A Framework for E-Governance System using Linked Data and Belief-desire-intention Agent

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Abstract

E-Governance systems are built for the government to interact with citizens and efficiently provide workflow between the organizations. These systems play major role in efficiently organizing the government knowledge and enabling citizen friendly services. Traditionally E-Governance systems are developed as a requirement basis trend, where the requirement of establishing a service is evaluated and a system for that particular requirement is deployed. A framework has been introduced to develop an E-Governance system in an evolutionary fashion where the core government model is deployed and further services are deployed over the core. The key element in achieving such evolutionary system is by adding semantics to the knowledge which is represented in the form of Linked Data.

Keywords: BDI Agent, E-Governance, Linked Data, Ontology, Semantic Web

1. Introduction

The knowledge expressed in the classical methods cannot be processed by machines. To make machines understand raw data we add semantics using domain ontology. Various languages exist to represent Ontology, Web Ontology Language (OWL) is one such language used to represent linked data in the web; capable of representing the concepts using description logic. Description logic is more expressive than First Order Logic, yet the knowledge expressed in DL can be reasoned efficiently.

OWL is an easy method to maintain and update large schemas. Querying over Web Ontology Language (OWL) knowledge base can deal with incomplete information. Schema of Government is very large, the schema for such large organizations are developed in an evolutionary fashion. During the evolution of such systems, in case of Relational Database Management Systems (RDBMS), it is inflexible to maintain and make changes to the systems which are dependent. In case of Ontology based knowledge systems, it is represented as concepts that can be added and removed and redefined easily, systems (Agents) dependent on such knowledge bases are given inputs to understand the new concept. Semantic knowledge bases can act as both transactional (OLTP) and analysis for decision support (OLAP). Organizations maintain the resources of their own concepts; resources are just linked as a relation with the instance of concepts of other organization.

Resource Description Framework (RDF) is loosely coupled with the schema, resource identifies itself with a single schema or multiple schemas. The instances of the concept are based on the unique Uniform Resource Format (URI) in the RDF format. The greater advantage is that interoperability. Two organizations operating in different sub domains, extends the concept on domain organization and independently define the concepts in the sub domain. In case of instance of the domain concept, it can be related to the concept in the sub domain. In case of linked data, it acts as a Subject, Predicate, and Object Graph. Where the subject and predicated are nodes connected by the edge object, the object is an element

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from ontology representing the relation between the subject and object.

The proposed framework aims at developing E-governance system which will be capable of being a Decision support system, Office workflow automation, providing services, Authorization on concepts, Agent based (Creation and registering Agents), Core government definition. Core ontologies chosen: FOAF (Friend of a Friend Ontology to represent the Person and his related Entities), time (Temporal Entity), event, organization, geospatial vocabulary. Shi3ld for authorization over SPARQL and http endpoints.

2. Literature Survey

The interoperability is the major issue that needs to be addressed in e-governance domain which is discussed in 1. Technically the interoperability is the exchange of government’s diverse information between two different systems of the government's entity, without the loss of semantics. Interoperability will enhance accessing and coordination among services, transparency, data gathering and parsing techniques for decision making. Three primary goals of interoperability are data exchange, meaning exchange and process agreement. Levels of interoperability are technical, semantic and organizational.

The various existing semantic technologies for the e-governance like interoperability, SOA and ontology based knowledge management is deliberated in 2. The approach in work 3 is used to make ontology based intelligent generation of web forms to collect data from user for a particular service. The work in 4 which explained ontology from Meta to granular level abstraction, i.e. from Government Agency to the Task level of each service. This is entirely different from the proposed method, which is information centric. The paper explored and comparatively studied in 5, helped to build Semantic web services and ontology in providing public services, with e-customs domain as a case study. The framework to create domain ontologies for E-Governance systems by extracting the semantic information from the services provided is found in 6.

The framework explained in 7 is to manage changes in the e-governance services using ontology where change is the concept adopted to existing services and capture inconsistencies that arise due to the change and provide the information to the users. The life event based services were provided and described in 8,5 were used in access E-Governance project. The interoperability issues in E-government are studied in 9 which proposed a SOA based model for governmental organization.

