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Research Article

Genetic-based Approach for Security Policies Negotiation in Web Service Environment

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Abstract: Web services is an important in the future internet especially in the field of business. The secure interaction between requester and the provider of the service is one of the main problems. This secure interaction requires negotiation and an agreement about their security requirements. In this study, a genetic-based approach is proposed for SOAP message security negotiation. The proposed approach covers the negotiation problem as a search space of solutions for different participants. Various security levels are proposed. These levels include three key security objects identity, integrity and confidentiality of SOAP messages. The proposed Genetic-based security negotiation approach is compared with traditional time-based negotiation and the adapted traditional time-based negotiation approaches. A telemarketing case study is addressed through experimental results. Besides, the execution time and message complexity of the three approaches are provided. Experimental results show the efficiency and effectiveness of the proposed approach compared to other two approaches.

Keywords: Cost/benefit model, genetic algorithm, message security, non-functional requirement, web service negotiation, web service security

INTRODUCTION

The objective of service selection and composition is to select a suitable service for provider and consumer. Selecting a proper service is not an easy task. Negotiation is an important process in the selection and composition phases of web service. To fulfill the security constraints of a consumer and provider, security levels need to be negotiated.

The negotiation problem can be defined as a communication between a group of entities represented by agents to get an agreement (Jin *et al*., 2002). It requires negotiation objectives, protocol and strategy (Jennings *et al*., 2001).

Negotiation objective represents what objects negotiated. Negotiation protocol denotes a protocol that defines how to exchange the SOAP messages between consumer and different providers (Messina *et al*., 2014). Negotiation strategy is the strategy that suggests the proposal (offer) and evaluates the received one. In general, negotiation conducted as bilateral (i.e., one consumer and one provider) or multilateral (i.e., one consumer and different providers). Multilateral negotiation is the conventional type ofnegotiation systems (Pan *et al*., 2013). Negotiation in web service negotiates non-functional attributes such as price, availability, security and others) (Singhera and Shah, 2006).

Security of a web service is one of the most non-functional requirement and capabilities of SOA (Bertino *et al*., 2009). Service provider and consumer have to agree on their capabilities and requirements. During SOAP message exchange between the services. Web service security includes the identity, the integrity and the encryption of the SOAP message exchanged between the participants (Geuer-Pollmann and Claessens, 2005).

Message security is used to assure that an end to end security of a message transferred between entities. Three key elements are used to guarantee message security: Identification, integrity and confidentiality. Identification uses security tokens to guarantee authentication of SOAP message. Integrity is guaranteed by using a digital signature. Confidentiality is guaranteed using encryption techniques. Security levels quantify a tradeoff between these security key elements.

El Yamany *et al*. (2009) introduced metadata for web service that provides four levels of web service message security (identification, confidentiality and integrity) which are high, moderate, low and guest. In this model, a metadata model is used to achieve an agreement between web service participants for securing SOA messages. Table 1 shows the levels security levels provided message security. The security token is used to assure message identification. A digital

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Table 1: Levels of message security (El Yamany *et al*., 2009)

Level	Certificate	Digital sign	Encryption
High	X.509	DSA	AES
Moderate	Kerberos	RSA-Sha1	3DES
Low	Username/Password	Any Hash Algo. (e.g., MD5)	128-bit key (e.g., IDEA)
Guest	Not required	Not required	Not required

signature is used to sign the message sent between entities. Encryption of soap message is used to guarantee confidentiality. This security guarantees SOAP message security transferred between consumer and provider.

The proposed approach extends the levels of message security to be eight security levels. Also, negotiation process conducted as a service on a third party not a process between consumer and provider. Besides to that, the proposed approach will be evaluated and compared with other two approaches. Execution time and message complexity will be measured in this study.

LITERATURE REVIEW

In general, the researchers conduct negotiation as a non-automatic process with human intervention. Automation is essential for the most computerized systems. Negotiation techniques have been used by different researchers in web service discovery and web service composition (Moghaddam and Davis, 2014). Negotiation decision functions; time-based utility functions and resource-based utility functions; are the most strategies used by developers (Faratin *et al*., 1998). The most valuable negotiation decision functions are time-based decision function which can be defined by three different functions; polynomial, exponential, or sigmoid (Abdelatey *et al*., 2016a).

