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Research Article

A Social Network-Based Web Service Framework for Optimal Actor Engagement for Enhancing Connectivity and Service in Agriculture

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ABSTRACT –

The emergence of social networks have opened a new paradigm for professional groups to student groups to exchange their information with their contemporaries quickly and efficiently. The social networking enables to set up re- lations among the people (called actors) who share common interests, activities or connections. An actor or a person plays a predominant role in sharing social networking services, hence optimal provision of web service to actors is essential. Web service is an important area of research which enables actors to acquire required services over devices such as smartphone, laptop, etc. In this paper, we present a Social Network based Web Service (SNWS) by considering actor's characteristic features such as personal information, professional information, social status, etc. along with relation among the actors. The designed SNWS is tested over an Agriculture Social Network (ASN) which constitutes a set of actors along with their characteristic features and the relations among the actors, and renders the required web service such as Uniform Resource Locator (URL) to actors. Results are obtained for accuracy of the Actor Relational Model (ARM), and the average service time required by a set of actors. The proposed Actor Relational Model is accurate, and there is significant improvement in the average service time.

Introduction: focuses on leveraging social networks to connect farmers, suppliers, and stakeholders for improved collaboration. It facilitates real-time information sharing, resource optimization, and knowledge dissemination. The framework enhances agricultural productivity by fostering community-driven solutions and personalized support. By integrating technology and social engagement, it bridges gaps in accessibility and service delivery.

Objectives: To establish a platform for seamless interaction and real-time communication between farmers, suppliers, agricultural experts, and policymakers, To optimize the sharing of agricultural resources, knowledge, and best practices among stakeholders, thereby improving efficiency and productivity, To provide data-driven insights and recommendations through analytics, enabling better decision-making in agriculture, To foster active participation and collaboration among stakeholders, addressing common challenges and developing collective solutions, To integrate modern technologies such as IoT, sensors, and data analytics for providing farmers with tailored recommendations and enhancing farming practices, To bridge gaps in access to critical agricultural information, tools, and market opportunities, especially for small-scale farmers.

Methods: The methodology involves designing a web-based platform that integrates social networking features with advanced agricultural tools and services. The framework leverages user profiles to categorize actors such as farmers, suppliers, experts, and policymakers, enabling targeted engagement and collaboration. Data collection through IoT sensors, satellite imagery, and user-generated content feeds into a centralized system for real-time analysis and decision-making. Algorithms are employed to match stakeholders with relevant resources, market opportunities, and expert advice. The system also incorporates communication tools, including forums, messaging, and video conferencing, to facilitate interaction. A pilot implementation phase with select agricultural communities is conducted to test the framework's effectiveness, followed by iterative improvements based on user feedback and performance metrics. The final framework aims to enhance connectivity, streamline resource sharing, and empower stakeholders through a scalable and user-friendly platform.

Results: The implementation is for Optimal Actor Engagement for Enhancing Connectivity and Service in Agriculture" demonstrated significant improvements in stakeholder collaboration and resource optimization. Farmers reported increased access to real-time information, expert advice, and market opportunities, leading to better decision-making and productivity gains. The platform facilitated faster communication between actors, reducing response times for critical issues such as pest outbreaks or weather-related challenges. Additionally, the use of analytics enabled tailored recommendations, improving resource utilization and promoting sustainable farming practices. Pilot studies showed a notable increase in farmer engagement, with measurable improvements in crop yields, cost savings, and market reach. The framework also strengthened the linkages between policymakers and grassroots actors, leading to more inclusive and effective agricultural strategies. Overall, the results highlighted the platform's potential to revolutionize agricultural connectivity and services.

Conclusions: the work successfully bridges the gap between agricultural stakeholders, fostering real-time collaboration, resource optimization, and informed decision-making. By leveraging modern technologies and social networking features, the framework enhances productivity, sustainability, and market access while empowering farmers and communities. This innovative approach demonstrates the potential to revolutionize agricultural practices, paving the way for a more connected, efficient, and resilient agricultural ecosystem.

Keywords: Actor, Characteristic Features, Relation, Social Network, Web Service. Actor, Characteristic Features, Relation, Social Network, Web Service.

