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Trust Optimization in The Single Web Services Using a Neuro-Fuzzy System

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Abstract

Due to improvement of Internet, employing web services is developed. Trust is a main criterion to choose the proper web service as web services selection is a main issue which is still absorbing researchers to conduct research works on this field and analyze it. Due to the significant of this problem, neuro-fuzzy system is used to optimize the trust of single web services. Eight factors such as QoS, user preferences, subjective perspectives, objective perspectives, credibility of raters, bootstrapping, dynamic computing of trust and independency are considered in the considered neuro-fuzzy system. To achieve a trust optimization, 8 membership function various neuro-fuzzy systems are considered in this paper. Ultimately, the obtained results illustrates that the root mean square error, the precision amount, the recall amount and the F score amount of the neuro-fuzzy system is: 0.0873 %, 0.986, 0.988 and 0.987.

Keywords:
Web service
Trust
Neuro-fuzzy system

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INTRODUCTION

These days, numerous web services were published because of fast development internet. WS (Web Services) are considered as novel solutions for building enterprise application systems. These services can share the services of various organizations utilizing facilities based on services, for such reasons as ease of performing, the possibility of reuse and the cost (Al-shargabi et al., 2020). A WS is a self-explaining software which can be located, utilized and advertised throughout the web by applying a series of standards including:

SOAP (Simple Object Access Protocol): this is an XML-based protocol allowing WS to interchange their information via HTTP.

WSDL (WS Definition Language): this describes the location, the details of the web and how to utilize WS.

UDDI (Universal Description, Discovery and Integration): this is a handbook to store data on a different WS.

WS supports direct interplays with other software applications employing XML-based messages via internet-based applications (Abidi et al., 2019).

Generally, WS includes community, composite and single structures. Single web services are facilities responding to user demand alone. For the demands of users who do not obtain a demand via a single web service, composite WS organized a set of single services. Also, community web services contain a couple of SWS or combined WS with various non-functionally and the same functionally abilities. The SWS, used for performing and optimizing community and composite WS, is the base of WSs (Wahab et al., 2015).

Trust plays a significant role in WS. It is typically a positive expectation or belief regarding the comprehended dependability, reliability and the confidence in a person, a smart organization, object and agent (Duan et al., 2019). Because of large number of WSs, selecting trusted WS is very significant. It is required to trust WSs to utilize those (Artz & Gil, 2007)

TMMs (trust management models) can work in different orders including WSs, computer networks and multi-agent system (Mareeswari & Sathiyarnoorthy, 2012).In addition, trust is a main component of interactive procedures which it has been explained by different researchers in different fields of study such as computers. Hence, in choosing the best WS, evaluating trust is a significant criteria (Wang & Vassileva, 2009). Employing trusted WS leads to many advantages: higher performance of evaluating systems in different applications, storing data more securely according to users' standards, the possibility of retrieving data sources based on users' criteria, the possibility of discerning reliable information and sources from false ones and distinguishing inappropriate services from decent ones (Wang & Huang, 2016).

This study is classified as: a literature review of recent papers about trust in WS is presented in part 2. Following, part 3 expressed this study's trust evaluating model for SWS including eight criteria with sub terms. After that, neuro-fuzzy system are presented for evaluation trust in SWS according to such criteria. The simulation tests and assessing the results are expressed in part 4. Ultimately, the conclusion of this paper is presented in part 5.

PREVIOUS WORKS

Trust is a necessary part for acceptance and utilizing new services. Recently, in selecting WS, trust level is a significant subject, no more so than when a client seeks a service among numerous services presented by various providers (Guo et al., 2017).

Most presented methods for managing and evaluating trust consider one aspect of trust. For instance, in the statement (Golbeck, 2005) evaluated trust based on societal criteria in social networks. In the statement (Skopik et al., 2014) proposed a new method for simulating trust based on interaction services among users. The trust can have social aspects, conceptual aspects, communicational structure and etc. therefore, in different queries, users can considered one or more aspects of the trust based on the type of query and, their requested web services.

In the statement (Liu et al., 2014) introduced a new assessment model of web services through the use of trusts as a solution. First, they integrated trust management module with one of standard service-oriented architecture and then after changing a web service network to small global network based on trust relationships from service entities, they have proposed a self-assessment model with a reformative logic. The results indicate that the proposed model have high detection capability. In the statement (Golbeck et al., 2003) developed a FOAF design including trust declaration with values from 1 to 9. Here, 1 means absolute distrust but 9 expressed absolute trust for who was issued a declaration. When users write a sentence on web, they can describe the information of trust by using sentences. Thus, trust networks are created for a particular concept based on trust declarations.

(Dragoni, 2010) classified trust-based methods in three main groups. At the first group, people use their past experiences to trust. In the second group, a trusted third party, chosen by votes received from trusted person, is employed to obtain the trust. In the third group, a combination method of group 1 and group 2 is applied.

The classifications of WS including community, combination and single WS were explained by (Wahab et al., 2015) who expressed the efficient criteria to evaluate trust for such WS. Additionally, they defined a series of techniques employed in the past studies for evaluating web service trust.

Generally, there are for techniques for evaluating single WS including techniques based on fuzzy, data mining, statistical and feedback. Recently, researchers conducted research based on these methods to assess, estimate and model single WS trust.

Feedback techniques are defined based on the opinion of gathering visit of an especial WS. After that, the visits are utilized for creating an amount of trust for the WS. A consumer or a producer can be the source of the visit. The information produced by consumer includes online visits done users who are related to the service prepared within recent interactions. For evaluating the trust in Web Service excluded from 5 criteria such as quality of service, user preferences, objective and subjective perspectives, dynamic computing of trust and independency (Maximilien, 2005)employed the method based on feedback obtained from the previous users' trust. This paper developed a multi-agent framework based on ontology to assess the quality of the service and then it presented a new model of trust so that providers declare their services and, users set their priorities. Ultimately, the services' ranking should be built and shared. Similarly, to assess the trust in web services (Malik & Bouguettaya, 2009) applied the method based on feedback and it considered four criterions including quality of service, user preferences, credibility of raters and the dynamic computing of trust. This article presented a framework based on reputation services providing the based-trust services for evaluating the credibility of service providers. In this technique, the consumer of the service presented an appropriate weight based on different votes of the evaluators regarding to future services providers.

