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# Towards Employing Social Information for Web services Management in SoC-based IoT Ecosystem

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**Abstract**

In the service oriented computing (SOC) stream, Web service management has a pivotal role such as service composition and recommendation, which are key aspects and high directive research field. With the emergence of social Web (Web 2.0), social-aware service composition and recommendation are becoming more and more widespread. Although, the benefits of employing social knowledge in different service management tasks, there has been no detailed investigation of using social data that are gathered from classic Web until smart Web (Web 4.0). This paper provides an overview of the integrating social information into service-based systems and attempts to show that exploitation of various social entities such as users, services and objects. In addition, it compared the different existing approaches and analysing them.

***Keywords***: Web Services ; Social Networks; Web of Things ; Social internet of Things; Recommendation; Composition.

## 1. Introduction

Web of Things (WoT) is the extension of classic Web that is expected to enable deploying Web services and to make it discoverable and compose new ones. Physical things offer many of those services. In service-oriented computing based WoT, service management has been one of the hot issues. Recently, a number of researchers have sought to tackle this issue. With the emergence of social Web (Web 2.0), several attempts have been made to enhance service management by exploiting Web 2.0 technologies. Over the last decade, there has been lots of research done both social computing, service oriented computing and WoT on providing new approaches for services management. Maamar et al. research's [15] is one of the few studies that have investigated the exploiting of the social aspect of the entities in classic Web (Web 3.0 and less), and classifying the social networks into users social networks and services networks. To the best of our knowledge, there is no analytical study has emphasized on the social aspect from social Web to Web of thing. Furthermore, no previous study has classified and analyzed the social-aware approaches according the three entities: User, Service and Thing.

The prevalence of social networks led up to new generation of service-based systems. Those systems are employed social data that are collected from social environment in order to enhance the performance of system. Intuitively, we divide the research on social computing into three draws, which are socialization of users, services and things. Some studies focused on the sociability of human, which used the classic social networks of people like Twitter and Facebook to mine social information, in order to improve services management tasks, such as recommendation and composition. Several researchers were concerned with sociability of Web services; hence, Collaborative networks of Web services are proposed in literature, which Web service passed from isolated to social one. The evolution of Internet of Things has led to define another kind of social entities, which are physical objects, that is what known as Social Internet of things.

In this paper, we present a survey on the blending of social-aware service management with WoT; in objective to clarify the social aspect, which may use in service management. The contributions of this paper as:

- Classifying social-aware services management approaches into three main categories: social user-aware, social service-aware and social thing-aware .
- Elaborating a new taxonomy for social networks of users based on the social nodes, Links between them, Social knowledge is considered, and which Social networks analysis and measures are used.
- Labeling Web services with sociability behavior into Intra social and Inter social services.

The rest of this paper is structured as follows: the second section introduces by defining some concepts, that we are used in our research. We present in Section 2 Social user aware approaches. We continue in Section 3 sketching the social service aware studies; before the paper is concluded in Section 5, we present in the section 4, Social Thing aware approaches.

## 2. Social user awareness approaches

In recent years, with the emergence of social Web, many research studies has been conducted on the exploiting the sociality of people, by imposing the social knowledge from the social networks in service oriented computing, such as Web service discovery, selection ,composition and recommendation…etc. This section presents related research on this topic .

In [1] the authors proposed a method for personalized recommendation of manufacturing services; they exploited friends' relationship amidst the social network of consumer enterprises, in order to find the trustworthy enterprises for consumer. The friendship is defined as the connections times; which represents the trust weight for global reputation calculation. [2] Provided Web service recommendation based on social network approach, In users' social network the trust is used as social relationship among users. Trust relations and similarity of users are combined to define the trust relevancy; which measures the trustworthiness of neighbors and weights the social network, in order to ratings prediction in making recommendation. The authors in [3] provided planning algorithm for semantic Web service composition in social environment of users, which they exploited the social trust information from users' ratings of the services to find the trustworthy services. [4] exploited the sociality of service providers to calculate the ratings of services using centrality measures, in order to build a framework for dynamic Web service composition. The authors in [5] integrated the social networks concept into composition process. The platform SoCo is built for service discovery and selection; which exploited the social ties among user to calculate the social proximity, and the user profile to mine the interactions between users and services. The services raking for recommendation is based on the knowledge is extracted for the social network. Reference [6] proposed multi-agent system based approach for Web service selection, which exploited different relations kinds in the social network. The selection of the trustworthy service is depend on his provider's trustworthiness, which the trustworthy service is service with high expertise, it is given from good recommender and it is offered by high social provider, hence the trust value is calculate upon three measures : i) Trust in sociability, ii)Trust in expertise, iii) Trust in recommendation. Reference [7] presented multidimensional social relationships; which constructed models for the relationships; the main matrix models the relations among services and mashups, the subsidiary matrices model on hand the relation of mashups with topics and creators, on the other hand the relation of services with topics, providers and tags. The social relationships are used to discover and to select services for mashup creation oriented recommendation. [8] presented a method for service providers recommendation, the trustworthy recommendation is based on the social context of the recommender users and the context of the target service. The social context of the participants is divided into dependent and independent social context; the first one presents the relations between the participants, such as the social intimacy degree and the trust, the second one refers to the personal characteristics of participant such as the preference and the expertise .In [9] the authors proposed a platform (SNRNeg) to recommend service for negotiation, the framework gathers the information from participants social network and then selects list of services, and finally ranks them by using the reputation of services. [10] provided a system allows owners of things to share the services offered by them on social network, which enables users to share their smart things on Web with trusted people (friends, neighbors, relatives…etc.). In order to trust management in IOT system, [11] proposed social network based method for service composition, which used three social relations: community of interests, social contact and friendship between the user and the trustee device .

