KNOWLEDGE BASED SERVICE SYSTEMS

Massimo De Santo[1], Antonio Pietrosanto[2], Paolo Napoletano[3], Luca Carrubbo[4]

ABSTRACT

Purpose – The general concept of a Service System is now used to refer to those complex systems composed of heterogeneous entities, including people, technology and business operations, which interact through the exchange of services. The aim of this paper is to introduce the concept of *Knowledge Based Service Systems* and demonstrate that the way to make an economic, managerial, organizational, industrial, computer system smarter, which means that the system evolves by adapting to the needs and changing conditions thereby reducing the mismatch and loss of resources, is to consider such a system as a Service System based on the management and manipulation of Knowledge.

Methodology/approach – To achieve a dynamic and adaptive system, we need a description of the system, entities and services, as well as a definition of the structured knowledge based on ontologies, metadata, taxonomies and thesauri, and so a kind of *Knowledge Representation* which contains both the raw data, obtained by recording the behavior of the system, and the knowledge gained through the study of the domain. Consequently, we need to design a *Data Mining* and *Knowledge*, *Inference* and *Learning* system, that is capable of working on both the raw and structured data and so bringing both understanding and prediction, with the aim of making the system able to adaptively evolve thereby reducing the mismatch in the services exchange mechanism.

Findings – It will be fundamental to exploit results obtained by the scientific community in the field of probabilistic methods for Collaborative Filtering which are based on techniques suitable for handling data belonging to the lowest level of the knowledge hierarchy (memory based), at the intermediate level (content based) and at the highest level (hybrid).

Research implications – This work can be considered as a Service Research advance in Knowledge based Service Systems.

Practical implications – Such a system could be implemented in every context in order to improve the management of available resources.

Originality/value – What is asserted in this paper could be interesting when it is necessary to reduce the mismatch in the service exchange process: management of alternative and/or sustainable energy systems, of agriculture and the environment, of heritage and artistic systems, of sustainable mobility, of homeland security, of health and life sciences.

Key words: 1. Smart Service Systems 2. Intelligent Systems 3. Knowledge Engineering 4. Collaborative Filtering 5. System Thinking

[1] Full Professor of Computer Science, Salerno University, desanto@unisa.it.
[2] Full Professor of Electrical and Electronic Measurements, Salerno University, apietrosanto@unisa.it.
[3] Research Fellow of Computer Science, Salerno University, pnapoletano@unisa.it.
[4] Ph.D in Business Management, DIAM, Dept. Cassino University, l.carrubbo@unicas.it.

Knowledge Based Service Systems

Premise

The general concept of a Service System is now used to refer to those complex systems composed of heterogeneous entities, including people, technology and business operations, which interact through the exchange of services. The entities of such a system employ resources to exchange services but with the risk that these resources are dispersed and/or badly used with the consequence that the resulting system is inefficient.

The aim of this paper is to introduce the concept of Knowledge Based Service Systems and demonstrate that the way to make an economic, managerial, organizational, industrial, computer system smarter, which means that the system evolves by adapting to the needs and changing conditions thereby reducing the mismatch and loss of resources, is to consider such a system as a Service System on the management and manipulation of Knowledge.

1. Introduction

What was once, quite superficially, with detachment and disinterest, commonly described as the tertiary sector, now represents something completely renewed, relevant, incisive and decisive. The service sector makes the economy of a country, of every country in the world, move. Services are, in fact, taking the place of the classic production sector, even in the collective imagination, with the consequence that all the economic, management, organizational, public relations and information technology next-generation systems are now inevitably service oriented.

In this context, Service Science has been established as an initiative, originally sponsored by the IBM Corporation, involving hundreds of researchers around the world with the aim of promoting a discipline capable of satisfying the most important emerging themes: the study of service systems (Maglio, Spohrer, 2008). Service Science, Management, Engineering and Design (SSMED), as it is usually named, is considered multidisciplinary, and covers many areas of interest and application. In terms of Science, it investigates how the so-called service systems should be considered and how they evolve, focusing on the active role of people, knowledge, shared information and technology. In terms of Management, it investigates the possible solutions for the implementation of performance assessment, sustainability of relations and the entire system interaction within service systems. In terms of Engineering, it deals with the development of new technologies for suitable methods for the inference, measurement and dissemination of information, which is considered to have the predominant and fundamental role in the active sharing in the processes of contemporary value creation. In terms of Design, it seeks to deepen knowledge of the appropriate configuration techniques for the proper structuring of service systems.

According to SSMED, the general concept of a Service System is now used to refer to those complex systems composed of heterogeneous entities, including people, technology and business operations, which interact through the exchange of services. The entities of such a system employ resources to exchange services but with the risk that these resources are dispersed and/or badly used with the consequence that the needs of those who have required those services are not fully satisfied. This makes the system inefficient which in the case of energy, computer or business systems can be translated into a catastrophic and irreversible loss of resources and an increase in dissatisfaction of those who receive the services (in this case we speak of non-quality costs or "failures").

As a consequence, it is necessary to develop service systems as dynamic entities capable of adaptively evolving in order to reduce the mismatch of the service exchange process, thus making it an interactive process which involves both the provider and the client in the design, creation, application and delivery of the service.

You do not adapt simply to your environment, but the system and its environment co-evolve and co-determination in a structural coupling (Beer, 1975; Golinelli, 2005). According to Viable Systems Approach (Golinelli, 2005; Barile, 2008), the concept of autopoiesis has also been applied in sociology (Luhmann, 1990), a system for defining the boundary between itself and its own environment, which separates it from an external infinitely complex. Similarly, the principle of self-study focuses on the retroactive effect, in which the output becomes the input, thereby producing new forms of learning, in order to reduce the entropy to increase internal external entropy (von Foerster, 1981). The approach was originally suggested by Stafford Beer and developed by the Italian school initiated first by Golinelli and later Barile, and states that the firm is conceived as a living system that is able to maintain a separate existence, survive and grow in a highly dynamic environment and at the same time, preserving their identity. The concept of learning is fundamental for intelligent systems, which may be able to self-reconfigure in order to resist in a sustainable manner over time. Systems are smart because they react to external changes through the intelligent and rational use of available resources by adapting its organization, the use of knowledge (Rullani, 2009), and trying to "feel" their environment by acquiring new and useful experience. This is the prelude to the concept of Smart Service Systems, in other words, systems are open, according to the logic of Viable System approach, and capable of simultaneously optimizing the use of resources and improving the quality of the services provided.