For describing the correlation between a set of variables acquired from mathematical equations, overall statistical techniques are employed. In single web services, statistical techniques are employed for calculating the trust's values for WS. These techniques depend on feedbacks of visits done by users or producers who may be incredible. This is one of the main challenge of feedback-based techniques which can be tackled by considering numerous sources of trust and applying the statistical techniques for combining them. (Malik & Bouguettaya, 2009) considered four criterions (quality of the service, user preferences, credibility of raters, dynamic computing of trust) for such goal. This paper presented a framework named RATEweb assessing the trust in service oriented environments. The overall target of RATEweb is making the choice easy and combining based on trust. In this framework, web services shared their experiences, obtained from service providers, with their counterparts through feedback comments. Ultimately, the authors presented a statistical technique for the combining the criterions of service providers and for the calculating the credibility of service providers. Additionally, this paper compared the framework with previous methods and finally it managed to obtain better results.

The existing service web trust models do not aggregate different sources of trust (objective and subjective), and they do not concentrate on different attributes such as efficiency, accessibility and etc. For this reason, (Nguyen et al., 2010) considered five criteria such as service quality parameters, user's priority, subjective and objective perspectives, credibility of raters and independency for evaluating the trust in single web services and it performed the trust evaluation by using bayesian network. This reference presented a reputation model and a bayesian network for web services. In this technique considered different states for bayesian network for addressing the problems of user's priorities and the trust based on multi-parameters of service quality. However statistical techniques evaluate trust by combining several types of trust sources, it cannot present initial trust for coming new web services.

(SHerchan et al., 2006) considered five criterions (service quality parameters, user's priority, subjective and objective perspectives, credibility of raters and independency) and it presented a fuzzy model in order to argue in reputation field in web services. The paper estimated the user's behavior ranking based on three parameters including: time response, accessibility and efficiency, in web services. The authors considered time response and accessibility as objective perspectives while they considered the efficiency as subjective perspectives. Additionally, the article expressed the user's behavior ranking based on aforementioned parameters as a criterion for reputation and web services ranking.

They presented a management framework of fuzzy trust determining the subjective perspectives of trust for web services requested by consumers. However this paper considered fuzzy methods based on users' requests, it did not take into account not only the details and the grouping of a web service but also bootstrapping strategy (Nepal et al., 2010).

They employed three-level fuzzy technique for assessing the trust. For calculating single web service, this paper changed subjective and objective perspectives to two disparate subjective perspectives and objective perspectives, and ultimately it performed the evaluation for eight obtained criterions by using three-level fuzzy technique (SHirgahi et al., 2017).

Data mining including an increasing tendency are more generalized in various areas such as engineering, business, science, medicine and etc. in spite of its significance, this technique is not employed for development and the operation in the area of reputation and trust matters in WS. This technique is typically used for evaluating the trust of service quality. (Throw & Delano, 2010) to calculate the QOS evaluation, trust evaluation in single web services used text mining in data mining methods for analyzing the users' opinions. Also, (Su et al., 2017) proposed a trust-aware method TAP for reliable personalized QOS estimation. At first, it clustered the users and then it computed the users' reputation based on the clustering data by using a beta reputation system. At the second, it introduced a series of trustworthy analogous users based on the computed users similarity and reputation. Ultimately, the paper recognized a series of analogous services by clustering the services and building a prediction for active users by mixing the analogous services and the QOS data of the trustworthy analogous users.

RECOMMENDED TECHNIQUE

Based on previous papers, these techniques considered some criteria of trust for evaluating the web services trust; however, they did not take into account all aspects of trust for WSs. In this paper, the authors concentrated exclusively on a single WS and they employed integrated criterions for optimization the single web services trust. This article used neuro-fuzzy system to obtain an exact prediction of the true faith. Neuro-fuzzy system were used to optimize the trust of the single web service, which is a new method that gives better results compared to the previous methods.

For evaluation the single WS trust, this article employed 8 criteria in order to develop quality and optimize the quality terms utilized by neuro-fuzzy technique. A fuzzy system applying a learning algorithm inspired by or derived from neural network theory is neuro-fuzzy system which determines its fuzzy rules and fuzzy sets by processing data samples.

Single web service trust criteria

To assess the trust of single web services, this study considers eight measures. fig. 1. illustrates the totality of criteria.

