functionality is

supported by semantic knowledge and formal reasoning; in Section 4 we provide some details about the demo prototype we developed and the results of a preliminary evaluation of it; Section 5 concludes the paper and sketches future steps.

## 2. RELATED PROJECTS

The growing interest in semantic technologies within e-government initiatives is demonstrated by the huge number of European projects focusing on the exploitation of semantic knowledge for e-government, funded by UE within the VI and VII Framework Programmes (see [21] for a partial survey of results). Particularly relevant, in the context of this paper, is the EU project FP6 IST SemanticGov<sup>1</sup> [21], chap. 12. Another interesting project is the EU project FP6 IST Access-eGov<sup>2</sup>, which developed software tools, based on semantic technologies, to support service integration. The goal of Access-eGov is to facilitate citizen access to PA services, by making service browsing, discovery, and execution easier and more effective. The approach proposed is based on the “life events” taxonomy (see below) and on user goals [9]. Within the project, researchers built a Core Ontology, a Life-Events Ontology, and a number of Domain Ontologies, containing specific knowledge about the domains considered for the developed prototypes. All such ontologies are based on WSMO<sup>3</sup>, a framework for the representation and management (composition/orchestration and mediation) of semantic Web Services [22], and on the SKOS<sup>4</sup> standard; moreover, they re-use parts of the following ontologies: Dublin Core<sup>5</sup>, vCard<sup>6</sup>, SemanticGov<sup>7</sup>, Terregov<sup>8</sup>, OntoGov<sup>9</sup>. The project also produced a tool for semantic annotation of services [9].

Also W3C started an e-Government Activity<sup>10</sup> and an e-Government Interest Group<sup>11</sup>, aimed at studying possible enhancements to the access to public resources on the Web.

Two relevant initiatives for (semantic) meta-data management are e-GMS<sup>12</sup> and IPSV<sup>13</sup>, which aim at defining meta-data vocabularies for the description of PA information resources. Another initiative in the same direction is the vocabulary for describing data belonging to the United States PA<sup>14</sup>.

An interesting recent proposal is the Core Public Service Vocabulary<sup>15</sup> (CPSV), an extensible data model for PA services, aimed at offering a simple standard for describing services in an interoperable format, without the complexity of OWL-S<sup>16</sup>. The main goal of CPSV is to represent core concepts, common to different services offered by PA, while our proposal tries to go beyond, and to capture concepts and relations belonging to the specific domains services are linked to (e.g., medical diagnostics).

Finally, an interesting project, launched by TopQuadrant<sup>17</sup>, is OE-Gov<sup>18</sup>, which has the goal of building and distributing open licenses for e-government ontologies, developed in OWL<sup>19</sup>.

As regards Web-based portals providing citizens with access to PA services, there are some experiences that are worth mentioning. First of all, the big English PA Web portal<sup>20</sup>, which represents an effective single access point to all information and services referring to PA. The main limit of this system is that it seems to be based on very simple search mechanisms, that do not actually go further keyword search (e.g., it links “to marry” and “marriage”, but it does not link “marriage” and “wife”).

It is worth also mentioning, as an example among other similar initiatives proposed by Italian local administrations, the project developed by the Municipality of Firenze<sup>21</sup> which published its data as Linked Data [7], thus making them accessible through a “semantic” Web browser (based on RDF<sup>22</sup>), or through a SPARQL (the query language for RDF repositories<sup>23</sup>) client. Within this project the Municipality of Firenze published an ontology for PAs<sup>24</sup>, including simple classes (such as *Person*, *Address*, *News*, etc.). Another ontology for PA can be found at the OntologiaPA Web site<sup>25</sup>. Some important experiences in the same direction have been carried on in Piemonte. For example, the project described in [14] proposes the exploitation of ontologies to model geographic (regional) data handled by CSI Piemonte<sup>26</sup>. A similar project, presented in [3] and [16], aims at publishing the huge amount of data managed by Piemonte PA, following the paradigm of Open Linked Data. The final goal is to build a conceptual semantic network supporting their exploitation in a public and accessible way.

We close this section by briefly discussing an approach that has been widely adopted in many Italian and foreign PAs, i.e. the approach based on the so called *life events* [15]. This approach stems from the idea that citizens needs are always situated within a typical situation, such as “being a citizen”, “having a baby”,

<sup>1</sup> [islab.uom.gr/semanticgov](http://islab.uom.gr/semanticgov).

<sup>2</sup> [www.access-egov.org](http://www.access-egov.org).

<sup>3</sup> [www.wsmo.org](http://www.wsmo.org).

<sup>4</sup> [www.w3.org/TR/2005/WD-swbp-skos-core-spec-20051102](http://www.w3.org/TR/2005/WD-swbp-skos-core-spec-20051102).

<sup>5</sup> [dublincore.org](http://dublincore.org).