The aim of this paper is to introduce the concept of Knowledge Based Service Systems and demonstrate that the way to make an economic, managerial, organizational, industrial, computer system smarter, which means that the system evolves by adapting to the needs and changing conditions thereby reducing the mismatch and loss of resources, is to consider, in terms of characterization, such a system as a viable system composed of components that interact through the exchange of services, and so as a Service System, and then from the point of view of the design and implementation, as a system based on the management and manipulation of knowledge, and therefore as a Knowledge Based System.

In order to achieve this aim, recent results from the world of Systems Thinking, and so from the Viable System Approach, and from Service Science will be exploited for the definition of the evolution criteria of a dynamic service system, for the description of relationships and entities, and for the identification and classification of resources employed in the process of services exchange between entities.

At the same time, we will give a description of the system, entities and services, as well as a definition of the structured knowledge based on ontologies, metadata, taxonomies and thesauri, and so a kind of Knowledge Representation which will contain both the raw data, obtained by recording the movements of the system, and the knowledge gained through the study of the domain. Consequently, we need to design a Data Mining and Knowledge, Inference and Learning system that is capable of working on both the raw and structured data and so bring both understanding and prediction, with the aim of providing the system with an autonomous behavior, so making it able to adaptively evolve thereby reducing the mismatch in the services exchange mechanism. To achieve this aim, it will be fundamental to exploit recent results obtained by the scientific community in the field of probabilistic methods for Collaborative Filtering which are based on techniques suitable for handling data belonging to the lowest level of the knowledge hierarchy (memory based), at the intermediate level (content based) and at the highest level (hybrid). Systems based on collaborative filtering are able to predict the behavior of a user based on the observation of the behavior of previous users, distinguishing two stages and alternating between them, the Learning of previous users' behavior and the Prediction of current users' behavior.

2. Becoming smarter

Since the early eighties there has been a progressive change in the traditional concept of the economic, management, organizational, relations and computer systems which considers that the exchange processes between the entities of these systems are centered on "goods", in other terms tangible resources, but rather to support a broader and structured concept, which considers the "service" as the main element in the exchange process. According to this new approach, called Service-Dominant Logic (Vargo, Lusch, 2006; 2008), the service is no longer considered as part of a “good”, but instead the service is really the only thing exchanged, consisting of "also" a tangible part, represented by just the “good”.

This change has slowly altered the original proportions between the three sectors of the economy, with the consequence that the tertiary sector, that is the service sector, currently occupies 70% of the labour force within the global economy (Ifm, IBM, 2008). The modern economic society has even encouraged the emergence of other sectors, for example, quaternary, to indicate those intellectual services that typically include services such as the information generation and sharing, information technology, consulting, training, research and development, financial planning, and other knowledge-based services.

The gradual increase in everyday life processes oriented to services has supported the development of service-oriented systems, called Service Systems. Examples range from a single person (e.g. designer, entrepreneur) to a government agency or business (for example, a branch post office or a bank) to multinational corporations (such as GAP, Zara, Federal Express) as well as industrial distribution companies (Energy Services, Telematic Services) and hospitals, universities, cities, national governments.

In the field of computer science let us consider the Service Systems based on the recent Service-Oriented Architecture (SOA), introduced to support the use of Web services, to ensure interoperability between different systems on the network and with the aim of consistently enabling companies to perform sustainable business with more agility in the costs employment and effectiveness, and so adapting to the changeable business conditions. According to this paradigm, individual applications can be used as part of the business process so that the user requests can be met in an integrated manner. Concrete examples based on SOA are those providing computing services or remote computing, such as those offered by Amazon Web Services for the Cloud Computing, the Remote Storage, scalable Database etc.

This recent development of systems based on the logic of the service has inspired a strong interdisciplinary debate on issues related to the design, study, and implementation of a service systems, resulting in what is now referred to as the Service Science.

The general concept of Service Systems is now used to refer to these complex systems composed of heterogeneous entities, including people, technology and business operations, which interact through the exchange of services. The mechanism of exchange of services, including its design, construction, application and delivery can be static or dynamic. It is static if the system actors interact only during the request and delivery of the defined service, thus making both the process of design and construction independent from such interactions. In this case, all the interactions between the Service Provider and its Clients are one directional, and no customer feedback is taken into account.

On the contrary, the nature of the mechanism is dynamic if the design, construction and then the delivery of the service depend totally or partially on the actor's request. Basically, this theory leads us to think that the service creation and delivery process should depend on the information about the customer/client. As a result of this, the Service Providers and Customers interact, establishing two flows of information:

1. From SP to Customer in order to provide services;
2. From Customer to SP in order to provide feedback on the service and general customer data.

Service systems and networks may also represent a separate type of modeling to the optimization problem (Thomas, Griffin, 1996; Dietrich, Harrison, 2006). Often, time points allow for analysis and statistical learning methods to be used to continually adapt and optimize performance of the models, such as: statistical control theory, game theory, theory and design of assessment mechanisms.

As a result, most modern systems are more focused on the central role of the customer and the processes of creation and provision of services are largely influenced by the interaction of clients with the systems and due to the fact that the conditions of a such a system may change over time then the mechanism of exchange of the service can be considered as dynamic. The dynamics of a system implies its evolution over the time and therefore its ability to adapt to the new conditions, and therefore the system's ability to remain effective.