1. INTRODUCTION

Social networks [11], [10], [2], [18], [16], [19] have influenced actors of different regions to share the information due to the advancement in the information technology. The main goal of a social network is to make the information space, where actors can share information like thoughts, personal data, events, etc. It shares the basic purpose of interaction and communication, and specifies goals and patterns that vary significantly across different regions of actors. Visibility of information [12], [14], structural variations [20], and access [15], [4], [5] are significant characteristics of a social network. The most distinguishing features of a social network are relationships among social entities, patterns and deduction of these, while linking structure of social relationships to behaviours of actors participating in it. The popularity of social networks have increased because they enable study of social network actors and relationships among them along with service provisioning. The blending of a social network with web services is the new area of research, which has opened new opportunities for service provisioning. A web service is a function that can be accessed by other programs over the web. Unlike in traditional web service which is targeted at programs, a social network based web service takes people (known as actors) into account. In other words, a social network-based web service has changed the way in which a web service is provided to actors considering relations among them along with their activity. A social network-based web service is the intersection of a social network, web service, and activity of actors as shown in Figure 1 [1][2].

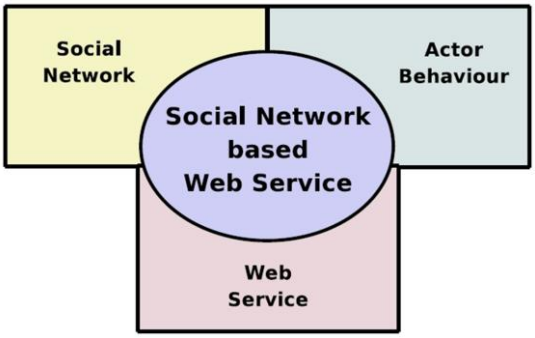

Fig. 1. Social network based web service.

1.1 Proposed Idea

In this paper, we propose a Social Network based Web Service (SNWS) which takes characteristic features of actors like personal information, professional information, social status, etc. into account along with activity of actors. Depending upon the relations built among actors and activity of actors, the desired URL is provided to the actors. Dynamic variation of relations along with activity information of actors are the key factors in the provision of the SNWS [3][4].

1.2 Organization of the paper

The organisation of the rest of the paper is as follows. Section II covers some of the existing works on social network-based web service. Some of the definitions and notations used in the social network-based web service (SNWS) are described in Section III. Design of a social network-based web service (SNWS) is presented in Section IV. An application of the Agriculture Social Network (ASN) where the SNWS has been deployed to provide specific web services to actors of the network is shown in Section V. Simulation environment and results are discussed in Section VI and Section VII, respectively, followed by conclusion in Section VIII.

2 Some of existing works on social network based web service

Very few works exist on social network-based web service, where an innovative support to monitor and describe services. to users via social, physical and computational information along with the socio-technical context was proposed [3]. Trust based recommendation for the social web was proposed [17] considering the trust relationship between users and their peers. A framework to manage web services using the concept of community and the metaphor of social networking was discussed [21], and five interactions were identified and referred to as supervision, substitution, competition, collaboration, and recommendation. Most of the studies did not consider the connection among the actors based on social network. Some of the studies proposed [7] an algorithm for searching a social network of web services in order to select an effective set of web services that can collaborate to attain the goal of composite web service [5][6].

Some of the external source techniques that were proposed were not feasible in most of the cases, hence Yang in [22] proposed an effective algorithm to cater web services for clustering web opinions that overcome the weakness of the existing document clustering techniques. Recently, a study of social network was carried out which focussed on developing a trust inference model, where the proposed approach involved construction a web of trust (i.e., a network of pair-wise trust relationships). A trust framework rating-based approach was presented [13], where partial feedback rating to predict a degree of trust was developed. Ranked and composed results for developing a web based personalised academic visit recommendation system was shown [23] along with social network ranking and composi tion strategies. An algorithmic framework for interests-based retrieval in the context of multiple interests types from social network was proposed [24], and developed the active academic visit recommendation application based on academic social network data [7][8].