<sup>6</sup> [www.w3.org/2006/vcard/ns-2006.html](http://www.w3.org/2006/vcard/ns-2006.html).

<sup>7</sup> [islab.uom.gr/semanticgov](http://islab.uom.gr/semanticgov).

<sup>8</sup> [www.regione.veneto.it/Temi+Istituzionali/e-government/Progetti/TERREGOV.htm](http://www.regione.veneto.it/Temi+Istituzionali/e-government/Progetti/TERREGOV.htm).

<sup>9</sup> [ec.europa.eu/idabc/en/document/5185/5808.html](http://ec.europa.eu/idabc/en/document/5185/5808.html).

<sup>10</sup> [www.w3.org/2007/eGov](http://www.w3.org/2007/eGov).

<sup>11</sup> [www.w3.org/2008/02/eGov/ig-charter](http://www.w3.org/2008/02/eGov/ig-charter).

<sup>12</sup> [www.esd.org.uk/standards/egms](http://www.esd.org.uk/standards/egms).

<sup>13</sup> [www.esd.org.uk/standards/ipsv](http://www.esd.org.uk/standards/ipsv).

<sup>14</sup> [vocab.data.gov](http://vocab.data.gov).

<sup>15</sup> [https://joinup.ec.europa.eu/asset/core\\_public\\_service/asset\\_release/core-public-service-vocabulary](https://joinup.ec.europa.eu/asset/core_public_service/asset_release/core-public-service-vocabulary).

<sup>16</sup> [www.w3.org/Submission/OWL-S](http://www.w3.org/Submission/OWL-S).

<sup>17</sup> [www.topquadrant.com](http://www.topquadrant.com).

<sup>18</sup> [oegov.org](http://oegov.org).

<sup>19</sup> [www.w3.org/2004/OWL](http://www.w3.org/2004/OWL).

<sup>20</sup> [www.gov.uk](http://www.gov.uk).

<sup>21</sup> [opendata.comune.fi.it/linked\\_data.html](http://opendata.comune.fi.it/linked_data.html).

<sup>22</sup> [www.w3.org/RDF](http://www.w3.org/RDF).

<sup>23</sup> [www.w3.org/TR/rdf-sparql-query](http://www.w3.org/TR/rdf-sparql-query).

<sup>24</sup> [oldsites.comune.fi.it/resource/rdf/page/ontologia.html](http://oldsites.comune.fi.it/resource/rdf/page/ontologia.html).

<sup>25</sup> [www.ontologiapa.it/pa](http://www.ontologiapa.it/pa).

<sup>26</sup> [www.csipiemonte.it](http://www.csipiemonte.it).

“living in health”, “building a new family”, and so on. In each situation, the citizen needs specific information items and services. Every event is then characterized by sub-events; for instance, the event of “living at home” can be detailed in “buying home”, “renting home”, “remodeling home”, etc.

The original taxonomy describing life events had an important limitation, as claimed by [17]: the classification of information items and services referring to life events cannot be mono-dimensional; instead, it is necessary to handle a multi-dimensional classification, based on *facets*, enabling PAs to classify each single service in more than one category, i.e. assigning it more than one *facet*. This requirement is closely related to another important aspect that has to be taken into account: in order to be effective and user-friendly, Web-based system managing PA services should be designed in a user-centered perspective. In particular, the classification of information items and services should reflect, as much as possible, the user point of view, taking into account that users can have different mental models about services [17]. A multi-facets classification represents a first step in this direction. Moreover, Hreno and colleagues considers life events as user *goals* [9], bringing the approach based on life events closer to a user-centered perspective. Following this suggestion, life events should be considered as more general *contexts*, in which more specific user goals can be situated.

### 3. THE SEM\_PAP PROJECT

#### 3.1 Goal of the Project

The goal of the SEM\_PAP (SEMantics for Public Administration in Piemonte) project we describe in this paper is to develop a feasibility study for a platform that: (a) enables service providers (typically Municipalities in Piemonte Italian region) to populate a service repository providing rich service descriptions; (b) allows citizens who are looking for services to query such a repository and get the information and services fulfilling their needs.

The approach adopted to face these challenges is to decouple the internal representation of services and the view users have on them. In this perspective, the scenario takes into account two typologies of users: the service providers, who populate the repository, and the final users, i.e., the already mentioned citizens looking for services. Both kinds of users should interact with a user-friendly, comprehensible User Interface (UI), not asking them to deal with the complexity of the internal (formal) representations. On the other side, in order to provide the system with the needed “intelligence” to support user queries (as we will describe in details in the following), internal service descriptions should be based on a formal semantic knowledge, represented by a Service Ontology, which could be exploited by a reasoner, in order to answer user requests.