How learning can affect future actions, which are set or reflected can be better judged by comparing all possible space and time variables within which the systemic action moves, studying the experience and knowledge gained by analyzing the iterative processes and assessments (eg the human brain) and the implementation of the procedures adopted.

Through the development of modern interpretations of service systems, we have seen the centrality of customers in the process of service creation and delivery, reinforcing the iterative and cyclical mechanism of contemporary service provision. In this direction, a new generation of complex systems which are capable of describing and analyzing a situation and taking decisions based on the available data in a predictive or adaptive manner can be defined as Smart. In fact, recent developments in Service Science Research have led to a new concept of service systems, arriving at a definition of the characteristics of Smart Service Systems (SSS).

SSS combine advances in IT tools with the evolution in thinking about system dynamic interactions, adaptive skills, sustainable development, enhanced learning, reconfiguration capacities and service innovation (IfM, IBM, 2008) in complex environments (Basole, Rouse, 2008; Demirkan et al., 2008), all converging toward something more “smart” than that we have been used to considering, generally referable, resulting in a sort of Smarter Planet.

The evolving and increasing role of interconnections, enablers, measures, standard quality and procedures represents the theoretical evidence of this evolution; intelligent utility networks and metering, intelligent transportation, consumer driven supply chains, intelligent oilfields, manufacturing productivity, instead, are the contemporary practical applications (Barile, Polese, 2010) as systems capable of serving customers better (this could be applied to water consumption and use, electricity distribution and management, public transportation, education, healthcare, etc.).

But what are the main features of a smart service system? How can we define the relevant new elements for this kind of system. In summary: What do we really mean by smart? How many perspectives do we have to consider? When do smarter conditions occur?

Are all IT systems able to get smart? How can we improve a system to consider it as smart? What are the direct implications for the business, managerial and organizational models?

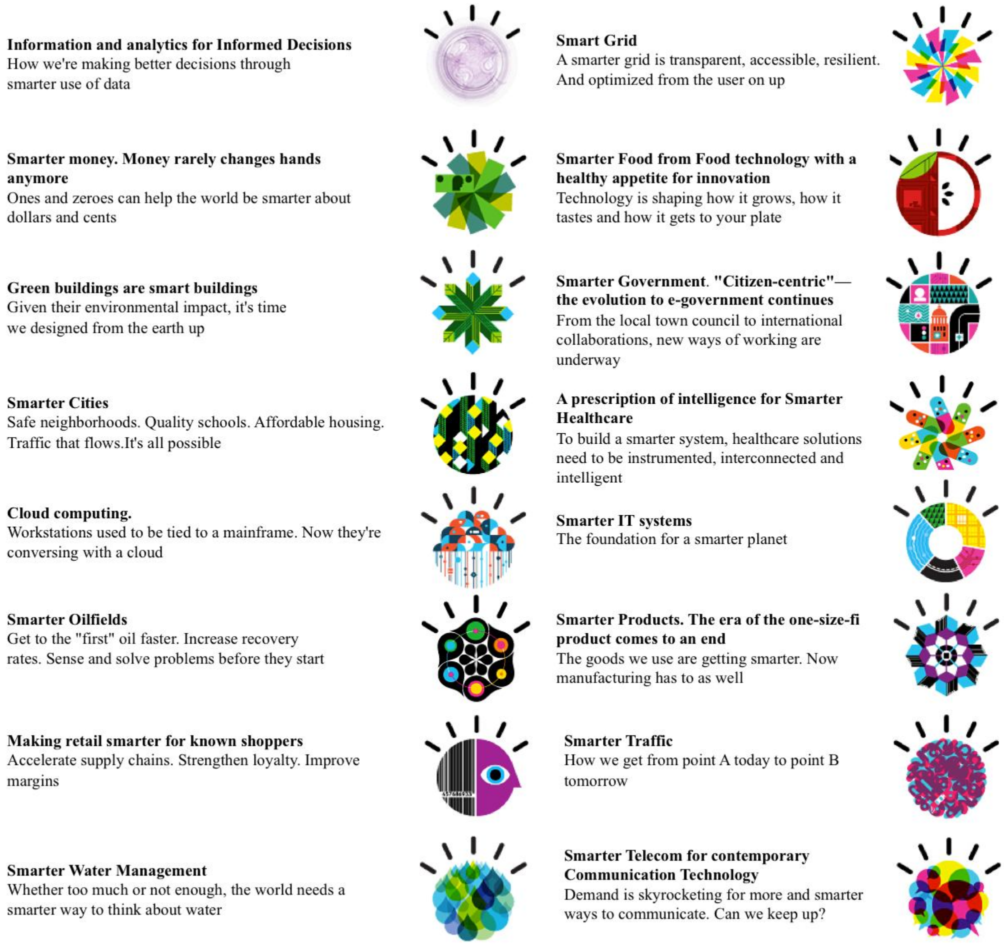

Figure1. *Smart Service Systems (SSS) on stage*

In order to stimulate thinking about smarter concepts (soon referred to as the Specific, Measurable, Agreed, Realistic and Timely phenomena), Service Science researchers have investigated every potential application of service research “on stage” (see Figure 1), referring to practical evidence about something really iterative, interactive, instrumented, interconnected, intelligent, i.e. a smarter planet. Considering a smarter overview, we have to understand what we can do to create a sustainable development of a complex system, characterized by many actors (workers, citizens, producers, providers, authorities, consumers, users, public boards, enablers, etc.) and many facilitators (such as in retail, IT, railways, grids, agriculture, finance, healthcare and government), improving managing capacities and collaborative approaches.

In this sense the intelligence of smart service systems derives not from intuition or chance, but from systemic methods of learning, service thinking, data collection, rational innovation, social responsibility and networked governance.

Applying a smart context, smart practicalities, smart cities, smart organizations, smart operations and smart outcomes to modern service “events”, we can enjoy several important changes in our life. We should note that action decisions are greatly influenced by information, highlighting the role of the barrage of data, the new contents elaboration, the intense analysis of feedback; nowadays, managers (of public or private sectors) take many informed decisions. Considering the increasing relevance of intangibility for all transactions in the modern service economy, every flow appears digital (for checking pay, retailing, depositing, accounting, etc.) and money becomes smart.