Very few approached provided methodologies for managing trust in social web services, hence a prototype of a trust-based selection, an ontology for managing trust in social web services was proposed [9]. The possibility of managing trust between the users of a web-based social network while recommending items to the members of the network was

investigated, and a novel framework was proposed [1] to recommend most appropriate item to a user of the network. Another study showed [8] how to exploit social network to provide privacy in personalised web search since privacy concerns have a long history. An approach [6] that combines social networking and semantic web technology to facilitate the dynamic web service composition based on artificial intelligence reasoning and planning was carried out [9][10].

3 Definitions & notations used in a social network

In this section we provide some of the definitions and notations associated with a social network. The most important constituent of a social network is an actor (ai) which is defined as an entity that can participate in a social network. Actors are connected with each other in form of a relation, and a relation among actors ai and aj is represented as raiaj . A group (G) is a collection of actors which is formed from common interests, activities, etc. of actors. Characteristic features of an actor ai (CF (a_i)) is defined as a set of qualities that describe an actor. Characteristics features of actors used in the SNWS are given in Table I. Some of the characteristic features of an actor ai are personal information ($PerI(a_i)$) which includes name, address, IP address and telephone number whereas professional information ($ProI(a_i)$) consists of education, occupation, qualification and role. Social status ($SocS(a_i)$) comprises of class, position, ethnicity and religion, while history ($Hist(a_i)$) includes coordination, interactions, etc [11][12].

An example of an actor a_i with the Characteristic Features (CF) is given by

(1) Personally Identifiable Information (*PerI*)	Name	{*name of the actors*}
	Address	{*home address of the actors*}
	IP address	{0.0.0.0.0.0 *to FF.FF.FF.FF.FF.FF*}
	Telephone	{*telephone number of the actors*}
(2) Professional Information (*ProI*)	Education	{*PhD, ME, MS, BE, BS*}
	Occupation	{*administrator, banking, finance, businessman*}
	Qualification	{*number of years spent in college, equipment handling, courses, conferences*}
	Role	{*provider, collector, manager, security*}
(3) Activity (*Act*)	Current	{*research activity, course teaching, session conduction, group seminar, meetings*}
	Past	{*joint number of publications, research topics undertaken, conference attended, positions*}

Characteristic features	Subcharacteristics	Set
(1) Personally Identifiable Information ($PerI$)	Name	$\{name\ of\ the\ actors\}$
	Address	$\{home\ address\ of\ the\ actors\}$
	IP address	$\{0.0.0.0.0.0\ to\ FF.FF.FF.FF.FF.FF\}$
	Telephone number	$\{telephone\ number\ of\ the\ actors\}$
(2) Professional Information ($ProI$)	Education	$\{PhD, ME, MS, BE, BS\}$
	Occupation	$\{administrator, banking, finance, businessman\}$
	Qualification	$\{number\ of\ years\ spent\ in\ college,\ equipment\ handling, courses, conferences\}$
	Role	$\{provider, collector, manager, security\}$
(3) Activity (Act)	Current	$\{research\ activity,\ course\ teaching,\ session\ conduction,\ group\ seminar,\ meetings\}$
	Past	$\{joint\ number\ of\ publications,\ research\ topics\ undertaken,\ conference\ attended,\ positions\}$
(4) History ($Hist$)	History of actor	$\{coordination,\ interactions,\ worked\ on\ similar\ project,\ research\ similarity,\ published\ papers\}$

Table 1. Characteristic features used in the SNWS.

$$CF(a_i) = \{XYZ, 21st\ street\ (NY), 080-86945668, PhD, Professor, Academics, Research, Publications\}$$

Consider a group G consisting of a set of actors $\{a_1, a_2, a_3, \ldots\ldots, a_k\}$, where each actor $a_i \in G$ have common characteristic features with the group G, i.e., $CF(a_i) \cap CF(G) \neq \varphi$. The set of characteristic features of the group G can be obtained as [13][14]

$$CF(G) = \sum_{i=1}^{n^k} CF(a_i) | \forall a_i \in G$$

$$= \sum_{i=1}^{n^k} \{PerI(a_i), ProI(a_i), Act(a_i), Hist(a_i), SocS(a_i) \mid \in G\}$$