- Discussion

This section discusses users' social networks, and proposes a taxonomy for those networks, which are widely exploited in service management approaches (Fig.1). A key aspect of exploiting social networks of users in service management is the answering of those questions:

- What is the purpose of using SNs?
- What is the usefulness of the social knowledge ?
- What are the social nodes?
- Which are the social relationships employed ?

In service oriented computing, numerous studies have been imposed the SNs in service recommendation such as [1][2][6] [9], in addition the SN concept has been used in service composition; which named social composition as in [5]. Likewise, the authors in references [3] and [4] used SNs analysis for service composition. In reference [7], social recommendation has proposed for mashup creation. Furthermore, in internet of things services the traditional social networks such twitter or Facebook are employed as frameworks to enable owners of devices to share them on the Web [10], in the same context, IOT system supported service composition are proposed in [11], which the trust management method based on social network of device owners. The social knowledge could be used in service composition or recommendation processes classified into two class; micro level knowledge and macro level knowledge. Micro level knowledge means the individual information of social entity such as user interest, experience and personal characteristics…, etc. In addition, macro level knowledge refers to the social behaviors and the public information in the SN such as the global reputation, trust values, ratings on services or users, tags, topics and all the different relationships among social node. In users social networks the nodes are consumers [3][5] or providers [4][6] or both of them [9]. Moreover, in IoT systems the social users are the owners of devices [10][11]. The costumers and the enterprises [1] able to be social entities in social networks for manufacturing services recommendation. Moreover, the participant in the social media such as Facebook on Twitter and their opinions and reviews are widely used for service oriented computing and internet of things. In the social networks there is numerous kinds of social relations could be

exploited, which are direct or indirect, implicit or explicit, one-dimensional and multi-dimensional. The most types relationships used are friendship, trust, neighborhood, social proximity…etc .

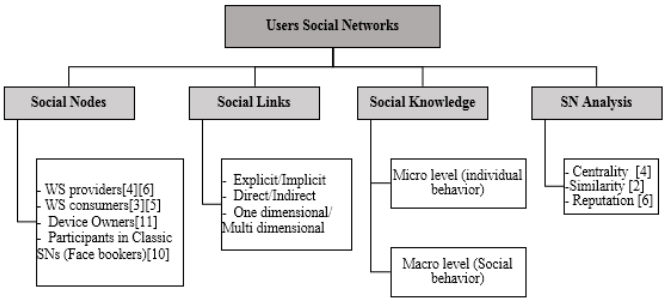


Fig.1. Users Social Networks Taxonomy.

## 3. Social service awareness approaches

Exploiting Web service sociability enables to improve the quality of service oriented computing applications such as service composition, recommendation, discovery and selection. We categorize the sociability of services into two main categories; which we called: “intra social services” and “inter social services.”.Inter social service refers to services capable to interact and communicate with different social entities such us human or things into a complex social networks. Contrarily, intra social service expresses Web services, which are able to connect just to other Web services that belong in the same services social network. In this section, we survey social service awareness approaches according to aforementioned our classification.