The increasing use of technology inside financial operations, and the related computer visualization and monitoring, solve many problems in banking activities. Inside the new construction style, following a specific logic for global policy, many aspects of building plans link to smart concepts. Lights, water, elevators, power and cooling for technology all contribute to making buildings a significant source of clean and reduced gas emissions and a real leading energy saver. Within a society in which the population expands and needs efficient infrastructures and utilities (such as transportation, healthcare, education, traffic organization and public safety), then we have to implement useful services to simplify the public governance of a so-called smart city, promoting greener programs, general accessibility, affordable housing, and the use of e-technologies for the evolution of a "Citizen-centric" government. Cloud computing refers to platforms designed for efficient, effective computing in wide open spaces everywhere inside diverse workloads of businesses, organizations and governments. Today, every function is in this nets-sphere. The need to understand a new kind of planet, a new style of work, a new way of making decisions, links to the possibility of teaching a new perspective in the way of doing things. The educational Masters in many important colleges in the world include T-shape issues for the contemporary MBA, for the manager of tomorrow.

The role of grids has also been raised in the last few decades; the IT development, the actualization of energy interests and the related potential meta applications all contribute to the importance of smart grids today. Connectivity, real time evaluation, standards metrics, intelligent metadata are then useful spin-offs of this new kind of networking through smarter IT and telecom. Nowadays, smart healthcare leads to a more confident diagnosis, intensive clinical knowledge, much more efficiency in officer services and waiting lists, and successful medical cases in hospital, all contributing to a collective wellbeing and sustainable improvement. Concerning the purchasing, cultivation, distribution and impact of food manufacturing, the new positive influence coming from service systems applications introduces better guidelines for smarter food, just as the car pool, mass transit and fuel-efficient solutions do for smart oilfields, or quality, quantity and collective clean availability do for smarter water.

3. The Viable System approach to Service Systems modelling

In the last decade a debate has been taking place among scientists, from different spheres of knowledge, who have been discussing the different interpretations and terminological proposals of the concepts of both service and system. This has definitely contributed to the contemporary conception of a service system (Napoletano, Carrubbo, 2010; Carrubbo, Sarno, 2010; Polese, Sarno, 2010).

In a Service Science optic, the service is considered as an entity exchanged among interdependent parts, which include people, technologies and business activities (Spohrer, Maglio, Bailey, Gruhl, 2007), and which are constantly in search of relations with other parts (Sampson, Froehle, 2006) in order to use the distinctive capacities that they possess and to attain sensible competitive advantages (Chesbrough, 2005). As a consequence, we understand that a Service System is basically composed of heterogeneous entities, interacting with each other and connected by value propositions in value chains, value networks, or value-creating systems. Dynamically, service systems appear today as value co-creators, resource integrators and connected enablers, socially constructed and knowledge-based (Maglio, Srinivasan, Kreulen, Spohrer, 2006; Vargo, Maglio, Akaka, 2008; Gummesson, Polese, 2009).

System studies and theories increase knowledge about multiple perspectives (informatics, managerial and organizational) and structuring capacities, linking components, connective functions and practical applications. Systems are in nature, in society, in science, within informatics tools and in economic sides. They are inside the human mind, organizations and general behavior. From Systems Theories we understand:

- i) "a system as a complex of interacting elements" (Von Bertalaffy, 1956);
- ii) "a system as an entity that is adaptable for the purpose of surviving in its changing environment" (Beer, 1975);
- iii) concepts of many part compositions (Parsons, 1965), boundaries, connections and different relationship levels show certain signs of system relevance and allow an interpretation of their own capabilities as being critical and influential and their relations with correspondent supra-systems and sub-systems;
- iv) "sub-systems focus on the analysis of relationships among their own internal components while supra-systems focus on the connections between the analysis unit and other influencing systemic entities in their context" (Golinelli, 2005);
- v) "a structure can be studied (what it is? how it is made?), a system should only be interpreted (how does it work? what logics does it follow?)" (Barile, 2008).

The idea of a service centered market started to become more concrete in the early eighties, when The Customer Contact Approach to Services theory was introduced (Chase, 1981; Vargo, Lusch, 2004). According to this theory the potential efficiency of a service system is a function of the degree of customer contact entailed in the creation of the service product. Basically, this theory leads us to think that the service creation and delivery process should depend on the information about the customer/client. Although the interaction between the Service Provider (SP) and its Clients is two directional, and although it can be considered as dynamic, it is not yet adaptive because the role of the customer is not active. The actions of the clients are not able in any way to influence the process of the design and construction of the service. As a consequence, most modern service systems are more concentrated on the central role of the customers and the creation and delivery processes of services are largely influenced by the interaction of the customers with the systems. This turns the service exchanging mechanism into a dynamic one.

In this situation the theories coming from the Viable System Approach can be fundamental if we need to study the evolution of a dynamic system. The company is considered as an open system that establishes relationships and interactions (flows of energy, resources, commodities and information), not only with the sub-systems, which contains and manages, but also with over-systems in which it is included. According to the Viable System Approach, systems represent a recognizable entity emerging from a specific structure within every observed active object (Golinelli, 2005) when particular conditions occur and produce some evidence. This kind of evolution derives from the dynamic activation of static existing basic relationships.

The entities of such a system employ resources to exchange services with the risk that these resources are dispersed and/or badly used with the consequence that the needs of who has required those services are not fully satisfied, and making the system inefficient which in the case of energy systems, computer or business can be translated into a catastrophic and irreversible loss of resources and an increase in dissatisfaction of those who receive the services (in this case we have non-quality costs or "failures"). As a consequence, it is necessary to develop service systems as dynamic entities capable of adaptively evolving in order to reduce the mismatch of the service exchange process, thus making it an interactive process which involves both the provider and the client in the design, creation, application and delivery of the service. This is the prelude to the concept of Smart Service Systems, in other words, an open systems, according to the logic of the Viable System approach, and capable of simultaneously optimizing the use of resources and improving the quality of the provided services.