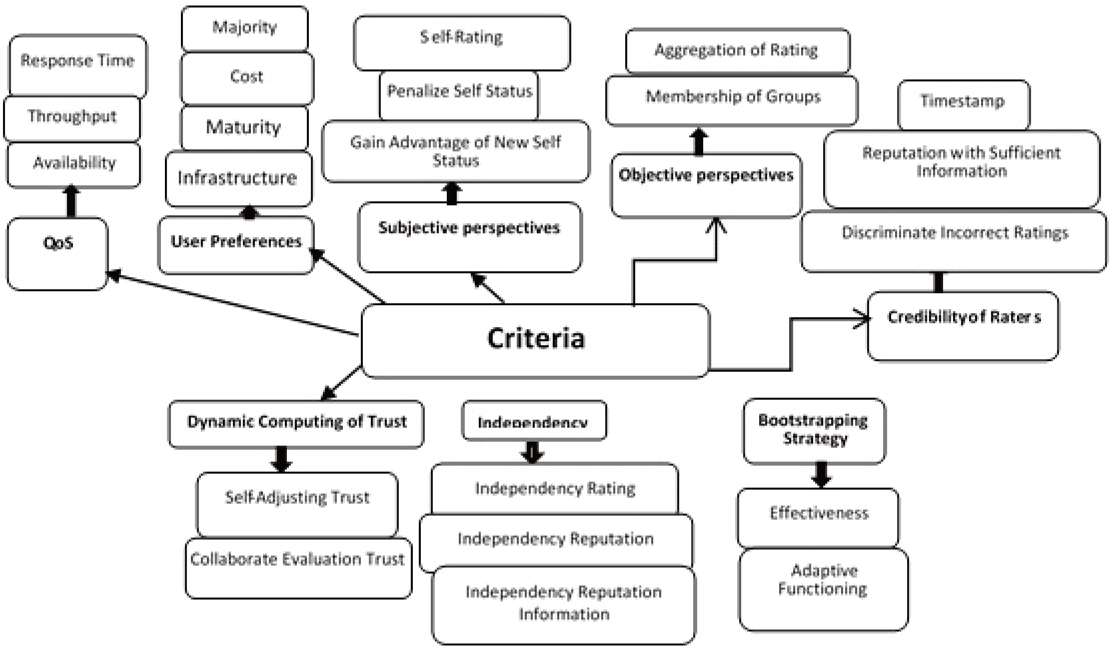

Fig.1. Qualitative Criteria of Single Web Service Trust

QoS: A series terms of QoS considered decent for a WS which provides the best of each of those terms can raise the trust in that special WS This article considers the terms of throughput, availability and response time for QoS (Nguyen et al., 2010).

User preferences: A series of terms determining the inclination of a user to choose a WS provide by a WS provider named standard user preference. This term is directly associated with user trust in WS. This means that the user preference to become fulfilled in the greater level. This study considers the terms of majority, infrastructure, maturity and cost for standard user preferences for WSs (Reddy & Raghavendra, 2013).

Subjective perspectives criteria: A series of terms on the base of intellectual nature and personal decisions of users to influence users in choosing WS is called Subjective perspectives. In most cases, the subjective idea of users have a special influence on trust in WSs. This should be said that this criteria on trust utilized as feedback of users (Vavlis et al., 2014).This study considers the terms of penalize self-status, gain advantage of new self-statues and self-rating for measuring subjective aspects of WS.

Objective perspectives: a series of terms on the base of evaluation or monitoring different users' terms on WSs in special time range called objective perspectives. As a matter of fact, the service quality is a sub terms of this criteria and in various research, service quality criteria was taken into account as a sub term of objective criteria; however, in this paper, this is taken into account as a separate criterion due to the significance of quality of WS (SHirgahi et al.,2016). Additionally, this study considers membership of groups and aggregations of ratings for measuring the aspects of objective WSs.

Credibility of raters: in system based on reputation highlighting the role of WS raters on WS trust evaluation, this criteria is applied. For assessing the exactitude of ranking from various aspects, credit of raters is a decent measure. This papers considers reputation with adequate information, timestamp and discriminate incorrect ratings as three criteria for crediting WS raters.

Bootstrapping strategy: For evaluating the trust of WS, bootstrapping strategy is a criterion referring to start a self-sustaining procedure that can continue to work without any outer input. Bootstrapping is one of the most significant matters in trust model. This criterion devotes an initial value of self-confidence to a new member of an unknown system (Yahyaui, 2012). This article considers adaptive functioning and effectiveness for benchmarking our WS bootstrapping strategy.

Dynamic computing of trust: typically WS competencies over time is recognized followed by deduction thus it is undeniable, it needs dynamic technique to manage. Service oriented and WSs architectures should compute the trust accurately with interactions and dynamic based mechanisms (Skopik et al., 2010). This study takes into account collaborate evaluation trust and self-adjusting trust for dynamic computation criterion for WS trust.

Independency: In different aspects, independency should be investigated, meaning that independence in decision-making must be considered in all sections of trust evaluation techniques (Kolomeets et al., 2017). This paper takes into account independency reputation, independency ratings and independency reputation information.

General structure of neuro-fuzzy system

For evaluation the trust of single WS based on criteria expressed, fig.2. illustrates the neuro-fuzzy structure of considered system.

At First, the neuro-fuzzy systems assess the quality of eight criteria according to the sub-criteria (this task is performed eight times with eight membership functions such as gbellmf, trimf, gaussmf, dsigmf, psigmf, gauss2mf, and pimf). Due to finding that what neuro-fuzzy membership function has the least value of error in the proposed method, this technique is performed with eight membership functions. Ultimately, it is found that the membership function of Psigmf has the least amount of error. Therefore, for this function, the proposed method evaluates the values of precision, recall and F-score. For creating neuro-fuzzy systems, single WS trust database from amazon WSs are applied (Amazon trust of single web services Dataset, 2015). This has 1100 records used by users in special time. We merely applied only properties stated in this paper to assess single WS trust in the dataset. This article takes into account 800 dataset records for creating the neuro-fuzzy systems. Following, the neuro-fuzzy systems are expressed in details.

IMPLEMENTATION AND EXPERIMENT

6 of 9 criteria were considered by (Maximilien, 2005) who employed feedback technique to evaluate the trust of SW services (see Table 1). Statistically, four criteria including OoS, user preference, dynamic computing of trust, and credibility of raters were employed by (Nguyen et al., 2010) to assess trust. In comparison to their sub-terms, some of our sub-terms are considered different. 6 criteria were considered by (SHerchan et al., 2006) who evaluated SW services trust in their fuzzy systems. Two criteria such as bootstrap strategy and the dynamic of trust were not considered by the authors. (Throw & Delano, 2010) employed data mining technique to assess trust. The authors considered four criteria including independency, bootstrap strategy and user preference and QoS to evaluate the trust of WS. Also, they considered subjective and objective aspects of criteria as a criterion of the trust. (SHirgahi et al., 2017) separated objective and subjective criteria to two criteria. Then, the authors used fuzzy technique to evaluate SW services with 8 criteria. This paper considers all 8 criteria to evaluate the trust.