A. Intra social services

In order to service recommendation, the authors in [12] constructed social network of Mashup services, which defined two types of social relationships among them; that are invocation and marking In IoT environment, the authors in [13] presented a social network of IoT services based on the relationships among devices. They provided three algorithms for service selection in order to enhance service composition, service selection process based on services clustering and classification according the social relationships between them, which are location, type and correlation Reference [14] is one of the first researches focused on the imposing the socialization concepts into Web services. Social network of semantic Web services is proposed to improve Web service discovery and composition oriented ranking. Social networks analysis such as link analysis and connectivity measures are mentioned in order to enhance the raking methods . Maamar et al. in [15] proposed two types of Web service social networks, which are similar and different. In similar social network, the nodes are Web services have similar functionalities. The links between Web services in this network are competition and substitution. The Web services are not have the same functionalities are able to collaborate in order to services composition, hence, they are clustered in different social network. In [16] the authors networked Web services by combining negative and positive links from historical composition based on popularity and time factors. Reference [17] provided three models of Web services networks, the nodes in those networks are Web services, their operations and input / output parameters. Clustering those nodes into networks allows making the matching phase efficiency and enhances Web service composition and discovery. Collaborative network of Web services is presented in [18] in order to trustworthy service selection. Three kinds of neighborhood clustering are proposed, input neighbors, output neighbors and invoking neighbors. The time is considered in the collaboration relationship between Web services. In [19] the authors exploited different social relationships among Web services in order build platform for Web service management, which taken on consideration all the interactions between services situated in the same community or from another communities. The social relations were used are supervision, competition, substitution, collaboration and recommendation .

B. Inter social services :

Reference [5] provided an extended social network based on classic social networks such Facebook. The proposed social network exploited the relation among users and Web services. In addition, mined knowledge from this social network is used to rank Web services. In order to create mashup, the authors in [7] provided Web service recommendation based on social network. The social nodes are users, Web services and past mashups, the relationships among those nodes are modeled by coupled matrix, which used to infer the implicit information and exploited it to rank Web services. In this section, we discuss the aforementioned studies, we proposed analytical table (TABLE.1), which defines two main criteria to analyze social service aware approaches. The first one is the description of social environment that includes the social environment, the social nodes and the links among them. The second criteria refers to the phase of services management, which is enhanced by imposing the social knowledge into their stages.

| Work | | Social Environment Description | | | WS Management |
|---|---|---|---|---|---|
| | | *Social Environment* | *Nodes* | *Edges* | |
| Intra social services | [12] | Mashup services SN | Mashup services | Invocation<br>Marking | Recommendation |
| | [13] | Social Web of things | IoT services | Location<br>Type<br>Correlation | Selection for composition |
| | [14] | Web service Social Network | Semantic WSs | N/A | Ranking for discovery and composition |
| | [15] | Similar WSSN | Atomic Web services | Competition<br>Substitution | Recommendation for Discovery |
| | | Different WSSN | | Collaboration | Recommendation for composition |
| | [16] | WSs collaboration Network | Composite Web services | Positive and negative connection | Recommendation for composition |
| | [17] | WSs Network | Web services | Co-Work services according operation and parameter matching | Discovery for Composition |
| | | Operation Network | Operations | | |
| | | Parameter Network | Inputs and Outputs | | |
| | [18] | Collaborative Network of WSs | Web services | Neighborhood<br>Timed Collaboration | Trustworthy selection for composition |
| | [19] | Web services communities | Masters and Slaves WSs | supervision competition substitution collaboration recommendation | Management |
| Inter social services | [5] | Extended Social Network | Users<br>WSs | User to user (Friendship)<br>User to Service (Consumption, composition) | Recommendation for composition |
| | [7] | Multi-dimensional Network | Users<br>Mashups WSs | Service to user (creating, providing)<br>Service to service (similarity) | Recommendation for Mashup creation |

TABLE.1 Social Services-aware approaches analysis

## 4. Social Thing based approaches

The social Internet of things paradigm refers to Social Networks of intelligent objects, which things are able to communicate with each other. The authors in [20] defined five kinds of social relationships among object. Reference [21] defined SIoT as an ecosystem enables humans and things to interact within social environment resembling classic social networks. The concept of Social WoT introduced in [22], which express the integration of objects into existing social networks, such Twitter and Facebook, in order to allow people sharing things and managing Web services offered by them. In the context of SOC-based IOT, Social Internet of Things has little been exploited for managing Web services. In literature a few studies has been conducted on this topic. The authors in [21] provided a framework for discovering services based on SIoT, Reference [23] proposed SIoT based method to optimize service recommendation for efficient composition. In order to services adaptation, [24] presented an architecture for services adaptation based on subjective and objective context. Saleem et al. in [25] proposed the concept of exploiting SIoT to enhance service recommendation . Although the abovementioned works handled the issue of SIoT, exploiting the social relations among real-world devices for Web services-based systems is still in its infancy.

## 5. Conclusion

This paper has explored and analyzed the different social- aware service management approaches. It was conducted in the form of a survey, with studies being gathered via Web 2.0 until Web 4.0. An objective of this study was to trace the contribution of the social data to enhance services management. In the future work, we also plane to investigate on the integrating of social relationships among IoT devices to improve the quality of service-based system such as service composition platforms and service recommender system in IoT environment.

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