4. Knowledge based Service Systems

The widespread use of digital technologies in all aspects of daily life has in fact improved knowledge about the behavior of individual entities involved in a complex system, thereby increasing both conscious and unconscious collaborative modes of service exchange. With the recent explosion of new generation of internet-based computer systems, that promote the information sharing and have improved the knowledge sharing on a large scale, the interactivity has been emphasized with the result that the traditional concept of the economy, which sees the difference between supply and demand as the core, has lost its meaning. According to these modes, the service, in addition to being exchanged through a dynamic mechanism, is adaptively exchanged among entities.

Thanks to the work from the Knowledge Representation community it has been possible to define the systems for the storage and processing of knowledge, initially as hierarchical databases and lattices (sixties), then relational (seventies), then such object-based (eighties), and finally semantic (thousands) or based on ontologies. And thanks to the work from the community of scientists who worked on Artificial Intelligence, Data Mining and Data Warehouse techniques applied to data, it was possible to derive models for the prediction and the fitting of a system data, thus rising a field of science that is now called Knowledge Engineering and that, according to this proposed paper, is one of the key component to obtain a Smart Service System.

In this case, the aim is to describe through structured data, which contain semantic information, and using the most recent technologies for the description of the knowledge, the set of heterogeneous entities, including people, technology and business operations, which form the system. Following this methodology, the interactions, exchanges, services, entities of such a system, become elements of matrices that contain records of raw data. The data are basic facts, encoded information that needs to be interpreted to provide knowledge. In this hierarchy, the data represents information if interpreted in a domain exploiting the knowledge about the domain, and finally, the knowledge is a set of models provided to understand the world. Once the data have conveyed knowledge, then you can do something more, and so providing understanding and prediction for further knowledge, thus following the hierarchical model, well known to the "Systems Thinking" and that is named Data, Information, Knowledge and Wisdom, and then working on structured data, with algorithms and automatic methods for inference and learning, can bring understanding and prediction. A system designed in this way is called Knowledge Based Systems.

The aim of this paper is to introduce the concept of Knowledge Based Service Systems and demonstrate that the way to make an economic, managerial, organizational, industrial, computer system be smarter, which means that the system evolves by adapting to the needs and changing conditions and thus reducing the mismatch and loss of resources, is to consider, in terms of characterization, such a system as a viable system composed of components that interact through the exchange of services, and so as Service System, and then from the point of view of the design and implementation, as a system based on the management and manipulation of knowledge, and therefore as Knowledge Based System.

In order to reach the aim, recent results from the world of Systems Thinking, and so from the Viable System Approach, and from Science Service will be exploited for the definition of the evolution criteria of a dynamic service system, for the description of relationships and entities, and for the identification and classification of resources employed in the process of services exchange between entities.

At the same time we give the description of the system, entities and services, as well as the definition of the structured knowledge based on ontologies, metadata, taxonomies and thesauri, and so a kind of Knowledge Representation which will contain both the raw data, obtained by recording the movements of system, and the knowledge gained through the study of the domain. Consequently, we need to design a Data Mining and Knowledge, Inference and Learning system that is capable to work on both the raw and structured data and so to bring both then understanding and prediction, with the aim of providing an autonomous behavior to the system, and making it able to adaptively evolve reducing the mismatch in the services exchange mechanism. To this scope, it will be fundamental to exploit recent results obtained by the scientific community in the field of probabilistic methods for Collaborative Filtering which are based on techniques suitable to handle data belonging to the lowest level of the knowledge hierarchy (memory based), at the intermediate level (content-based) and at the highest level (hybrid). Systems based on collaborative filtering are able to predict the behavior of a user based on the observation of the behavior of previous users, distinguishing two stages and alternating between them:

1. Learning of previous users' behavior (Learning)
2. Prediction of current users' behavior (Inference).

The most important feature of collaborative filtering based techniques is the ability to cross, relating to a specific situation, different aspects of knowledge.

4.1 Knowledge based systems

Regarding to the formality of the knowledge needed in this system, we can affirm that two aspects must be taken into account, (Gruber, 1993; Guarino, 1998; Hepp, 2007; Hjrland, 2009; Hofmann, 1999):

1. the degree of formality and expressivity of the language used to describe it;
2. how formal are the information sources used to build such a knowledge.

Based on this consideration we can form a continuum of kinds of knowledge (Chang, 2001, 2002, 2005; Uschold, 2004), starting from raw data, relational and object -based data and continuing to rigorously formalised semantic representation until ontology-based description, see Figure 2, which contribute to form a hierarchical organization of the knowledge (Giunchiglia, 2005).