Features of neuro-fuzzy system

In this article, neuro-fuzzy system with 8 criteria as can be seen in Table 1. were considered to evaluate SW services trust (performed by matlab software). Eight functions of neuro-fuzzy system such as trapmf, gbellmf, trimf, gaussmf, dsigmf, psigmf, gauss2mf, pimf are used to implement the proposed method.

(1) Trapmf (Trapezoidal membership function): is a function of a vector, x, and depends on four scalar parameters a, b, c, and d, as given by Eq.1.

$$trapmf(x,a,b,c,d) = \begin{cases} 0 & x \leq a \\ \dfrac{x-a}{b-a} & a \leq x \leq b \\ 1 & b \leq x \leq c \\ \dfrac{d-x}{d-c} & c \leq x \leq d \\ 0 & d \leq x \end{cases} \quad (1)$$

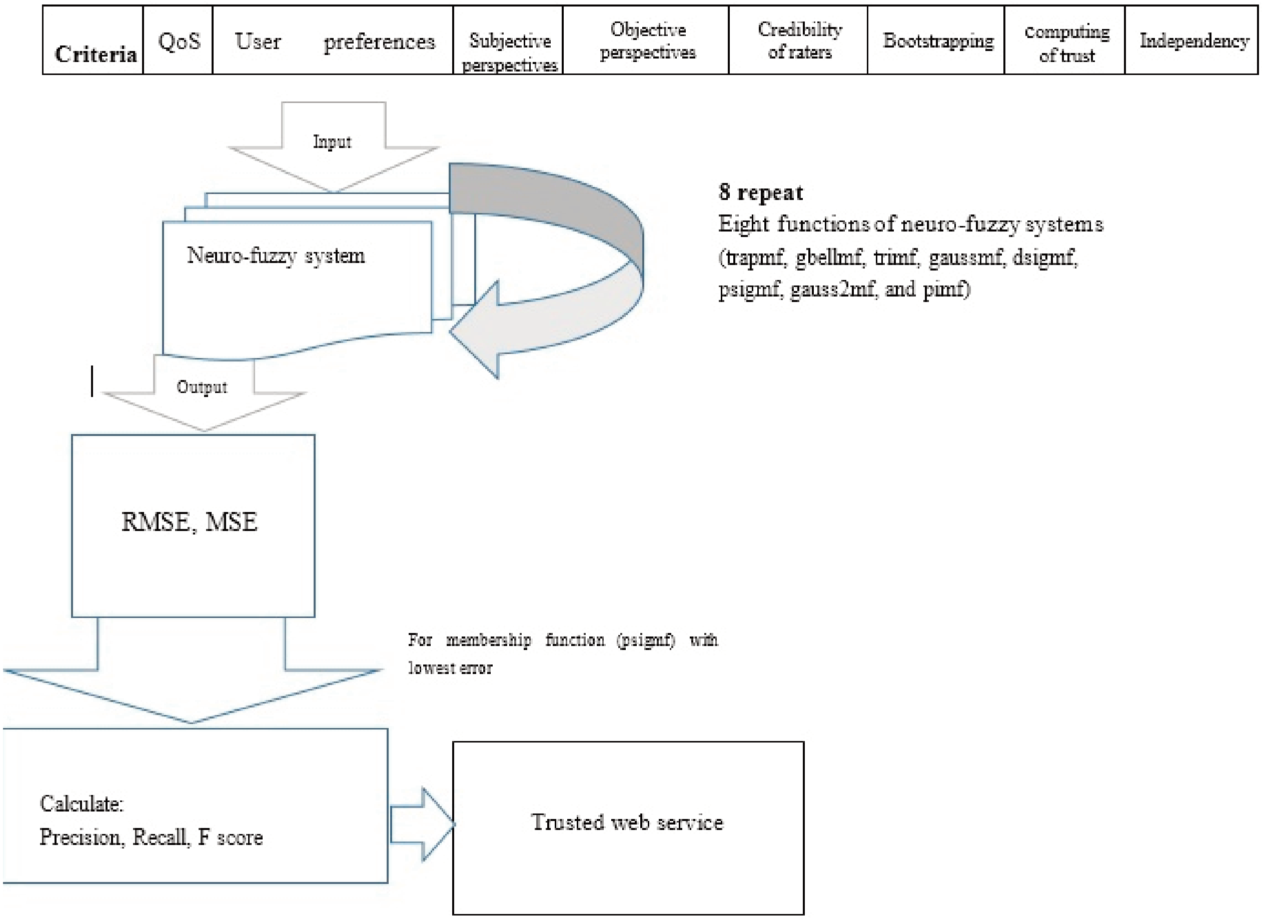

Fig.2. A Neuro-Fuzzy Structure For Evaluate Single Web Service Trust

Table 1: Some Techniques Employed To Evaluate Trust in Single Web Services (A Comparison)

Criteria methods	QoS	Userprefer-ences	Subjective	Objective	Credibili-tyof raters	Bootstrap-ping	Dynamic com-putingof trust	Independ-ency
Feedback								
Statistical								
Fuzzy								
Data mining								
3-levelFuzzy								
neuro-fuzzy								

(2) Gbellmf (The generalized bell shaped membership function): is a symmetrical shape similar to a bell as given by Eq.2. This function employs three parameters: A determines the width of the bell like curve, b is a positive integer, while c sets the center of the curve in universe of discourse.

$$gbellmf(x, a, b, c) = \frac{1}{1 + \left|\frac{x-c}{a}\right|^{2b}} \quad (2)$$

(3) Trimf (triangular membership function): is defined by three parameters for defining three points: A and c for feet, and b for the tip of the curve as given by Eq.3.

