Social Semantic Web and Collective Knowledge Systems as Technological Enablers for Value Co-Creation in Service Systems

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ABSTRACT

Purpose – *Service Science* is the study of *Service Systems* and of the co-creation of value within networks of integrated resources (Spohrer et al., 2008). Thus, value creation becomes the *core* part of services and can be interpreted by using different views. Service-Dominant (S-D) Logic (Vargo and Lusch, 2008) considers the roles of producers and consumers as not distinct. This means that value is always co-created by means of the interactions among providers and consumers.
In this context, the purpose of this work is to propose and motivate the *Collective Knowledge Systems (CKS)* model and the *(Social) Semantic Web* platform as technological enablers for value co-creation.

Design/Methodology/approach – *CKSs* are human-computer systems in which machines enable the gathering of human-generated knowledge (Gruber, 2008). This work aims at defining a framework in which a Service System handles "collective intelligence" (provided by businesses, customers, etc.) considering the principles of CKSs. In this scenario, the role of the *Social Web* (Bojars et al., 2008) is to gather the "collective intelligence" through Web 2.0 apps and the role of the *Semantic Web* (Berners-Lee, 2001) is to create new value from the collected data, by exploiting knowledge representation and reasoning techniques.

Findings – As a proof of concept we focused on a *Customer Care Service* that receives customers' requests (Web 2.0 application), tries to match requests with available answers and returns the most suitable matches. All the available answers, as well as customers' requests, are represented and annotated by means of Semantic Web vocabularies like SIOC[1]. If there is no match, the request is broadcasted on a community (possibly containing also customers with similar problems) which can answer to it. The answer is "semanticized", relayed to the customer who made the request and stored to be made available for next requests. The requesting customer can *rate* the request by using ReviewRDF[2]. New value is co-created by both a community of people and an adequate use of Semantic Technologies.

Originality/value – The main proposal of this work is that Service Systems are modeled as *CKSs* by means of *Social Semantic Web* technologies. This aspect allows communities of businesses and customers, connected to a service, to co-create value that is "semanticized" and immediately exploited as an improvement of the service itself. This is also the original contribution of this paper.

Key words – Service-Dominant Logic, Collective Knowledge Systems, Social-Semantic Web, Value Co-Creation

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[1] http://rdfs.org/sioc/spec/
[2] http://vocab.org/review/terms.html

Paper type – Conceptual paper

Introduction

In recent years, as stated in (Maglio et al. 2010), economic models have demonstrated that human education, knowledge and skills play a growing role in the changing world economies. This transformation has relations with the rising share of services and, in particular, with their changing characters. The Service Science seeks to study and facilitate this change. It pays attention to complex networks of resources and service systems, their interaction and their potentiality of creating value.

In fact, the Service Science is the study of Service Systems and of the co-creation of value within networks of integrated resources (Spohrer et al., 2008).

The user participation is the primary driver of value inside the Social Web. Many web sites and applications (*Wikipedia, MySpace, YouTube, Flickr, Del.icio.us, Facebook, Technorati,* etc.), whose architectures are well described in (Tim O'Reilly. 2010), represent the Web 2.0. The collective contributions of all the people writing articles for Wikipedia, sharing tagged photos on Flickr, sharing bookmarks on del.icio.us, or streaming their personal blogs into the open seas of the *blogosphere* represent what in the discussions of the Social Web, is named as "*collective intelligence*" or "*wisdom of crowds*". This is the value created directly by the users. Something is changing and new environment like *Neo4j*[3] are emerging.

As stated in (Gruber, 2008), the systems able to share collective intelligence are the *collective knowledge systems*. They are human-computer systems in which machines enable the collection and harvesting of large amounts of human-generated knowledge. A simple example of them is by the author "FAQ-o-Sphere". In general, these systems have three key parts:

1. *A social system, supported by computing and communication technology, which generates self-service problem solving discussions on the Internet. These are the product support forums, special interest mailing lists, and structured question-answer dialogs in which people pose problems and others reply with answers on the Internet.*
2. *A search engine that is good at finding questions and answers in this body of content. Google, for example, is very good at finding a message in a public forum in which someone has asked a question similar to one's query.*
3. *Intelligent users, who know how to formulate their problems in queries that the search engine can match to online question/answer pairs. In addition, users help the system learn when they provide intelligent feedback about which query/document pairs were effective at addressing their problems.*