The architecture of the platform supporting these interactions is shown in Figure 1. In the feasibility study described here, we focused on the core of the system, i.e. the *Service Ontology*, the *Reasoner*, the *Service Repository* and how they can support the final users (i.e., citizens) in finding the services they need. This involves the functionality of the *Repository Manager* and the *User Query Manager* (system components in focus are boldface in the figure). Further steps of this project (not discussed here) are the design of the component building service descriptions on the basis of the information from providers (*Service Description Manager*), and the user interfaces (the *service providers UI* and the *citizens UI*).

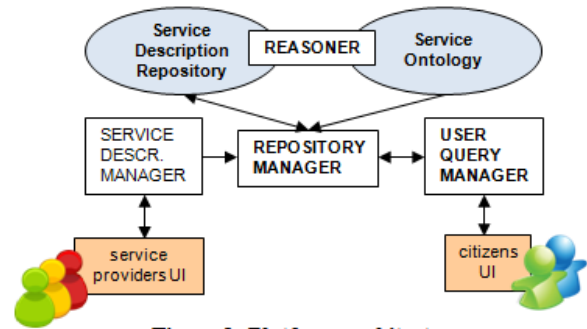


Figure 1: Platform architecture.

The *citizen UI* supports two interaction modalities: a facet-based filter, enabling the user to provide information about herself, and a free-text search field, allowing users to state their goals, i.e. what they are looking for. In the following sections we will explain how this information is used, coupled with the semantic knowledge, to provide users with “smart” answers to their queries.

#### 3.2 An Informal Use Case

In this section we informally describe a use case, in order to sketch how the system works, from the final user viewpoint.

Maria is 50 years old, she lives in Torino (an Italian city in the Piemonte region) and needs to book a mammography as a periodic check. She connects to the Piemonte PA service Web portal and, thanks to the facet-based filter, she easily inputs her gender, age, and town she lives in. As an alternative, if Maria is already registered to the Piemonte PA service Web portal, she can simply login, and all information about her is automatically available to the system. In both cases, Maria writes “mammography” in the search field.

The portal provides her with the following results:

- (a) *Prevenzione Serena* (female cancer screening), together with the indication of the services which belong to this health program: cytological screening, two-year mammographic screening, annual mammographic screening. Moreover, the system highlights the two-year mammographic screening, since its target users are women between 50 and 69 years old.
- (b) Medical examination booking service, i.e., the Web site providing information about how to book: at the hospital counter, by phone, online; for this last case, the system also informs Maria that she has to be registered.
- (c) Payment service for medical fees.
- (d) Registration service.
- (e) Other potentially useful links (medical services).

#### 3.3 How Semantic Knowledge Enables the Use Case

How does the system decide that the results provided to Maria are actually relevant for her? Maria's query (“mammography”) is processed, in order to find a corresponding ontology concept that could be interpreted as Maria's *goal*. The mapping between the word “mammography” and the ontology concept *Mammography* is easily found; this concept is connected, in the ontology, to the concepts *Two-yearMammographicScreening* and

*AnnualMammographicScreening*, which are components of the *PrevenzioneSerena* set of services. Moreover, the target users of the service represented in the ontology by the concept *Two-yearMammographicScreening* are women living in Piemonte, from 50 to 69 years old. Since Maria is a 50 years old woman living in Torino (which is in Piemonte), the system infers that she is a potential user of the *Two-yearMammographicScreening* service (suggestion (a)).

As far as the information about booking medical examinations and paying medical fees (suggestions (b) and (c)) are concerned, the knowledge encoded in the ontology enables the system to know that a mammography is a medical exam, and, typically, to access medical exams users have to book them and pay the corresponding fees. Thus, it can infer that (probably) Maria has to book the exam and pay the fee. The system also knows that there are different modalities to book exams, and that, in order to book online, the user has to be registered. This implies, for the system, that Maria (if she did not login as an already registered user) is a potential user of the service represented by the concept *OnLineRegistration* (suggestion (d)).

Up to here, system suggestions are based on inferences exploiting a combination of the user goal (as expressed in the free-text search field) and users characteristics (explicitly stated, or contained in her profile). However, users goals typically refer to a particular *life context*. Life contexts, in our approach, are what we called *life events* in Section 2 and represent the general context of the user query. In the present use case, the user goal, represented by the ontology concept *Mammography*, is related to the “living in health” life context. From this relation the system infers that Maria could be interested in other medical information and services (related to the same life context), and thus suggests her some links pointing to them (suggestion (e)).

## 4. PROTOTYPE IMPLEMENTATION AND PRELIMINARY EVALUATION

### 4.1 Demo Prototype

In order to test the feasibility of the approach, we developed a demo prototype, which exploits the knowledge encoded in the Service Ontology to provide users with links to information and services fulfilling their actual needs, as expressed by their search query, coupled with their profile.