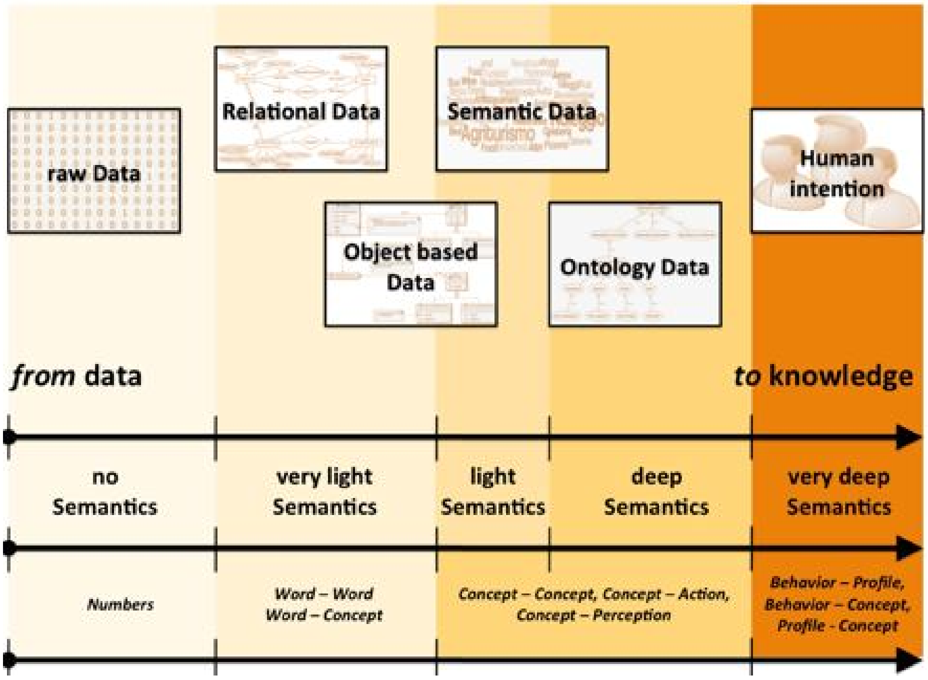

Figure 2. *Hierarchical organization of the knowledge*

In everyday life, people rely on recommendations from other people through word of mouth, reference letters, news reports from news media, general surveys, travel guides, and so forth. Recommender systems assist and augment this natural social process to help people sift through available books, articles, web pages, movies, music, restaurants, jokes, grocery products, and so forth, to find the most interesting and valuable information for them. The developers of one of the first recommender systems, Tapestry (Goldberg, Nichols, Oki, Terry, 1992) (other earlier recommendation systems include rule-based recommenders and user-customization), coined the phrase "collaborative filtering (CF)," which has been widely adopted regardless of the facts that recommenders may not explicitly collaborate with recipients and recommendations may suggest particularly interesting items in addition to indicating those that should be filtered out (Resnick, Varian, 1997). The fundamental assumption of CF is that if users X and Y rate n items similarly, or have similar behaviors (e.g. in buying, watching, listening), they will rate or act on other items similarly (Goldberg, Roeder, Gupta, Perkins, 2001).

There are many challenges for collaborative filtering tasks (Xiaoyuan, 2009). CF algorithms are required to have the ability to deal with very sparse data, to scale with the increasing numbers of users and items, to make satisfactory recommendations in a short time period, and to deal with other problems like synonymy (the tendency of the same or similar items to have different names), shilling attacks, data noise, and privacy protection problems. Early generation collaborative filtering systems, such as GroupLens (Resnick, Iacovou, Suchak, Bergstrom, Riedl, 1994), use the user rating data to calculate the similarity or weight between users or items and make predictions or recommendations according to those calculated similarity values. The so-called memory-based CF methods are notably deployed in commercial systems such as http://www.amazon.com/ and Barnes and Noble, because they are easy-to-implement and highly effective (Linden, Smith, York Linden, Smith, York, 2003).

Customization of CF systems for each user decreases the search effort for users. It also promises a greater customer loyalty, higher sales, more advertising revenues, and the benefit of targeted promotions (Ansari, Essegaier, Kohli, 2000). However, there are several limitations for the memory-based CF techniques, such as the fact that the similarity values are based on common items and therefore are unreliable when data are sparse and the common items are therefore few. To achieve a better prediction performance and overcome the shortcomings of memory-based CF algorithms, model-based CF approaches have been investigated.

Model-based CF techniques use the pure rating data to estimate or learn a model to make predictions (Breese, Heckerman, Kadie, 1998). The model can be a data mining or machine learning algorithm. Well-known model-based CF techniques include Bayesian belief nets (BNs), CF models (Su, Khoshgoftaar, 2006), clustering CF models (Ungar, Foster, 1998), and latent semantic CF models (Hofmann, 2004). An MDP (Markov decision process)-based CF system (Shani, Heckerman, Brafman, 2005) produces a much higher profit than a system that has not deployed the recommender. Besides collaborative filtering, content-based filtering is another important class of recommender systems (Clarizia, Colace, De Santo, Greco, Napoletano, 2010). Content-based recommender systems make recommendations by analyzing the content of textual information and finding regularities in the content. The major difference between CF and content-based recommender systems is that CF only uses the user-item ratings data to make predictions and recommendations, while content-based recommender systems rely on the features of users and items for predictions (Si, Jin, 2003). Both content-based recommender systems and CF systems have limitations. While CF systems do not explicitly incorporate feature information, content-based systems do not necessarily incorporate the information in preference similarity between individuals. Hybrid CF techniques, such as the content-boosted CF algorithm (Melville, Mooney, Nagarajan, 2002) and Personality Diagnosis (PD), combine CF and content-based techniques, hoping to avoid the limitations of either approach and thereby improve recommendation performance.

5. Conclusion and future works

In this paper we have focused the attention on several aspects related to the design and analysis of Service Systems, which have led to a wider conception that considers the digital technologies as the main core of such systems.

The enormous success of the digital technologies in all aspects of daily life has in fact provided new ways of monitoring, recording, interpreting and discovering of the behaviour of individual entities involved in a complex system. Such technologies include tools for information management, and so for knowledge representation and management, and tools for information processing, and so for knowledge inference, discovering, data mining. Those aspects are fundamental in the creation of what we have called the Knowledge based Service System, that is the extension of classic conception of a Service System with the contribution of digital technologies for its management.

In the last years, due to the resources crisis in each field, it has been discovered the necessity of resources optimization, which have slowly led to the idea of a Smarter Planet, now considered as more than a slogan. Due to the fact that the Service System paradigm is today used to model each economic, managerial, organizational, industrial or computer system, the idea of a Smarter Planet can be easily pursued by focusing on the design of a smarter Service System, that evolves by adapting to the changing conditions and thus reducing the mismatch and loss of resources. Such a system can be obtained by considering, in terms of characterization, such a system as a viable system composed of components that interact through the exchange of services, and so as

Service System, and then from the point of view of the design and implementation, as a system based on the management and manipulation of knowledge, and therefore as Knowledge Based System.