The collective knowledge systems include also other simpler and older approaches. For example, the *Citizen Journalism*, as stated in (Gillmor, 2004), where people want to get the scoop on a story before the mainstream press, or get a diversity of opinions. Moreover, *Product reviews for consumer products,* that are the best information on a gadget, a piece of computer equipment or a digital camera to buy that is not the marketing literature. Moreover, *Collaborative filtering to recommend books and music,* that are recommendations based on other customers' choices allowing knowing the books and music closer to that I like. Platforms like *Amazon*, *Netflicks,* for instance, already provide these suggestions to the users. They are great systems having in common the key properties of *collective knowledge systems* that are, as stated in (Gruber, 2008), the following:

- *User-Generated Content:* humans, instead of expert systems or databases, provide the bulk of the information by participating in a social process.
- *Human-machine synergy:* humans and machines together provide more domain coverage, diversity of perspective and more much volume of information that is difficult to obtain otherwise.

[3] http://neo4j.com/

- *Increasing returns with scale:* having many contributes from many people means the system contains much more information and then it gets more useful.

When the volume of content grows, the amount of information grows as well and a simple keyword search engine does not get more useful to discriminate among documents. This is the reason we need some technologies injection able to face this limitations (Miranda et al. 2015). In fact, the increasing availability of new technologies has made the collective knowledge systems cheap and easy to adopt. They allow users capturing signals, storing and distributing information, communicating by overcoming any existing barriers of space and time. They allow creating collective intelligence. However, to create value from it the Semantic Web plays the main role in collective knowledge systems. This should be the way to aggregate user contributions, to summarize and sort the data, to trigger sharing and computing across heterogeneous social web applications, to activate reasoning processes and to discover new knowledge distributed among many available sources.
Thus, the Social Semantic Web together with the Collective Knowledge Systems could represent a platform able to allow a community of users sharing content and resources, communicating and learning. When we move this approach into an ecosystem of services, we may think at this combined approach as a possible way to co-create value.

Our approach

Gathering the human-generated knowledge is one of the goals of our approach. In particular, we would represent the knowledge by using the technologies coming from the W3C Semantic Web vision. This choice guarantees a layer of interoperability and cooperation among applications (or apps), the fundamentals to build knowledge-based applications, the chance to use a standard query language like SPARQL1.1, the possibility to integrate and reuse existing ontologies, vocabularies and metadata to model several aspects of the knowledge, the capability to support reasoning, inference and so on.
The Semantic Web provides us with a set of methodologies, languages and technologies. A possible effective and efficient representation to adopt is a three layers model as showed in the following Fig.1. Firstly, the upper layer consists of several linked ontologies (described by using RDFS/OWL/OWL2[4]) used to model the key concepts (ontology classes). Secondly, the lower layer consists of the instances of the classes we can find in the upper layer. Lastly, the middle layer is made of a set of lightweight ontologies used to classify and organize the lower layer elements.

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[4] http://www.w3.org/TR/owl2-overview/

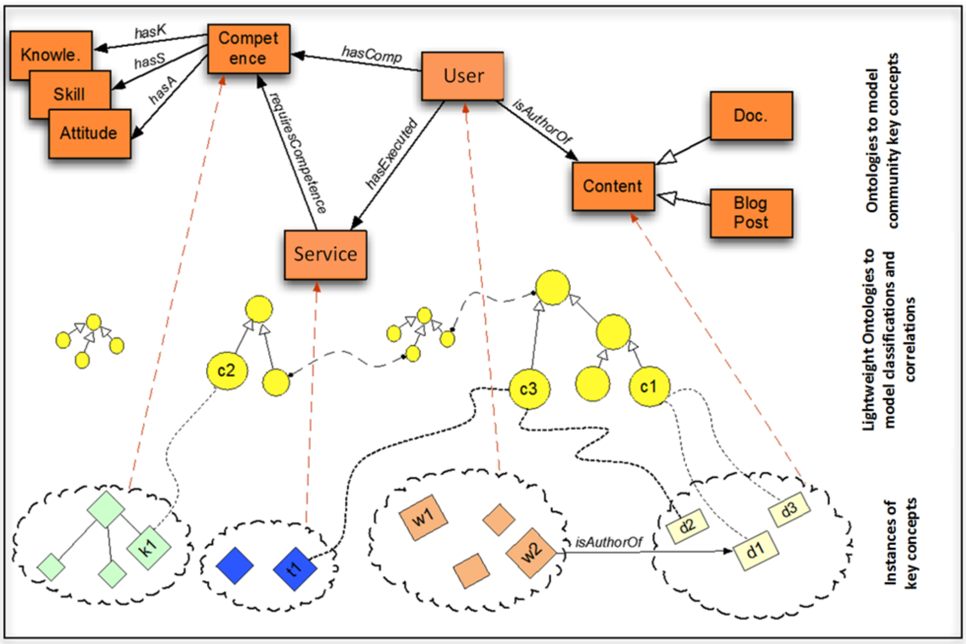

Fig. 1 Three layers of structured Knowledge.