Al-Aaidroos *et al*. (2011) introduced an agent-based framework for web service QoS negotiation. This framework negotiates price, availability and some users. The negotiation process uses agent system as a negotiator between consumer and provider. A time-based utility function exponential is used to generate offers and evaluate incoming offers from both sides. Authors prove that 90% of negotiations are successful.

Zulkernine and Martin (2011) presented a broker negotiation framework that conducts bilateral bargaining between a service provider and a service consumer using agents. This broker negotiation framework negotiates QoS attributes which are price, some users and availability. Three time-based utility functions are used which are polynomial, exponential and sigmoid (Faratin *et al*., 1998). As opposed to the above frameworks that negotiate QoS attributes of a web service using a time-dependent tactic (i.e., time-constrained negotiation), some researchers advocate the negotiation problem as a search problem (Jennings *et al*., 2001).

A search problem is an issue with different solutions and points in a space that can be searched to get an acceptable solution for both sides of the negotiation. Genetic-based negotiation method used by researchers to describe the problem as a space of solutions for solving negotiation problem (Abdelatey *et al*., 2016b).

Hashmi *et al*. (2014) used the genetic algorithm as a mathematical model for QoS negotiation problem of a web service model. The genetic approach used in multilateral negotiation for finding an acceptable solution. In this approach, consumer involved in the negotiation process with different providers. Authors compared the genetic approach with hill climbing and random search techniques. They do not address the visibility of solutions/populations of the used search techniques.

In general, the researchers in the web service selection concentrate on negotiating QoS attributes. The security negotiation problem has not been considered so far.

GENETIC-BASED WEB SERVICE SECURITY NEGOTIATION APPROACH

The study is conducted at faculty of computers and information, Menoufia university in a general lab at the mid of 2017.

The proposed approach negotiates a security level of a consumer and different providers. It defines the negotiation problem as a search problem with various solutions. The proposed genetic-based approach gets the attributes of the different negotiators and conducts the negotiation process on a third party as a negotiation service. The negotiation process between consumer and different providers is conducted after searching a list of services. It is conducted by one consumer and N providers to get the best suitable web service, provider. At the end, the third party connects the acceptable provider and share the agreement with that provider and the consumer.

Negotiation approaches have three problems:

- The negotiation skills of the negotiators is not the same level
- The negotiation approach is not integrated with the SOA architecture
- The negotiation approach consumes more time in the negotiation process besides more messages transferred between consumer and Providers that may lead to a distributed system problems.

The proposed approach overcomes these problems as; the negotiation conducted by a third party, not on different participants having different skills. Thus the approachovercomesthe problem of dissimilarity of negotiation skills. Also, the proposed approach is

Table 2: Eight security levels

Level	Certificate	Digital Sign	Encryption
Level 8	Biometric authentication	RSA	AES-256
Level 7	Smart card authentication	DSA	AES-192
Level 6	X.509 certificate	SHA-512	AES-128
Level 5	Kerberos token	SHA-384	Camellia-128
Level 4	CHAP authentication protocol	SHA-256	Blowfish-128
Level 3	CAVE authentication protocol	SHA-224	3TDEA(3DES)
Level 2	PAP authentication protocol	SHA-1	2TDEA(2DES)
Level 1	Not required	Not required	Not required

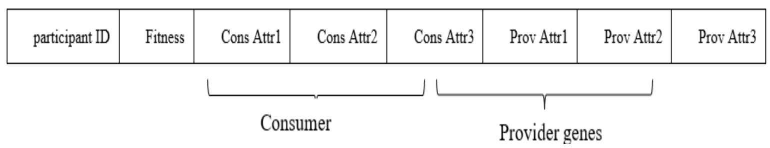

Fig. 1: Encoding scheme of a solution

integrated with the SOA architecture as the negotiation conducts as a separate service on a separate party which has no conflict with the SOA architecture. Furthermore, the proposed approach consumes less time and message transferred. So, there is no overhead of the communication process between negotiation participants.