The authors consider, as a future work, to apply such theories to some real cases such as: management of alternative and/or sustainable energy systems, of agriculture and the environment, of heritage and artistic systems, of sustainable mobility, of homeland security, of health and life sciences.

6. References

ANSARI, A., ESSEGAIER, S., KOHLI, R. (2000), "Internet recommendation systems", in *Journal of Marketing Research*, vol.37, n.3, pp. 363-375.

BARILE, S. (eds) (2008), *L'impresa come sistema. Contributi sull'approccio sistemico vitale*, II ed., Giappichelli, Torino.

BARILE, S., POLESE, F. (2010), "Smart service systems and viable service systems: applying systems theory to Service Science", in *Service Science*, vol.2, n.1/2, pp.21-40.

BASOLE, R.C., ROUSE, W.B. (2008), "Complexity of service value networks: Conceptualization and empirical investigation", in *IBM Systems Journal*, vol.47, n.1, pp.53-70.

BEER, S. 1975. "Preface", in H.R., Maturana, F.J., Varela, Autopoietic Systems, BLC Report 9, University of Illinois.

BITNER, M.J., BROWN, S.W. (2006), "The Evolution and Discovery of Services Science in Business Schools", in *Communications of the ACM*, vol.49, n.7, pp.73–78.

BREESE J., Heckerman, D., Kadie, C. (1998), "Empirical analysis of predictive algorithms for collaborative filtering," in *Proceedings of the 14th Conference on Uncertainty in Artificial Intelligence*.

CARRUBBO, L. (2010), "Service science, management, engineering and design and its suggestions for destination management", in Proceedings of the 13th TOULON Verona Conference, in Coimbra.

CARRUBBO, L., SARNO, S. (2010), "The emerging perspective of Service Science for management and marketing research", in *Impresa Ambiente Management*, vol.3; pp.1-14.

CHANG, SHI-KUO, (2001, 2002, 2005), Handbook of Software Engineering and Knowledge Engineering (ed., vol. I, vol. II, vol. III),

CHASE, R.B., (1981), "The Customer Contact Approach to Services: Theoretical Bases and Proactical Extension", in *Operations Research*, vol.21, n.4.

CHESBROUGH, H. (2005), "Towards a new science of services", in *Harvard Business Review*, pp.204-210.

CLARIZIA, F., COLACE, F., DE SANTO, M., GRECO, L., NAPOLETANO, P. (2010), A New Technique For Identification Of Relevant Web Pages In Informational Queries Results, in *Proceedings of the 12th International Conference on Enterprise Information Systems*.

DEMIRKAN, H, GAUL, M. (2006), "Towards the Service Oriented Enterprise Vision: Bridging Industry and Academics", in *Communications of the Association for Information Systems*, vol.18, pp.546-556.

DIETRICH, B., HARRISON, T. (2006), "Serving the Services Industry", in *OR/MS Today*, vol.33, n.3.

GIUNCHIGLIA, F, MARCHESE, M., ZAIHRAYEU, I. (2005), Towards a theory of formal classification, in *Proceedings of the AAAI05 International Workshop Contexts and Ontologies: Theory, Practice and Applications*, AAAI Press.

GOLDBERG, D., NICHOLS, D., OKI, B. M., TERRY, D. (1992), "Using collaborative filtering to weave an information tapestry", in *Communications of ACM*, vol.35, n.12, pp.61-70.

GOLDBERG, K., ROEDER, T., GUPTA, D. PERKINS, C. (2001), "Eigentaste: a constant time collaborative filtering algorithm", in *Information Retrieval*, vol.4, n.2, pp.133-151.

GOLINELLI, G.M. (2005), *L'approccio sistemico al governo dell'impresa. L'impresa sistema vitale*, CEDAM, Padova.

GRUBER, T.R. (1993), "A translation approach to portable ontology specifications", in *Knowl Acquis*, vol.5, pp.199-220.

GUARINO, N. (1998), *Formal Ontology in Information Systems*, IOS Press, Cambridge, MA.

GUMMESSON, E., POLESE, F. (2009), "B2B is not an island", in *Journal of Business & Industrial Marketing*, vol.24, n.5, pp.337-350.

HEPP, M., DE BRUIJN, J. (2007), "Gentax: A generic methodology for deriving owl and rdf-s ontologies from hierarchical classifications, thesauri, and inconsistent taxonomies", in *4th European Semantic Web Conference*, LNCS Springer, pp.129-144

HJRLAND, B. (2009), “Concept theory”, in *Journal of the American Society for Information Science and Technology*, vol.60, pp.1519-1536.

HOFMANN, T. (1999), “Probabilistic latent semantic indexing”, in*: Proceedings of the Twenty Second Annual International SIGIR Conference*.

IFM, IBM (2008), *Succeeding through Service Innovation: A Service Perspective for Education, Research, Business and Government*, University of Cambridge Institute for Manufacturing, Cambridge.

LINDEN G., SMITH, B., YORK, J. (2003), “Amazon.com recommendations: item-to-item collaborative filtering,” IEEE Internet Computing, vol.7, n.1, pp.76-80.

LUHMANN, N. (1990), *Soziale Sisteme. Grundriß einer allgemeinen Theorie*, Suhrkamp Verlag, Frankfurt.

MAGLIO, P.P., SPOHRER, J. (2008), “Fundamentals of service science”, in *Journal of the Academy of Marketing Science*, vol.36, n.1, pp.18-20.

MAGLIO, P.P., SRINIVASAN, S., KREULEN, J.T., SPOHRER, J. (2006), “Service systems, service scientists, SSME, and innovation”, in *Communications of the ACM*, vol.49, pp.81-85.

MELVILLE, P., MOONEY, R.J., NAGARAJAN, R. (2002), “Content-boosted collaborative filtering for improved recommendations,” in *Proceedings of the 18th National Conference on Artificial Intelligence*, Edmonton, Canada, pp. 187-192,.