$$trimf(x,a,b,c) = \begin{cases} 0 & x \le a \\ \frac{x-a}{b-a} & a \le x \le \\ \frac{c-x}{c-b} & b \le x \le \\ 0 & c \le x \end{cases} \quad (3)$$

(4) Gaussmf (Gaussian curve membership function): Also has a smooth curve. The symmetric Gaussian function depends on two parameters However, among all three membership functions mentioned above, it utilizes only two parameters: c for locating center and for determining the width of the curve as given by Eq.4.

$$f(x,\sigma,c) = e^{\frac{-(x-c)^2}{2\sigma^2}} \quad (4)$$

(5) Dsigmf (Difference between two sigmoidal functions membership function): depends on four parameters, a1, c1, a2, and c2, and is the difference between two of these sigmoidal functions. f1(x; a1, c1) - f2(x; a2, c2).The parameters are listed in the order: [a1 c1 a2 c2]. The sigmoidal membership function used depends on the two parameters a, c is given by Eq.5.

$$f(x,a,c) = \frac{1}{1 + e^{-a(x-c)}} \quad (5)$$

(6) Psigmf (Product of two sigmoidal membership functions): The sigmoid curve plotted for the vector x depends on two parameters a, c as given by Eq.6.

psigmf is simply the product of two such curves plotted for the values of the vector x f1(x; a1, c1) × f2(x; a2, c2). The parameters are listed in the order [a1 c1 a2 c2].

$$f(x,a,c) = \frac{1}{1 + e^{-a(x-c)}} \quad (6)$$

(7) gauss2mf (Gaussian combination membership function): The Gaussian function depends on two parameters sig and c as given by Eq.7. The function gauss2mf is a combination of two of these two parameters. The first function, specified by sig1 and c1, determines the shape of the leftmost curve. The second function specified by sig2 and c2 determines the shape of the right-most curve. Whenever c1<c2, the gauss2mf function reaches a maximum value of 1. Otherwise, the maximum value is less than one. The parameters are listed in the order: [sig1, c1, sig2, c2].

$$f(x,\sigma,c) = e^{\frac{-(x-c)^2}{2\sigma^2}} \quad (7)$$

(8) Pimf is a type of contribution function operating which in the equation variable x is input and a, b, c, d, are constant values that specify domains of these functions based on Eq.8.

$$\text{Pimf}(x,a,b,c,d) = \begin{cases} 0 & x \le a \\ 2\left(\frac{x-a}{b-a}\right)^2 & a \le x \le \\ 1 - 2\left(\frac{x-a}{b-a}\right)^2 & \frac{a+b}{2} \le x \\ 1 & b \le x \le \\ 1 - 2\left(\frac{x-c}{d-a}\right)^2 & c \le x \le \\ 2\left(\frac{x-c}{d-a}\right)^2 & \frac{c+d}{2} \le x \le \\ 0 & x > d \end{cases} \quad (8)$$

From amazon WS, the trust dataset of SW services are employed to perform neuro-fuzzy systems. It has 1100 records for SW services in a certain period. The reference merely features expressed were applied to assess the trust of SW services. This article, use 800 records of the dataset for train and 300 different records are applied as test.

Performance evaluation parameters

To do the assessment of neuro-fuzzy systems, test data are run and a comparison of assessed trust of this system and database real trust is presented. Additionally, Table 1. illustrates the criteria of previous assessment techniques and the criteria of proposed method. At first, this paper uses different criteria such as RMSE, MSE and SI for 8 functions of neuro-fuzzy system expressed in 4-1 to understand which function has the least amount of error. Following, the parameters of precision, recall, F score for the function with the least error are performed optimize the trust.

The Parameters of RMSE, recall, precision, F score, MSE and SI are expressed in Equations 9-16.

MSE (Mean Squared Error): based on Eq.9. represents the difference between the actual and predicted values which are extracted by squaring the average difference over the data set. It is a measure of how close a fitted line is to actual data points.

$$MSE = \frac{\sum_{i=1}^{N}(Predicted_i - Actual_i)^2}{N} \quad (9)$$

RMSE (root-mean-square error): based on Eq.10. is differences between trust amount predicted by neuro-fuzzy system and the actual values of the trust. N, Predicted data, Actual data are records reviewed number, trust value assessed for ith record in neuro-fuzzy system and real trust expressed in Dataset for the ith record, respectively.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(Predicted_i - Actual_i)^2}{N}} \quad (10)$$

To assess SW service trust, the trust calculation is used to find if a user can depend on a SW service or he cannot. For instance, if the system obtained great levels of trust, the user trusts SW service and if not, they do not trust. As it is an option and a decision, we utilized precision and recall term to find the exactitude of techniques. This paper defines precision and recall in four different conditions as below:

Trust: the term applied to compute precision are as below Eq.11-13:

At: is the number of web services which we should trust them

Bt: is the number of web services which neuro-fuzzy system does not recommend trust them

$$precision_t = \frac{A_t \cap B_t}{B_t} \qquad recall_t = \frac{A_t \cap B_t}{A_t} \quad (11)$$

Distrust: the term applied to compute precision are as below:

Ad is the number of web services which we should not trust them

Bd is the number of web service which neuro-fuzzy system do not recommend trust them

$$precision_d = \frac{A_d \cap B_d}{B_d} \qquad recall_d = \frac{A_d \cap B_d}{A_d} \quad (12)$$

Null: the terms applied to compute the precision are as below:

AN is the number of web services which have a neutral impact

BN is the number of web services which neuro-fuzzy system recommend they should not have a neutral impact

$$precision_N = \frac{A_N \cap B_N}{B_N} \qquad recall_N = \frac{A_N \cap B_N}{A_N} \quad (13)$$

General conditions: this situation (Eq.14) is a combination of three aforementioned conditions and terms, recall and precision terms are utilized for verifying of the technique.

$$recall = \frac{(A_t \cap B_t) + (A_d \cap B_d) + (A_N \cap B_N)}{A_t + A_d + A_N}$$

$$precision = \frac{(A_t \cap B_t) + (A_d \cap B_d) + (A_N \cap B_N)}{B_t + B_d + B_N} \quad (14)$$

This paper F score criteria is employed to obtain the exactitude of the proposed technique. F score criteria creating an accurate balance between recall and precision criteria is computed based on Eq.15.

$$F\ Score = \frac{2 \times recall \times precision}{recall + precision} \quad (15)$$

Experiments

For testing, three hundreds records, with which systems were tested, were considered from database to optimize the trust of single web services. As mentioned for 8 neuro-fuzzy functions, the criteria (RMSE and MSE) were optimized. As can be seen in figs. 3. and 4, the psigmf function has the least amount of error.