The proposed approach depends on eight levels including more security algorithms for securing SOAP messages. These levels are presented in Table 2. The proposed eight security levels quantify the securing of messages; which may contain personal information; based on three key elements: Identification, Integrity and Confidentiality.

A weighted sum genetic algorithm (Rubenstein-Montano and Malaga, 2002) is used to facilitate a multilateral and multi-objective negotiation using the genetic approach. Populations of the genetic represent the solutions. A chromosome represents a solution. A chromosome introduces an offer from/to a consumer or a provider. The chromosome is a set of genes which are consumer and provider attributes with the added gene for a participant ID and a gene for fitness function of a solution. The encoding scheme of the chromosome which represents a solution is presented in Fig. 1.

The fitness function in the negotiation approach evaluates the disagreement between the consumer and the provider attributes' value. A fitness function presents the weighted objects with disagreement value as a value. It is calculated for a solution/chromosome according to Eq. (1). The disagreement between provider and consumer is presented in Eq. (2):

$$f_j = \sum_{j=0}^{n} \left(\mathrm{w}C_j * \Delta_{ij} + \mathrm{W}P_{ij} * \Delta_{ij} \right) \tag{1}$$

$$\Delta_{ij} = \frac{C_j - P_{ij}}{C_j} \tag{2}$$

where,

Δ_{ij} = Disagreement of a solution/a chromosome between consumer and provider' values
$\mathrm{w}C_j$ = The weight of consumer jth attribute
wP_{ij} = Weight of the ith provider value for jth the attribute
n = The number of participants, moreover
j = The participant ID

Low fitness value means less disagreement between objects' values of the consumer and the provider. Likewise, higher fitness value means higherdisagreement. So, the goal of the genetic approach is to decrease the fitness value. The fitness value "0" means that the solution (offer) is accepted for both sides of the negotiation process.

Now we are ready to describe the proposed approach which so-called Genetic-based security negotiation Algorithm 1. The proposed algorithm generates the initial population randomly as a classical GA. A roulette-wheel selection method is used as a selection method for the proposed approach (Whitley, 1989). A uniform crossover operator is applied with a certain probability (crossover rate) (Williams and Crossley, 1998). Also, the mutation operator is applied with a certain probability (mutation rate). Once the new offsprings/solutions are created, we use delete-all replacement method of a GA. A repairing algorithm is applied after each operator of the proposed genetic-based negotiation (Ai and Tang, 2008; Tang and Ai, 2010). It handles infeasible solutions and ensures all these constraints are met. Consumer and provider objects' values within a solution have to be in the allowable range of defined security levels. These constraints are represented by Eq. (3) and (4):

$$C_{j(\min)} \le C_j \le C_{j(\mathrm{maz})} \tag{3}$$

$$P_{ij(\min)} \le P_{ij} \le P_{ij(\max)} \tag{4}$$

Algorithm 1: Genetic-based security negotiation algorithm:

- Initialize the population of the negotiation problem with random solutions

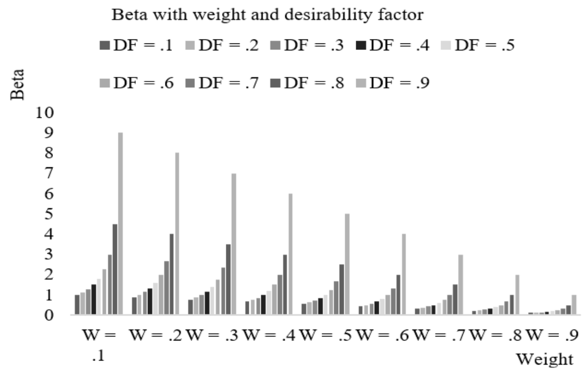

Fig. 2: The β relation

- Repair each infeasible solution using repairing technique
- Evaluate the fitness of each solution based on the fitness function defined in Eq. (1)
- While the negotiation termination condition is not reached do
  - Select the best-fit solutions for survival using roulette-wheel selection.
  - Apply a uniform crossover operator to generate new solutions.
  - Apply a mutation operator randomly on solutions.
  - Repair each infeasible solution using repairing technique
  - Evaluate the fitness function of each solution as expressed in equation 1.