The Service Ontology is written in OWL; the prototype is developed in Java, exploits the OWL API<sup>27</sup> to interact with the ontology, and is based on the HermiT reasoner<sup>28</sup>.

The Service Ontology used by the demo prototype is populated with some instances of service descriptions, as they should be produced by service providers; such descriptions are mainly characterized by the definition of the other services which are necessary in order to use them (which can be seen as *preconditions*), and the types of user the services are targeted to.

We do not describe here the whole Service Ontology developed within the SEM\_PAP project, but, instead, we focus on some aspects which are particularly important for the reasoning mechanisms enabling the system to provide “intelligent” answers

to users queries. The main technical issue, in this respect, is the following: in the context of this project, there is the need of reasoning about some *instances* (e.g., a particular user) and, at the same time, about some *classes* (e.g., typologies of users, or services). In OWL, in order to preserve decidability, it is necessary to guarantee a clear distinction between instances and classes. However, in our domain, in some cases we need to introduce a concept representing a user or service typology, and we would like to treat it both as a class (maybe involved in some class-level - i.e., second order - relationships), and as an instance (e.g., when we consider it as an individual in some reasoning processes requiring to place it in the discourse domain). Obviously, we cannot do it, since we would violate the previously stated principle (clear separation between instances and classes). One possible solution to this impasse is to use the *reification*: we introduce a number of classes, e.g., *PhysicalPerson\_n*, characterizing special kinds of users (or services). These classes have their instances, representing individual users (or service executions). Moreover, we introduce a class representing the general concept of user or service typology, e.g., *PhysicalPersonType*, or *ServiceType*; this class have instances, e.g., *physicalPersonType\_n*, representing the reification of the previously mentioned classes (e.g., *PhysicalPerson\_n*). The correspondence between these classes and their reifications is ensured by an ad hoc relationship (*characterized\_by*), which expresses, for example, the fact that each instance of *PhysicalPerson\_n* is characterized by the type *physicalPersonType\_n*.

The reification just described enables us to reason about users and services as required by the described use case (Section 3). For example, when a service provider introduces the description of a new service, a new instance of the class *ServiceType* is created (e.g., *CytologicalScreening*); moreover, new facts are added to the knowledge base, linking this instance to other individuals, such as the target user type (e.g., *PhysicalPersonType\_I*). These individuals, however, are reification of corresponding classes (e.g., *PhysicalPerson\_I*), which are needed to state that the individual user (e.g., Maria) is an instance of that user typology, and thus a potential user of the mentioned service. Thanks to the reification of entity typologies, service descriptions can also be specified by means of RDF graphs<sup>29</sup>, in a clear and clean way, such that each non-literal node is always an instance of a Service Ontology class. For each user query, a new instance representing the user performing the search is generated and added to the knowledge base. Then, thanks to the reasoner, the system infers which are the services this new entity is a potential user of. At the end of the process, the instance representing the user is removed from the knowledge base.

### 4.2 Preliminary Evaluation

In order to test the effectiveness of the approach, we performed a qualitative evaluation of the first prototype. Since the current version of the prototype only has a command line UI, we built an ad hoc mockup GUI for the test, simulating the user interaction with the system. Ten users, both males and females, aged from 25 up to 60, with a medium-high cultural level, and quite used to navigate over the Web and to use PA Web portal, were selected. Participants were asked to interact with the system to look for some specific services. At the end of the test, participants

<sup>27</sup> owlapi.sourceforge.net.

<sup>28</sup> www.hermiT-reasoner.com.

<sup>29</sup> www.w3.org/RDF.

answered a simple questionnaire, aimed at eliciting their qualitative evaluation of the results provided by the system.

The participants answers were generally positive: users said that it is much easier to find the needed services by interacting with the prototype rather than using the current PA Web portal they are used to. A couple of them were not really happy about the possibility of providing personal data in the facet-based filter (although it was not mandatory), while three of them said that they would like to interact with an even more flexible UI, possibly answering to full Natural Language questions.

## 5. CONCLUSIONS

In this paper we presented a feasibility study aimed at demonstrating how ontological knowledge can support Web-based PA portals to provide citizens with a user-friendly and effective access to PA information and services.

We designed in details and evaluated the component devoted to process the final users queries and to apply the inference mechanisms to suggest results satisfying such queries. Next step of this project is the detailed design and implementation of the component aimed at acquiring service descriptions from service providers.

A second prototype will be developed, including a limited number of services, but providing full functionality. This prototype will be tested by real users: this evaluation is essential also to verify the scalability of a system based on formal semantic knowledge such as the one presented in this paper.

## 6. ACKNOWLEDGMENTS

This project has been funded by CSI Piemonte ([www.csipiemonte.it/en/](http://www.csipiemonte.it/en/)), and developed in collaboration with CSI Piemonte staff, to whom we address our thanks.

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