Lightweight ontologies (described by using SKOS[5]) can be connected each other in order to correlate concepts (at the same layer) and instances (at the lower level). More in details, the ontologies at the upper layer allow describing the semantics of domain-independent concepts in organization like *Service*, *Competence*, *User*, *Content*, *Document*, *BlogPost*, etc. that could be implemented as OWL classes. Whilst, the middle layer defines conceptualizations for domain-dependent knowledge in a specific organization. For instance, the main research topics could be modelled as instances of *skos:Concept* and organized in semantic structures like taxonomies or conceptual maps. It is clear that the middle layer is more dynamic than the upper layer, in the sense that the lightweight ontologies (as we have defined them) could evolve in the time. Instead, the probability that a concept could change in the upper layer is very low. The construction of the lightweight ontologies implementing the middle layer is a critical and difficult task. The idea is to generate the aforementioned ontologies by exploiting textual data embedded in artefacts and documents (Gaeta et al., 2011) that are representative for a community of users. For this aim, we exploit the framework described in (De Maio et al., 2012) that is based on a fuzzy extension of the Formal Concept Analysis (Tho et al., 2006). The objective of the above-mentioned framework is building a taxonomical conceptual structure starting from a collection of text documents. The framework defines an ontology generation workflow consisting of three main steps: text processing, fuzzy data analysis and ontology building.

The goal of the first step is to construct a Fuzzy Formal Context, i.e. a matrix showing the relationships between the keywords extracted from the input documents and the documents. It extracts the set of keywords from the documents; it filters them (by eliminating non-informative words by using stopword lists), normalizes them (by means of stemming and POS-tagging) and enriches them by inserting the synonyms of all words in the set. Then, it creates a matrix of relationships among all the terms. The goal of the second step is to analyse the Fuzzy Formal Context by means of Fuzzy Formal Concept Analysis (FFCA) and transform the matrix into a Fuzzy Concept Lattice (nodes in the lattice are called Fuzzy Formal Concepts). The Lattice is a mathematical model of the knowledge embedded in the input documents. Lastly, the goal of the third step is to transform the Fuzzy Concept Lattice into a taxonomy structure by executing some rules. In our approach, we could use a SKOS-based representation of the final taxonomy instead of the OWL-based representation adopted in (De Maio et al., 2012). SKOS is more suitable than OWL when the objective is to organize large collections of objects and provide a lightweight intuitive

[5] http://www.w3.org/2004/02/skos/

conceptual modelling. At the end of the process, the obtained SKOS structures may represent the aforementioned lightweight ontologies. It is important to underline that the documents, used as input of the ontology construction process, should be already related to their respective concepts in the SKOS structures. New documents, as well as other artefacts, can be subsequently classified (by manual and/or automatic operations) by using the lightweight ontologies. Definitely, the lightweight ontologies can evolve by exploiting a similar process based again on FFCA.

The traditional Collective Knowledge Systems follow a top-down approach. Due to the social-collaborative dimension of social media, this approach is now incorporating a more personal knowledge management dimension where a bottom-up approach is growing. Thus, this new kind of Service Systems may handle "collective intelligence" that includes documents, content and other information provided by organizations, businesses and customers or other "non-institutional" users as well. In this scenario, the role of the Social Web (Bojars et al., 2008) is to gather the "collective intelligence" through Web 2.0 apps and the role of the Semantic Technology layer is fundamental. It is the enhancement for the Collective Knowledge Systems able to create new value from the collected information. By exploiting knowledge representation and reasoning techniques, in the Service Ecosystem, all the information becomes "collective intelligence" and, thus, this new kind of systems is what may really co-create value for the community.

A first proof of concept

Usually, a customer service department is responsible for maintaining customer satisfaction, helping to retain customers and assisting in generating repeat revenue for the company. For this reason, the training is important for all the employees but, often, this is not enough to face any problem the customers raise. Asking right questions is one thing to ask many questions as a customer service representative. It is a skill to be able to understand the right questions to ask. When a customer service representative understands the right questions to ask, it helps to make her seem competent to the customer. Asking the right questions makes the customer feel as though the customer service associate understands the issue, and is qualified to help. This means a good ability in fitting solutions with problems. A good customer service representative has a comprehensive understanding of the solutions that are available to him, and he has the ability to match up those solutions with a variety of customer issues. The customer service associate also knows when it is necessary to send the issue to a higher level, and stays on the line with the client until someone at the next level picks up the phone. Understanding which solutions work for customer issues can give the customer the feeling that the service department is competent and efficient. This process of selecting the right questions and finding the right answers leverages knowledge and skills of people engaged, referring to the domain of the problems and solutions, and also to the ability of using tools and accessing repository of cases and situations in order to satisfy the customer requests. We have chosen this service as a proof of concept of our approach where the Web 2.0 applications meet the semantic web technologies.