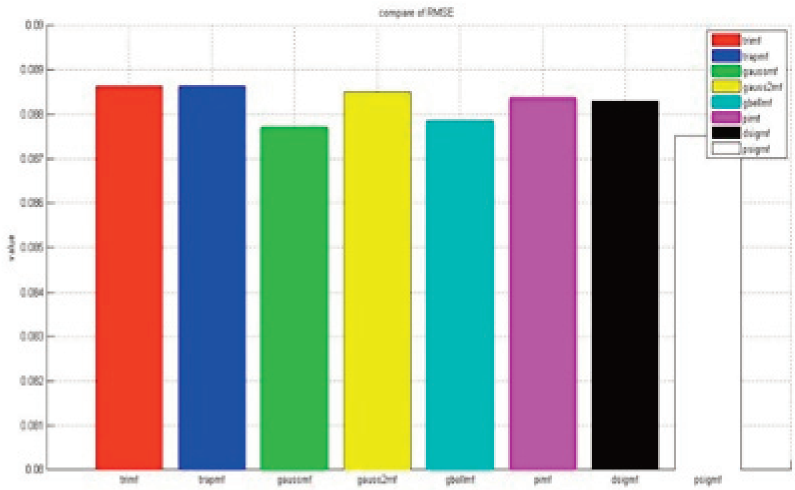

Fig.3. Compare of RMSE for Eight Neuro-Fuzzy Functions

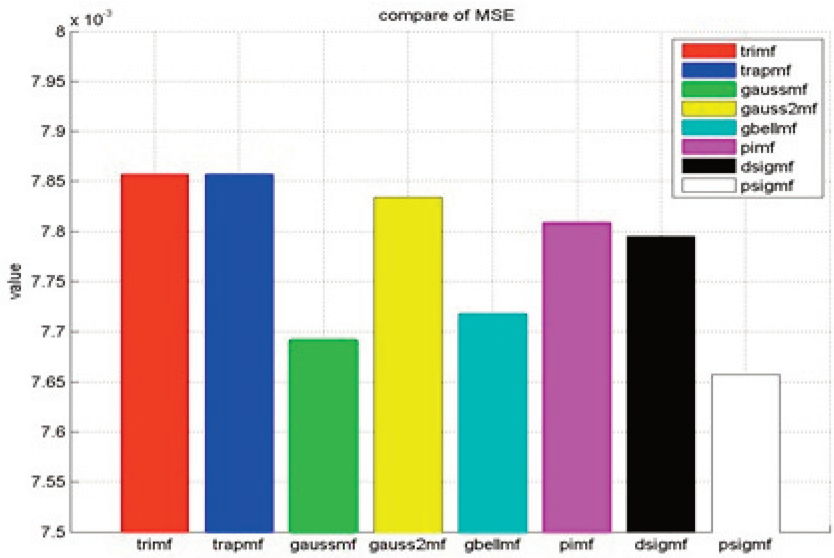

Fig.4. Compare of MSE for Eight Neuro-Fuzzy Functions

The criteria precision, recall and F score are calculated for the psigmf (the function with the least amount of error).

Fig. 5 displays the precision amounts in the psigmf. As can be observed, the precision have the values of 0.982, 0.993 and 0.984 for distrust, null and trust, respectively.

Fig. 6. displays the recall amounts in the psigmf. As can be observed, the recall have the values of 0.981, 0.989 and 0.997 for distrust, null and trust, respectively.

Fig.7. displays the final values of Precision, recall and F Score of the neuro-fuzzy system. As can be observed, the precision have the value of 0.986, the recall have the value of 0.988 and the F Score have the value of 0.987.

Comparison with other methods

In this section, the proposed method is compared with other technique, stated in Table 1. Test data is performed based on feedback, statistics, fuzzy system and data mining and 3-level fuzzy system. Then their criteria trust vales are compared with real trust value for Web services trust assessment. (Figs. 8- 11)