A relation ($R_{ij} = R(a_i, a_j)$) defines the way in which two actors a_i and a_j are connected in a social network. A relation R_{ij} can be defined as an expression involving one or more common characteristic features of actors a_i and a_j. The relation among actors a_i and a_j is set up based on their common characteristic features as [15][16]

$$R(a_i, a_j) = \{PerI(a_i) \cap PerI(a_j)\} + \{ProI(a_i) \cap ProI(a_j)\} + \{SocS(a_i) \cap SocS(a_j)\} + \{Hist(a_i) \cap Hist(a_j)\}$$

Figure 2 shows two actors a_i and a_j with relation $R(a_i, a_j)$ amongst them.

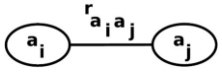

Fig. 1. Relation ($r\ a_i a_j$) among actors a_i and a_j.

There are five primitive operators in relational algebra, and other operations can be deduced through these primitive operators. According to the relational model, we could define five basic operators of relational algebra over characteristic features of actors. Consider actors a_i and a_j with respective set of characteristic features CF (a_i) and CF (a_j). The following operations can be easily followed [17][18].

Union Set

$$CF(a_i) \cup CF(a_j) = \{CF \mid (a_i) \vee CF \in CF(a_i j)\}$$

Intersection

$$CF(a_i) \cap CF(a_j) = \{CF \mid (a_i) \wedge CF \in CF(a_i j)\}$$

Difference Set

$$CF(a_i) - CF(a_j) = \{CF \mid CF \in CF(a_i) \wedge CF \in / CF(a_j)\}$$

Selection

$$\sigma_p(CF(a_i)) = \{CF \mid p(CF) \wedge CF \in CF(a_i)\}$$

Projection

$$\prod_{k_1, k_{2,\ldots,} k_m} (CF(a_i)) = \{(k_1, k_2, k_3, \ldots, k_m) \mid k_i \in CF(a_i) \wedge for\ i\ taking\ values\ from\ 1,2, \ldots . m\}$$

In a social network, acquisition of social context information about actors is important to provide necessary ser vices. Context describes own view of a thing or an actor. For example, an actor social environment, what he/she is related to, etc. The context information is gathered from social, physical, system and application environments. The most important context information for a social network is the social context which includes social behaviour, preferences, social identity, social trust, etc. A construct is a multiway data structure with predefined context variables. Social CI-Constructs (SoCI-Constructs) are used to collect an actor's social context information. We have designed the following SoCI-Constructs by choosing [19][20]:

- SoCI-What: this construct asks for social context information on something.
- SoCI-Who: introduces clause of giving social information on an actor.
- SoCI-When: specifies social information at or on which.
- SoCI-Where: provides social information in or to what place.

An example of SoCI-Who construct is shown in Figure 3.

4 Social network based web service

Social network based web service is the process by which an actor can be provided with the required web service such as URL (Uniform Resource Locator). We discuss a Social Network based Web Service (SNWS) which takes relationship among actors and their social context information into consideration as shown in Figure 4, and provides appropriate URL's to actors. Dynamic change of relationship among actors and their changing context are the key factors in the proposed SNWS [21][22].

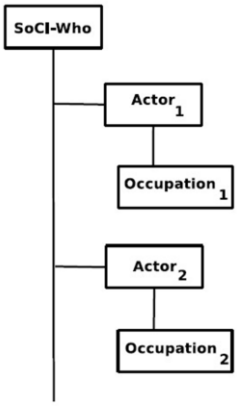

Fig. 3. Social Context Information-Who (SoCI-Who) Construct.