End

For efficient genetic-based negotiation approach, we address the improvement of the fitness function of the solutions. Two control parameters; crossover rate and mutation rate; affects the fitness function (Ye *et al*., 2010). Tuning of these parameters is conducted to decrease the value of the fitness function to improve the solutions. This tuningis addressed through experimental results.

In addition to the proposed genetic-based approach, traditional time-based negotiation strategy has been addressed through this study (see Algorithm 2). The traditional time-based negotiation approach has been used by different researchers (Zulkernine and Martin, 2011; Yaqub *et al*., 2014). It depends on the time factor as the important factor. The theoretical model of the negotiation utility functions is addressed by Faratin *et al*. (1998). The fitness function of the traditional time-based negotiation is computed as a weighted sum approach of each issue for each bid. The affecting negotiation curve β parameter is computed at first for each issue. Each bid for each participant is evaluated with accept, reject, or create a new proposal.

Algorithm 2: Traditional time-based security negotiation algorithm:

Input: t_{max}, issues, t = 0

Output: Proposal

1. Compute β for each issue
2. Compute $\propto(t)$ for each issue
3. Current Proposal← get Starting Proposal ($\propto(t)$)
4. Compute Utiltiy Function() for each issue
5. Current Fitness←compute Global Utility Function()
6. While t < t_{max} do

a. Compute $\propto(t)$ for each issue
b. Temp Proposal ← create Proposal ($\propto(t)$)
c. Compute Utiltiy Function() for each issue
d. temp Fitness←compute Global Utility Function()
e. if temp Fitness> = current Fitness then
f. accept (temp Proposal)
g. end if
h. current Proposal← temp Proposal
i. if accept (current Proposal) then
j. return current Proposal;
k. end if
l. t++;

end while

Through a traditional time-based utility approach, polynomial function is used for generating $\propto(t)$ for each bid. The polynomial function presented in Eq. (5); the affecting parameter of the conceding curve of the negotiation; is the main parameter affecting the function. Note that β parameter is the main parameter affecting the function because it conceding the curve of the negotiation.

$$\propto(t) = e^{\left(1-\frac{\min(t,t_{\max})}{t_{max}}\right)^{\beta} \ln k} \quad (5)$$

where, $0 \leq \propto(t) \leq 1$

A model is defined for computing β dynamically from security attributes of a web service. The security attributes contain attribute ranges, weight of each attribute and Desirability Factor (DF). DF is the factor that define the negotiator needs to reach an agreement in what percentage. The proposed β relation is computed separately for each attribute according to the DF and the weight of each attribute; which affect the negotiation. The relation to compute β is presented in Eq. (6):

$$\beta = (1-weight)/(1-DF) \quad (6)$$

This relationship is validated with the substitution of different values of the DF and weights. DF value represents the percentage of the participant needs to get an agreement. Weight value represents the importance of that attribute in the negotiation problem. Different values of DF [10%-90%] with different values of weights [10%-90%] are tested. The β computing model relation between weight and DF is presented in Fig. 2. Increasing β parameter means that an attribute concedes faster. As presented in the figure, with the same weight, the β parameter increases with increasing the DF value. Each attribute has a different conceding curve, so it has