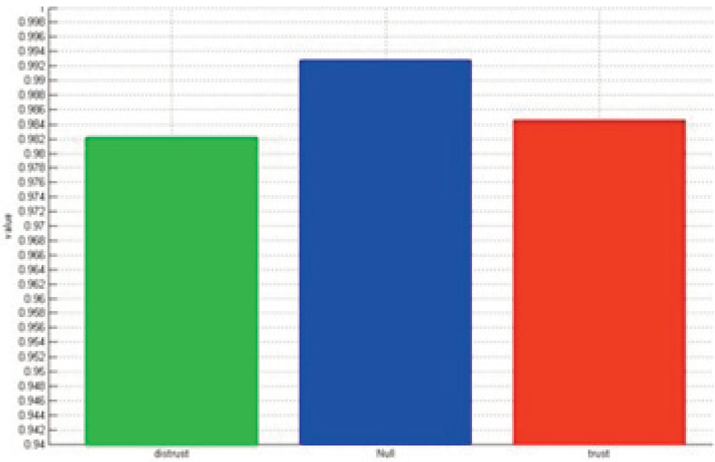

Fig.5. Compare of Precision Of Neuro-Fuzzy Psigmf

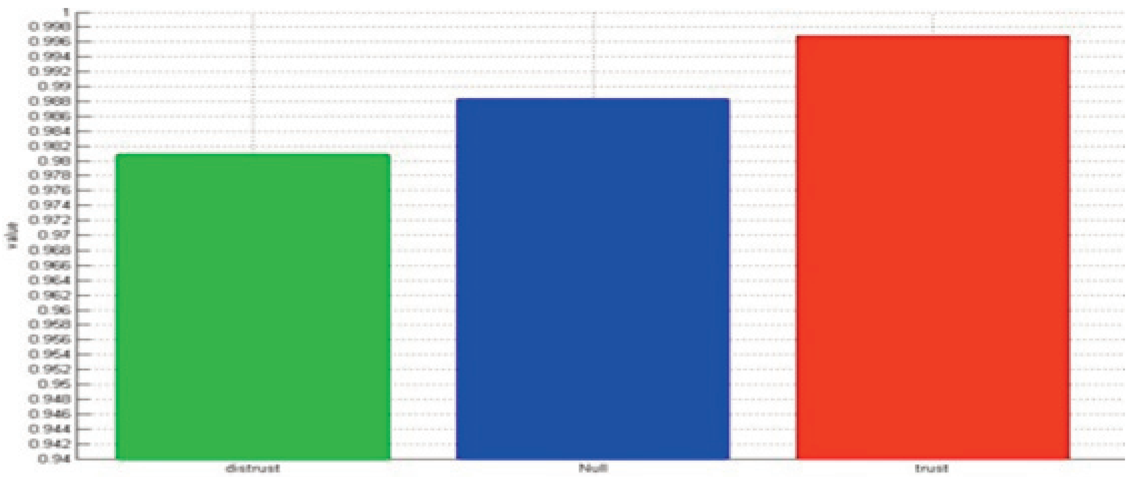

Fig.6. Compare of recall of neuro-fuzzy psigmf

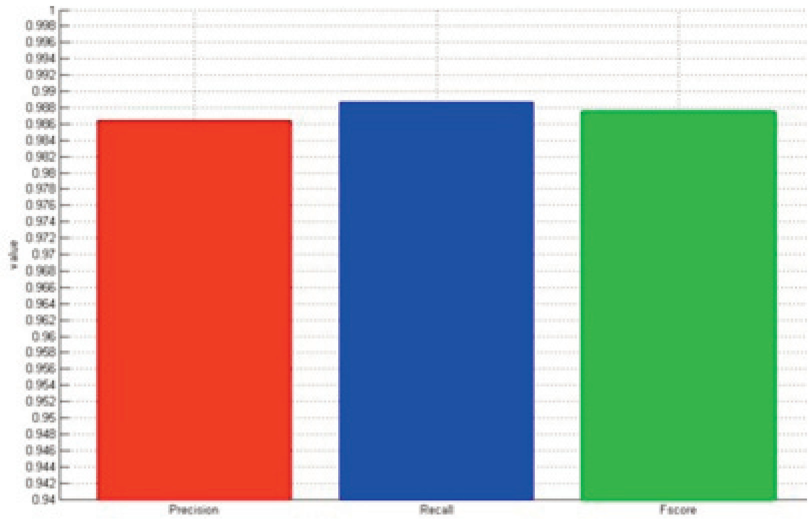

Fig.7. Compare of Precision, Recall, F Score of Neuro-Fuzzy Psigmf

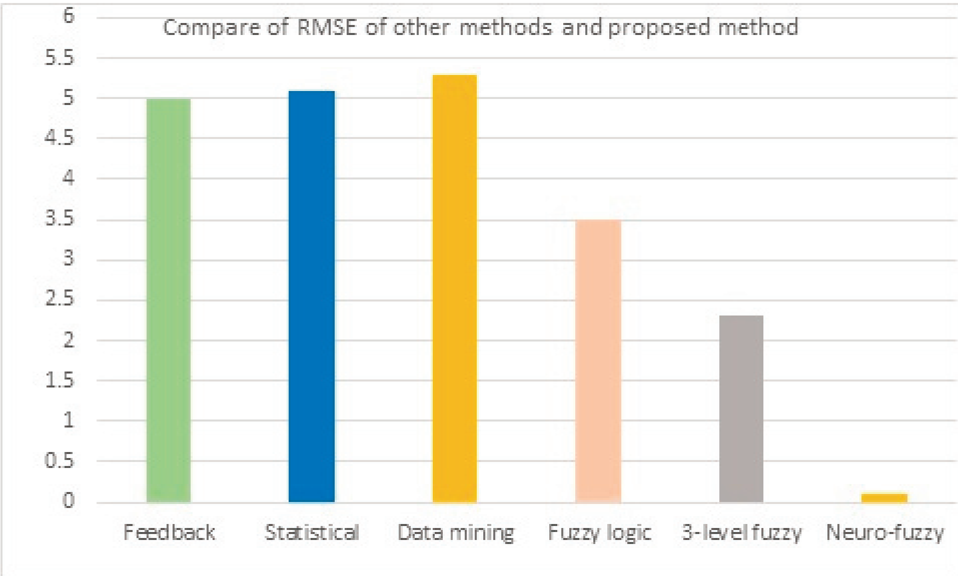

Fig. 8. Compare of RMSE of Other Methods and Proposed Method

A comparison of root mean square error in the neuro-fuzzy system and other types of techniques is demonstrated in fig. 8. In the neuro-fuzzy system, the root mean square is 0.0873% which has the lower amount compared to previous techniques (form 2.3% to 5.2%).

A comparison between precision in the neuro-fuzzy system and other techniques is shown in fig. 9. which its amount is ranged from 0.955 to 0.981 whereas it is 0.986 in the neuro-fuzzy system.