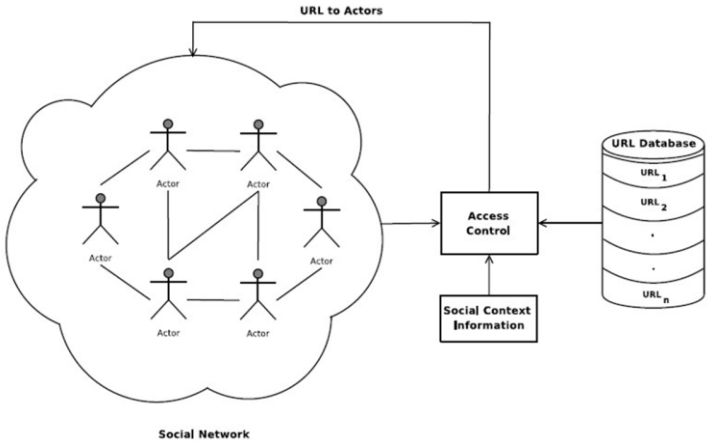

Fig. 4. Social Network based Web Service Model.

4.1 Relation among actors in a social network

A relation (R) defines the way in which two or more actors are connected in a social network. A function (F) can be defined as an expression involving one or more characteristic features of actors. Formulation of relations from characteristic features (CF) of actors such as personal information ($PerI$), professional information ($ProI$), activity (Act), history ($Hist$), etc., and functions are shown in Figure 5, where relations are deduced bases on the available functions over the characteristic features of actors. The set of relations $R = \{r_1, r_2, ..., r_r\}$, where r_i is the selected from the set of relations R which contains r_1 to r_r relations used to represent various functions on which the relation will be formed. The functions are formed for all possible characteristic features, i.e., by taking the given characteristic features in 2s combination, 3s combination and so on. Similarly, the relations (R_{ij}) among actors a_i and a_j are formed for all possible functions, i.e., by taking the given functions in 2s combination, 3s combination till Ks combination. For example, (see Figure 5), a set of functions (f_1 and f_2) over characteristic features ($PerI$ and $Hist$) may lead to the relation (r_1) among actors a_1 and a_n. The categorisation of the relationship among actors a_i and a_j is given as [23][24]

$$Relation\ among\ a_i\ and\ a_j = \begin{cases} r_1 & \text{if } R_{ij}\ is\ formed\ as\ f_1 \cup f_2 \cup f_3 \\ r_2 & \text{if } R_{ij}\ is\ formed\ as\ f_2 \cup f_k \\ . & . \\ . & . \\ r_r & \text{if } R_{ij}\ is\ formed\ as\ f_3 \cup f_k \end{cases}$$

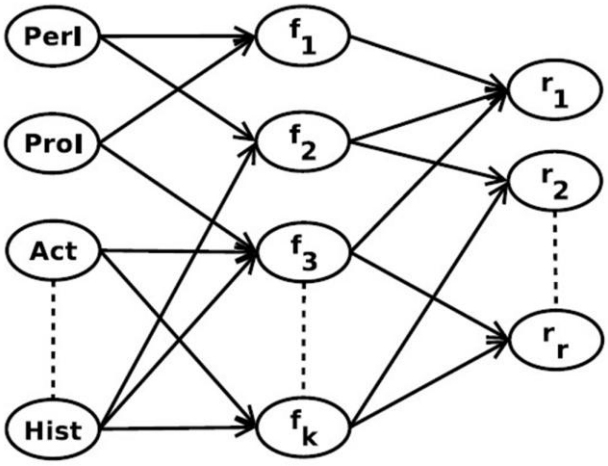

Fig. 5. Formulation of relation from functions and characteristic features of actors in a social network.

4.2 Acquisition of social context information using constructs

We have designed a template of SoCI-Construct to suit to collect social context information either from the devices of actors. They are SoCI-What, SoCI-Who, SoCI-When, and SoCI-where. For example, consider an actor a_i belonging to a social network, who want a web service. The social context information construct collects the following information about the actor a_i [25][26]

- SoCI-What a_i: ask for what web service the actor a_i wants.
- SoCI-Who a_i: introduces clause like who is the actor a_i.
- SoCI-When a_i: specifies when the actor a_i requires the required web service.
- SoCI-Where a_i: provides the web service to the actor a_i at a particular place.

4.3 Web service selection based on relations & social context information

Web service such as URL selection mainly depends on the social relations among actors, and social context information. Consider an actor a_i who wants URL_i. The actor a_i is in relation with other actor a_j who has access over URL_i. Using social context information of the actor a_i and a_j such as who is the actor, what he does, when and where the service is required, the provision of the required web service URL_i can be carried out. Functioning of the service selection module is given in Algorithm 1 [27][28].