The highlights observed in 2 and 10 give an overview of using semantic technologies for e-governance domain. The various semantic technologies and its effectiveness on e-governance are studied in 12. The SWS based approach for E-governance is found in 13 and an Integrated E-Services through WSMO is found in 14. The conceptual framework for government interoperability, with entrepreneur scenario as a case study is originated in 15. The various challenges like human and technology in implementing e-governance in India is depicted in 16.

3. Proposed System

3.1 Core

The System or Agent contains the core of the government. The core contains the core semantics, core knowledge and core services. The further services offered by the lower level organizations are extended over the core system which is represented Figure 1. The core uses the existing standard ontologies and extended further to support the government semantics. The reused standard ontology set is time, event, organization, geospatial, foaf, intellLeo workflow. Reusing the standard ontologies rather than defining new expands the scope of the language understood by the Agent, and can effectively save time and cost5. The semantics of the core governments states about the concept of union, state and other federal structure of the government. The base rules for the lower level organizations to function (i.e.) the rules obtained from the constitution of India.

The core acts as a knowledge base using the description logics. The concepts and description logics are expressed in the form of OWL. The service is provided as reasoning services and data endpoint services. The part of Core ontology excluding the third party import is given in Figure 4.

Scenarios of Citizen’s Life Event: BirthEvent, MarriageEvent, DeathEvent, DivorceEvent, PurchaseEvent. In case of BirthEvent the hospital or the panchayat office registers it. When a hospital raises the birthEvent, its superior Organization will be Ministry of Health; the Agent designed for the ministry of health receives the
Event, It does not have any desire to react; forwards it to the core. The core responds by creating a unique resource identifier as a Citizen of India. This is a scenario where how agents react to the basic life event.

Figure 1. The System’s operating model.

Agents are not explicitly programmed; they are programmed in meta-level to react to the events perceived according to its belief. In e-governance domain policies, concepts and organizational structure are subject to change. In such scenarios the system must be able to recognize the changes and act accordingly. For example, if a new policy is made, it should reflect at all levels of the organization and ensure that the concepts that are affected by the policies are redefined and changes for services provided upon the concepts are also reflected.

How an effective knowledge transfer is achieved between two parties, like organization, person or even a machine? A knower could transfer his knowledge to other only if the languages of the both communicating parties are same, i.e. both interpret the same semantics for the knowledge communicated. In the proposed system we use OWL-S a w3c standard as the common language between the agents. Further the domain concepts are well understood by the agents as their knowledge is extended from core.

3.2 Extension of Core

Agents for organizations, to act behalf of users to register events, workflow automation, connect with higher and lower organizations. Agent can approve an agent to provide access to certain concepts in the core. Each agent is represented with the organizational semantics in the form of OWL and rules for the agent to work. The agent reads the event and acts accordingly.

BDI Agent is chose; Belief Desire Intention Agent where Belief is the current state of the Agent, due to the knowledge it possess. Desire is the goal to be achieved by the Agent. Intention is the set of actions to achieve its Desire.

In proposed system, The BDI possess the knowledge defined using the OWL in the form of linked data. Desires are viewed as requests from the users or other agent, and intentions is the set of actions the agent performs to achieve the requesting agent’s desire.

The communication between the Agents is through the Semantic web services defined upon OWL-S to build automatic semantic web services. In traditional Service Oriented Architecture (SOA), the services have to be registered in UDDI Registry and should be manually discovered by the client. In case of Semantic web services, it is designed to automatically identified by the agents and build a communication channel and interact each other, through a common agreed ontology.

When a new service is to be provided to the citizen, the knowledge about the new concept is provided to the Agent. Further, the specification of the new service is provided to the Agent. The Agent automatically composes the semantic web service and made available to the user. Belief - knowledge base constructed using the core ontology. Desire – User or Agents requests. Intentions – set of semantic web services. Agent’s interoperability: exchange proper semantics of the data. Know what to do when exchanged, this is interpreted as desires of the agent on acquiring a new belief.