NAPOLETANO, P., CARRUBBO, L. (2010), “Becoming Smarter: Towards A New Generation Of Services Systems”, in *Impresa Ambiente Management*, vol.3, pp.1-14.

NAPOLETANO, P., CARRUBBO, L. (2010), “Becoming smarter: towards a new generation of services systems", in *Impresa, Ambiente e Management*, anno IV, n.3/2010, pp.409-431.

PARSONS, T. (1965), *Il Sistema Sociale*, Edizioni Comunità, Torino.

POLESE F., CARRUBBO, L. (2008), “La Service Dominant Logic ed una sua interpretazione al fenomeno turistico”, *in Impresa Ambiente e Management*, anno II, n.1/2008, pp.5-36.

POLESE F., MORETTA TARTAGLIONE, A., SARNO, S., CARRUBBO, L. (2009), “An Efficient Value Chain, or a Service Value Network? Best Practices deriving from Zara”, in Vrontis, D., Weber, Y, Kaufmann, R., Tarba, S. (eds), *Managerial and Entrepreneurial Developments in the Mediterranean Area*, EuroMed Press: Cipro.

POLESE F., RUSSO, G., CARRUBBO, L. (2010), “Managing business relationships. Between Service Culture and Viable Systems Approach", in *Esperienze di Impresa*, vol. 2/2010, pp.135-158.

POLESE, F. (2009), “Local government and networking trends supporting sustainable tourism: some empirical evidences” in Fusco Girard, L., Nijkamp, P. (eds), *Cultural Tourism and Sustainable Local Development*, Ashgate, London, pp.131-148.

POLESE, F., MINGUZZI, A. (2009), “Networking approaches for sustainable destination management: an Italian case study”, in Kozac M., Andreu L., Knoth J. (eds), *Advances in Tourism Marketing. Managing Networks*, Routledge, London, pp.113-124.

POLESE, F., RUSSO, G., CARRUBBO, L. (2009), “Service Logic, value co-creation and networks: three dimensions fostering inter-organisational relationships: competitiveness in the boating industry”, in *Proceedings of "12th QMOD and Toulon-Verona Conference*", Verona, 27–29 Ago.

POLESE, F., SARNO, S. (2010), “Service innovation within new public governance theories e-platforms as Smart Service Systems for public utilities”, in *Impresa Ambiente Management* vol.3; pp.1-14.

RESNICK, P., IACOVOU, N. SUCHAK, M. BERGSTROM, P. RIEDL, J. (1994), “Grouplens: an open architecture for collaborative filtering of netnews”, in P*roceedings of the ACM Conference on Computer Supported Cooperative Work*, New York, pp.175-186.

RESNICK, P., VARIAN, H.R. (1997), “Recommender systems”, in *Communications of the ACM*, vol.40, n.3, pp.56-58.

RULLANI, E. (2009), “Impresa come sistema intelligente: alla ricerca di nuovi modelli di governance e di valore”, in *Sinergie* vol.80, pp.103-142.

SAMPSON, S.E., FROEHLE, C.M. (2006), “Foundations and Implications of a Proposed Unified Services Theory”, in *Production and Operations Management*, summer, pp.329-343

SHANI, G., HECKERMAN, D., BRAFMAN, R.I. (2005), “An MDP-based recommender system”, in *Journal of Machine Learning Research*, vol.6, pp.1265-1295.

SI, L. JIN, R. (2003), “Flexible mixture model for collaborative filtering,” in *Proceedings of the 20th International Conference on Machine Learning*, Washington, DC, vol.2, pp.704-711,

SPOHRER, J., BARILE, S., POLESE, F. (2010), “System Thinking for Service Research Advances”, Editorial of Special Issue in *Service Science*, Vol.2 No.1/2, pp.I-III.

SPOHRER, J., MAGLIO, P.P., BAILEY, J., GRUHL, D. (2007), "Steps Toward a Science of Service Systems", in *IEEE Computer*, vol.40, n.1, January, pp.71-77.

SU, X., KHOSHGOFTAAR, T.M. (2006), "Collaborative filtering for multi-class data using belief nets algorithms", in *Proceedings of the International Conference on Tools with Artificial Intelligence*, pp.497-504,

THOMAS, D.J., GRIFFIN, P.M. (1996), "Co-ordinated supply chain management" in *European Journal of Operational Research*, vol.94,n.3, pp.1–15.

UNGAR, L.H., FOSTER, D.P. (1998), "Clustering methods for collaborative filtering," *in Proceedings of the Workshopon Recommendation Systems,* AAAI Press.

USCHOLD, M., GRUNINGER, M. (2004), "Ontologies and semantics for seamless connectivity", in *IGMOD Rec*., pp.58-64

VARGO, S.L., LUSCH, R.F. (2004), "Evolving to a New Dominant Logic for Marketing", in *Journal of Marketing*, vol.68, pp.1-17.

VARGO, S.L., LUSCH, R.F. (2006), "Service-Dominant Logic: What It Is, What It Is Not, What It Might Be", in R.F. Lusch, S.L. Vargo (eds), *The Service-Dominant Logic of Marketing: Dialog, Debate, and Directions.* Armonk, ME Sharpe, pp.43-56.

VARGO, S.L., LUSCH, R.F. (2008), "Service-Dominant Logic: Continuing the Evolution", in *Journal of the Academy of Marketing Science,* vol.36, n.1, pp.1-10.

VARGO, S.L., MAGLIO, P.P., Akaka, M.A. (2008), "On value and value co-creation: a service systems and service logic perspective", in *European Management Journal*, vol.26, n.3, pp.145-152.

VON BERTALANFFY, L. (1956), "General System Theory", in Emery, F.E., (eds.), *General System, Yearbook of the Society for the Advancement of General System Theory*.

VON FOERSTER, H. (1981), *Observing Systems*, InterSystems Pubblication, Seaside.

XIAOYUAN, SU, TAGHI, M., KHOSHGOFTAAR, T.M. (2009), "A Survey of Collaborative Filtering Techniques," in *Advances in Artificial Intelligence*.