5 Design of a social network based web service for the agricultural social network

In this section, we demonstrate an application for the Agriculture Social Network (ASN) using the SNWS. We have

Algorithm 1 - Selection of the required web service=

1) Begin
2) Input: Set of relations among actors and their social context information
3) Output: Selection of the required web service (URL)

4) Selection of the web service based on relations
5) Refine the obtained web services by using social context information
6) Select unique highly matched web service based on relations and social context information
7) Provide the required web service URL to the actor
8) Return web service
9) End

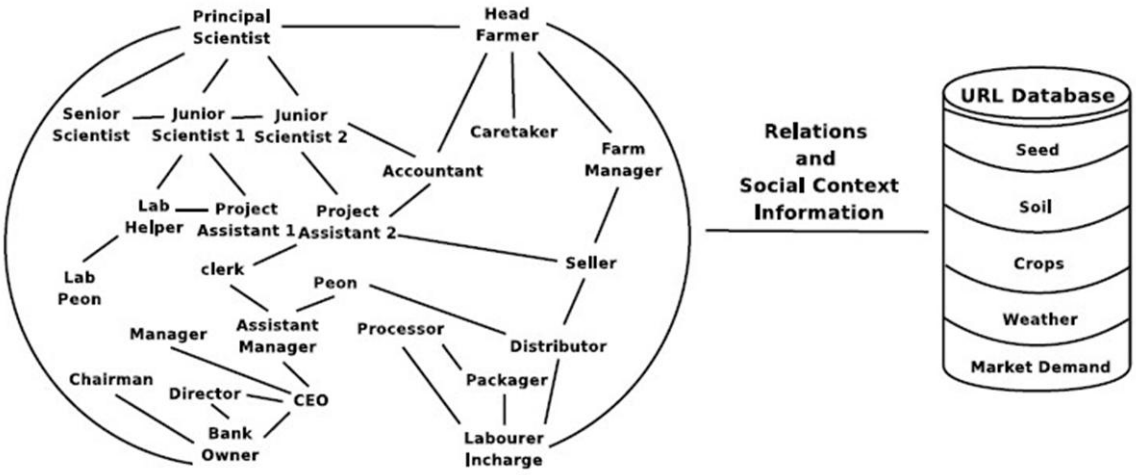

Fig. 6. A typical application the agriculture social network.

This could be considered as a typical 25 actors based ASN to discuss the GAMSN as shown in Figure 6. Dynamic acquisition and updating of actors' relations and their social context information are the key to achieve a social network based web service provisioning in the ASN.

6 Simulation Environment

We have considered relations among actors and four groups of actors to simulate the SNWS. Initially the relation among actors are found out along with the acquisition of the social context information. As actors enters the system randomly, the SNWS dynamically monitors different relations among the actors, and depending upon social context information of actors, required web service is provided [29].

7 Simulation Results

We have simulated the SNWS (on Java platform) and result is shown in Figure 7, where the graph is plotted as average service time against number of requests of different actors of the same group, and shows that upto certain number of requests (28) the average service time is nearly equal but as number of requests increases, there is significant difference in the average service time. Another graph is plotted in Figure 8 for average service time for number of requests of different actors of different groups, and again shows that initially average service time is nearly same (upto 21 number of requests), but as number of requests increases, the average service time varies significantly. In both the cases the average service time decreases with consideration of relations and constructs for the same number of requests [30][31].

Bar graph 9 shows the comparison of the percentage of satisfaction for different actors of the same group, and indicates that the percentage of satisfaction is more in case of consideration of relations and constructs than in case of consideration of without relations. For the case of percentage of satisfaction more than 75%, the number of actors satisfied are more in case of consideration relations and constructs than in other cases. The comparison for the percentage of satisfaction for different actors of different groups is shown in bar graph 10, and also explains that the number of actors satisfied are more for the case of consideration of relations and constructs (72 for ¿75) than in other cases (62 and 54 for ?75%) [32][33].