Figure 2, explains how a birth event is triggered and travels through different layers of the system, Element 1 represents the user initiated or system generated events like birth event, purchase event, marriage event etc. Events contain the details about the environment and how the event occurred with the common accepted ontology, in this case it contains the location, time, child’s parent entity ID, sex and other physical details, Element 2 explores knowledge about the event is updated in the local system which triggers it, in this scenario the birth event is triggered by the panchayat or hospital and a reasoning is done over the KB, Element 3 and 4 shows the output of the reasoning would be to trigger new notification event to the Health ministry as there is a new birth, Element 5 and 6 explores the health ministry adds knowledge to its KB and reasons over trigger that responds with notification to the Core government for creation of new citizen which is shown in Element 7 and 8.
Authorization on certain concepts and restrict on certain concepts to the Agents involved in the government process. The authorization of concepts is achieved using the shield type named graphs. It is the central system where any access to the core data is walled through the authorizations system.

4. Cases for Extending Core

The domain knowledge is expressed in the form of ontology and relationships between the concepts are defined using object Property. SWRL is incorporated to further extend the DL with rules. SWRL contains two clauses antecedent and consequence. The clause contains set of atoms, if the antecedent is true the consequent clause is asserted as true. We further describe the complex concepts using the SWRL; a scenario where concept SeniorCitizen should be expressed,

\[ \text{SeniorCitizen}(x) \equiv \text{Citizen}(x) \cap \text{Age}(x) \geq 60 \]

Similar concept knowledge is expressed using the SWRL rules. The whole concepts and rules upon the concepts constitute the knowledge base. The instance of Senior Citizens will be inferred from the person individuals represented in the triple format as in triple (1). The set of triples in (1) leads to inference as concept SeniorCitizen.

\[
\begin{align*}
\text{person}_{1243} & \text{ egov:name “xyz”}. \\
\text{person}_{1243} & \text{ egov: birth Date “1960-02-11”}@\text{xsd:date}. \\
\text{person}_{1243} & \text{ rdf:type egov:Citizen}.
\end{align*}
\]

Further new Services of G2B, the coal allocation can be used as scenario, where Coal Allocation will come under union government where the union government agent is added with new service of Coal Block Allocation, participated by Private and Public Business which will be further interacted by Agents of that particular participants. The government to business participation through core ontology is given in Figure 3. The participation of Ministry Agent in the Coal Allocation block for G2B, and Fund Transfers for G2G and LPG subsidy for G2C. This provides the individual organizations to extend the core ontology, define the Agent for the organization register with the core government, define services and further communications between the organizations are through the agent, which is as described in the Figure 2, where the birth event from a panchayat or hospital will be triggered till the top level where new citizen is added.
The knowledge base is stored in the form of RDF. The SPARQL endpoints are provided over the knowledge base gives way to access the instances of the concepts. Authorization for concepts is provided through the shi3ld. The knowledge base provides options for statistical analysis, logical reasoning pipelines. The logical reasoning over the knowledge base is done through the pellet reason. Semantic web services are deployed over the knowledge base for access over the concepts. These semantic web services are the point of contact for other organizations from the core government.

The core government knowledge base is extended by the sub organizations with their domain operating knowledge. The sub organizations extend the core ontology and define its own concepts and instances of the concepts are maintained by the same.

Figure 4. Core government ontology excluding the imports from third party ontologies.

5. Conclusion

The purpose of E-Governance is to enable smart and easy governance. The structure and entities taking part in the government are subject to change often in a large scale. So, when developing systems for government it must be highly inter-operable and flexible for changes. The proposed frameworks has incorporated both the concerns of the governance system and explained that the systems can be built in an evolutionary fashion, with the help of ontology and linked data. The interoperability is achieved through common conceptual communications through OWL. The extension and ease of adding services are achieved through the Agents realization of concepts defined in ontology.

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