Web 2.0 applications for a customer care service are very simple. The first application we consider is an instant messaging tool: the *chat*. The chat is a friendly way to allow users discussing problems and possible solutions and, thus, to offer customer support, but, first, the person which has to interact with the customer is not chosen in terms of competences close to the raised problems, it happens only on specific topics. Second, during the dialogs, it is often difficult to keep external resources available (documents, reports, manuals, etc.). Moreover, usually, the conversations are not stored and indexed. This does not allow reusing them to show possible answers to incoming questions by getting similar conversations, or, in particular, conversation on topics similar to the treated ones.

In fact, one of the hardest operation to do is finding the best answer to a customer question. This means pointing out the best participant to the dialog (who is the person having competences on the posed question), then, collecting and keeping available the best resources in terms of existing

manuals, notes and other material and also in terms of past stored conversations treating the same topics.
To do so, it implies understanding what is the mean of the question, looking for the best participant, then looking for similar questions (in terms of treated topics), then, looking for the related possible answers. Among all the possible answers, the process goes on by identifying the best one and, eventually, storing new conversations to reuse them again in the future.
The proposed approach allows exploiting the existing knowledge in order to foster conversations by means of the provision of adaptive feedbacks, implemented as suggestions, for both the participants to the conversation.
The computer-mediated conversations represent the first key point. In our approach, they are dialogues between two participants, the customer and the employee of the customer care department, who exchange messages through instant messaging tools (D'Aniello et al. 2014).
The model we refer to is similar to those defined in (Laurillard, 2009), where the author provides a framework for a conversational learning approach. As in that framework, there are two conceptual levels: the lower and the upper. In the lower one, the customer masters the topics while the conversation partner provides the experiential environment (e.g. delivery of available resources) where the process is executed. In the upper one, the customer and the conversation partner that is an employee of the customer care department are engaged in a dialogue by exchanging messages containing their understanding and representations of the topics obtained through the experience performed at the lower level and adapting their behaviors. Reflection occurs when the customer and the partner talk about what they are doing at the lower level. Adaptation occurs when they modify what they are doing at the lower level based on their talk. Several types of dialogues (e.g. argumentation-based dialogues, tutoring dialogues, peer dialogues, and so on) can be instantiated, but this work, in particular, focuses on customer care dialogues. A sort of virtual assistant is committed to help the conversation partner in playing his/her role.

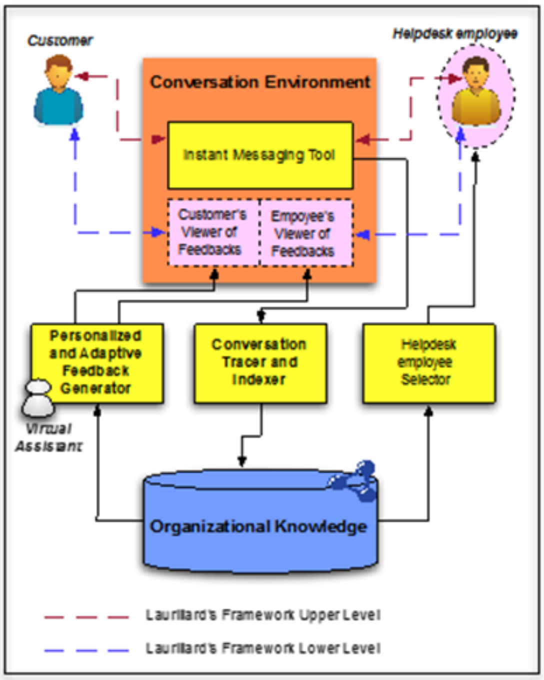

Fig. 2 High-level architecture of the conversation environment

The second key point is the capability to generate adaptive feedbacks able to foster conversations in order to increase the probability that meaningful answers occur during dialogues. We adopt the definition of feedback reported in (Shute, 2008): *«[..] feedback is defined in this review as information communicated to the learner that is intended to modify his or her thinking or behavior for the purpose of improving learning. And although the teacher may also receive student-related information and use it as the basis for altering instruction [..]»*. In our proposal, a virtual assistant