The graph (Figure 11) is plotted as normalised percentage of accuracy of the model for different actors of the same

group, and shows the accuracy of the model for different actors is more in case of consideration of relations and constructs, than in case of without relations. Another graph is plotted in Figure 12 normalised percentage of accuracy of the model for different actors of different groups, and shows that the accuracy of the model increases with consideration of relations and constructs [34].

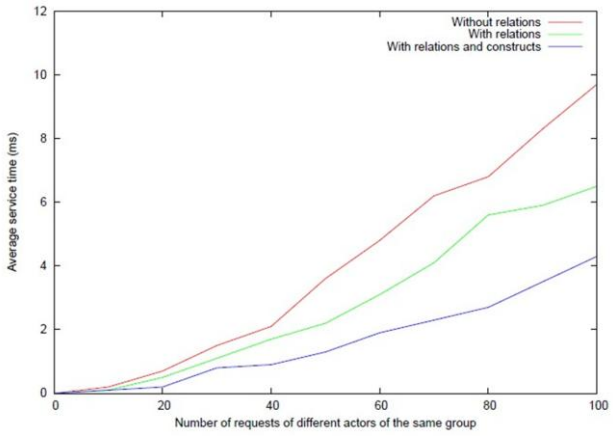

Fig. 7. Average service time vs Number of requests of different actors of the same group.

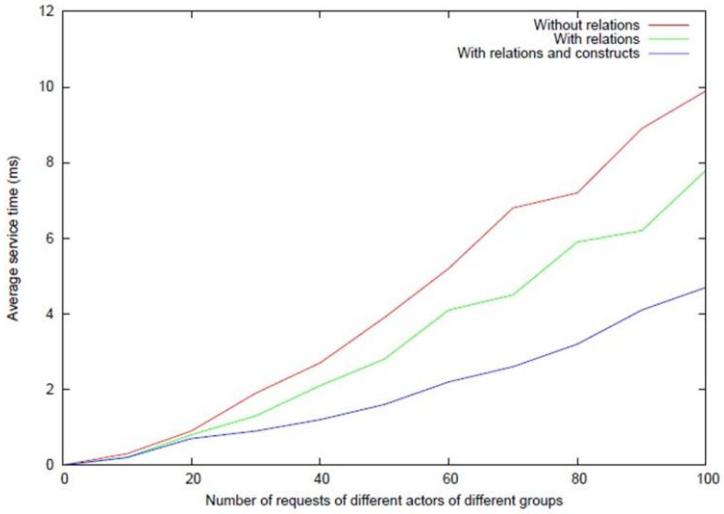

Fig. 8. Average service time vs Number of requests of different actors of different groups.

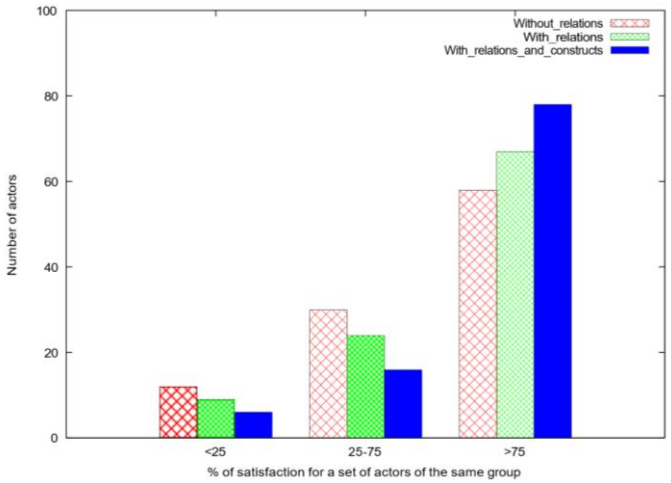

Fig. 9. Number of actors vs Percentage of satisfaction for different actors of the same group.