A comparison of recalls values in neuro-fuzzy systemand other techniques is shown in fig. 10. In comparison to other techniques having the recalls values from 0.942 to 0.985, the recall value in the neuro-fuzzy system is 0.988.

Fig. 11. displays the F score amounts in the neuro-fuzzy system and in other techniques. As can been observed, in the proposed method, the F score is 0.987 while its amount is ranged from 0.949 to .0981 in other techniques.

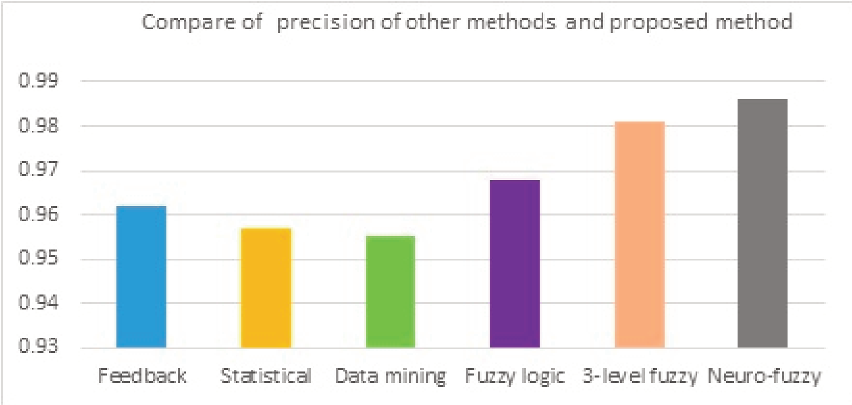

Fig. 9. Compare of Precision of Other Methods and Proposed Method

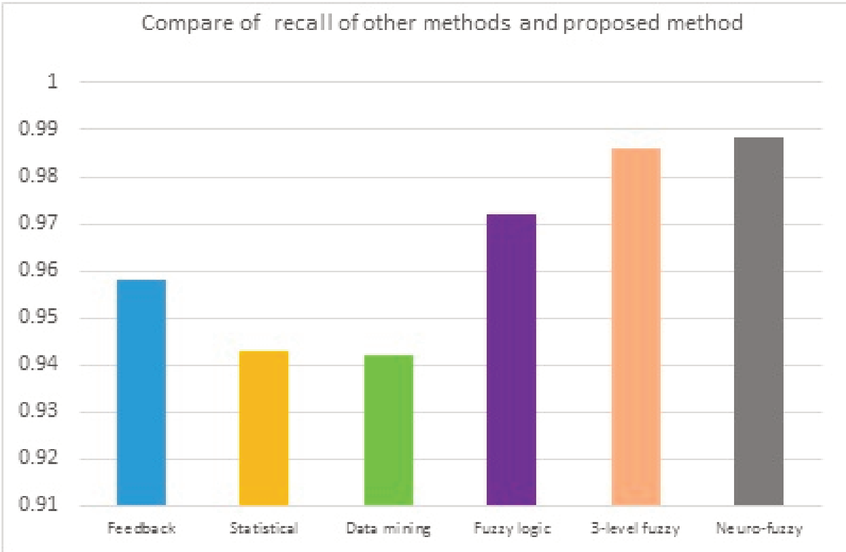

Fig. 10. Compare of Recall of Other Methods and Proposed Method

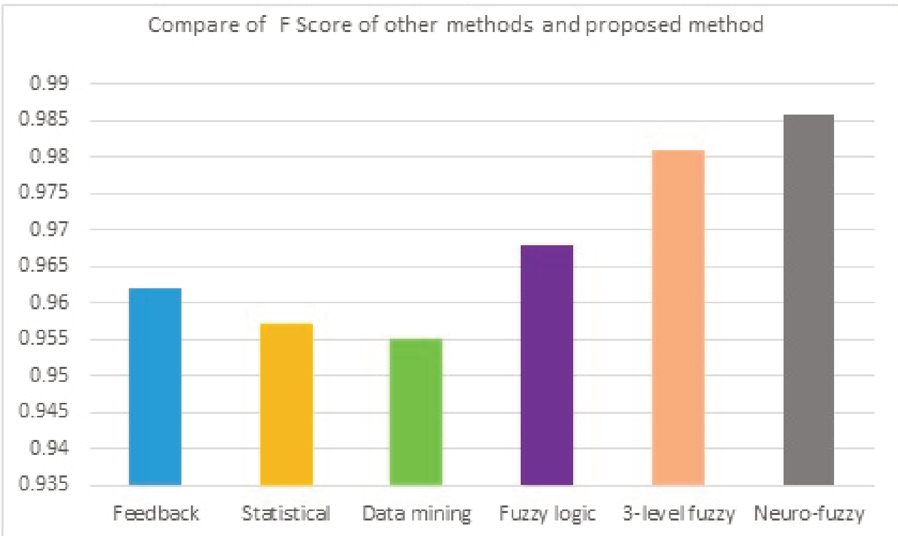

Fig. 11. Compare of F Score of Other Methods and Proposed Method

CONCLUSION

The main goal of this study was optimizing the trust of single web services applying the 8 criteria, because web services selection is a main issue which is still absorbing researchers to conduct research works on this field and analyze it. This paper optimized the trust of single web services considering quality criteria in choosing the single web services. Ultimately, in the considered neuro-fuzzy system, eight criteria such as QoS, user preference, objective perspectives, subjective perspectives, trust dynamics, bootstrapping, credibility or raters and independency were considered. 8 membership functions of neuro-fuzzy systems (i.e., trapmf, gbellmf, trimf, gaussmf, dsigmf, psigmf, gauss2mf, pimf) were considered to test in matlab software. Following the data testing among these functions, the best function of neuro-fuzzy system (psigmf) is obtained. In this system, RMSE, precision, recall and the F score values are 0.0873%, 0.986, 0.988 and 0.987, respectively. In comparison to previous techniques, these values present acceptable results to optimize the trust of single web services.

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