analyses a specific conversation fragment and queries the organizational knowledge inside the customer care department to generate feedbacks with content that could foster the dialogue and help the customer (Mangione, 2013). Feedbacks are adaptive, in the sense that the virtual assistant generates them by considering the concepts that really emerge from the conversation fragment, and personalizes them by taking care of both customer and employee profiles. To simplify, we divide feedbacks in two types: customer-related and helpdesk/employee-related. The first ones are topic contingent feedbacks suggesting correlations among the topics to treat and the customer's prior knowledge (Shute, 2008). The second ones are hints/cues/prompts about worked examples provided by the employee (conversation partner) in response to automatic suggestions, produced by the system, concerning the existence (in the organizational customer care department knowledge) of documents, user-generated content, etc. that are related to the topics to master. The main idea is to build these feedbacks in the form of dialogue moves by exploiting classifications provided by the authors of (D'Mello et al., 2010) and (Lu et al., 2007). In this way, even if indirectly, the dialogue is adapted but it maintains its common dialogue scheme (Gaeta et al. 2013).
The third key point is the exploitation of the organizational knowledge of the customer care department in order to support computer-mediated conversations as well as other processes. In this paper, we refer to the organizational knowledge as the set of all types of knowledge existing in a specific department. For instance, it includes tacit knowledge in the minds of employees, embedded knowledge in procedures, explicit knowledge recorded in artefacts (e.g. documents, etc.) and in information systems (e.g. information about the competences of each workers, etc.), and so on. In our approach, the organizational knowledge is represented by means of a model exploiting the Semantic Web stack. The so represented organizational knowledge is mainly useful to accomplish three objectives. The first one is to enable search for suitable conversation partners among all the available human resources in the organization. The second one is to enable search for resources (e.g. documents, user generated content, task and project information) useful to generate personalized and adaptive feedbacks fostering helpful conversations (in this case the virtual assistant, once extracted the concepts from the conversation fragment, uses SPARQL1.1 to query the organizational knowledge and provide content to construct feedbacks). The third one is to enable storage and correlation of conversations with the existing knowledge in organization in order to foster its reuse.

The proposed approach differs from a typical recommender system providing item-based filtering for the following reasons:

1. The user preferences are modelled as users' prior knowledge and context (concepts elicited from the conversation fragment text);
2. The recommendations are further personalized with respect to the conversation role (customer or employee/expert);
3. The recommendations are generated by using a semantic representation (Boticario et al., 2011) of the organizational knowledge.

Lastly, the provided approach may enable two different adaptation strategies. The first one, based on the construction and provision of adaptive feedbacks, is a micro-adaptation strategy. The second one, based on the dynamic selection of the conversation partner, is a macro-adaptation strategy. Feedbacks, suggestions and adaptation trigger and improve cognitive processes in the people involved in this kind of learning activities. The customer receives stimulus on these processes and goes in the reflection on what he/she is talking about with his/her dialog partner (Miranda et al. 2013).
This combination of Social Semantic Web and Collective Knowledge Systems allows a department offering a service, the opportunity to improve its own service by enriching it by means of a "collective intelligence" gathered and managed by semantic technologies. Thus, this could represent a technological framework we may consider as an enabler for the co-creation of value in Service Systems.

Conclusions and future works

In this paper, we have described an "injection" of social semantic web to the collective knowledge systems and we moved it into service science scenario where customers, organizations and other users represent a sort of community and their requests and possible answers are dramatically numerous. We have chosen as a proof of concept a Customer Care Service by imagining customers and employees using web 2.0 applications, sharing content and documents, interacting by means of an instant messaging tool. All this material, the customer requests, the possible answers and the dialogs as well, are represented and annotated by means of Semantic Web vocabularies like SIOC.

It allows analyzing customers' requests and comparing with all the available answers and documents in order to return the most suitable matches or, if there is no match, to broadcast the request to the community where these semantic technologies give a support to find similar problems and related adopted solutions. In fact, answer are "semanticized" and stored to be available for next requests. Moreover, each requesting customer can rate the answers he/she receives by using ReviewRDF. People supported by semantic technologies co-create new value for the community itself.

This approach of modelling Service Systems as CKSs by means of Social Semantic Web technologies should be experimented in a real context, but we are enough confident that it allows communities of businesses and customers, connected to a service, improving the service itself.

In the Service Science, this symbiosis of Collective Knowledge Systems and Social Semantic Web technologies may represent a framework for a "collective intelligence" and, thus, for the co-creation of value.

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