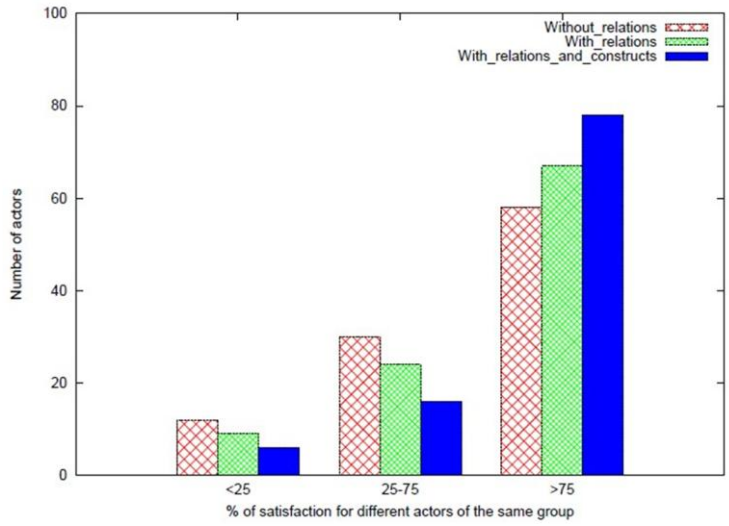

Fig. 10. Number of actors vs Percentage of satisfaction for different actors of different same groups.

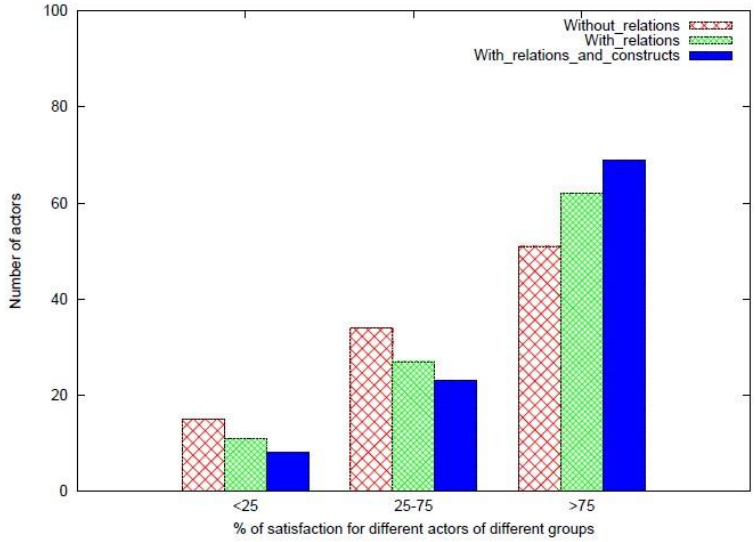

Fig. 11. Normalised percentage of accuracy of the model for different actors of the same group vs Actor.

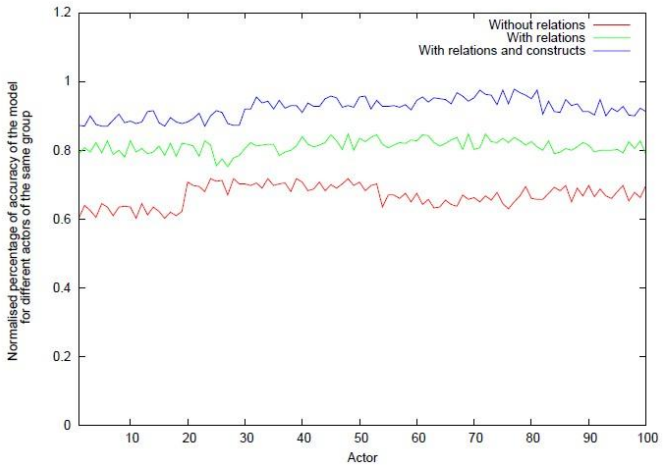

Fig. 12. Normalised percentage of accuracy of the model for different actors of different groups vs Actor.

6 Conclusions

A social network-based web service is a new concept in provision of web service for the actors in a social network. A

social network-based provisioning of web services was presented, which facilitated provision of information about different URL to actors. It utilized relations among actors and their social context information. The SNWS was designed for the agriculture social network, where the acquisition of the relations among actors and social context information related to the actors of the agriculture occupation was carried out. Relations of actors were dynamically acquired and updated. Graphs obtained were consistent with the generalised formulation and the application. The proposed model can be easily deployed to provide the required web services to actors in a social network.

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