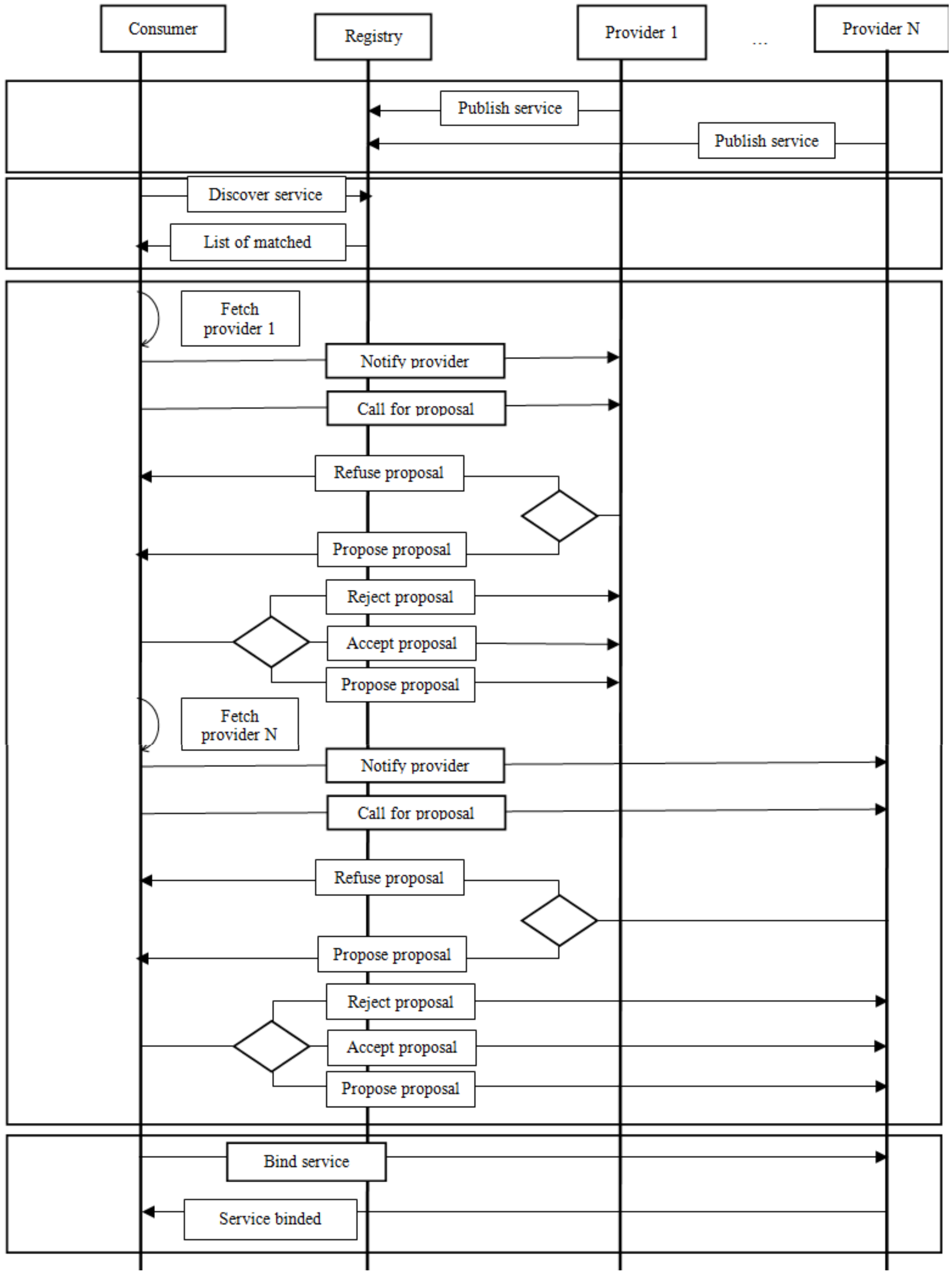

Fig. 3: Traditional time-based negotiation communication

a different β value. When decreasing weight value and increasing DF value, the attribute concedes faster.

The communication structure of the traditional time-based security negotiation approach is presented in Fig. 3.

Consumer negotiates with N providers. Each provider communicates with consumer simultaneously. A lot of messages transferred between the consumer and N providers. An adaption to the traditional time-based negotiation strategy has been adjusted through this study. This adoption decreases the communication structure of messages by adding a third party that becomes a central participant for all negotiators. Consumer and N providers send their attributes to that third party. The third party conducts the negotiation process in the same way as a traditional time-based approach. At the end of, the third party sends a notification message to the agreed participants; consumer and agreed provider. The adapted traditional time-based approach is presented in Fig. 4. A

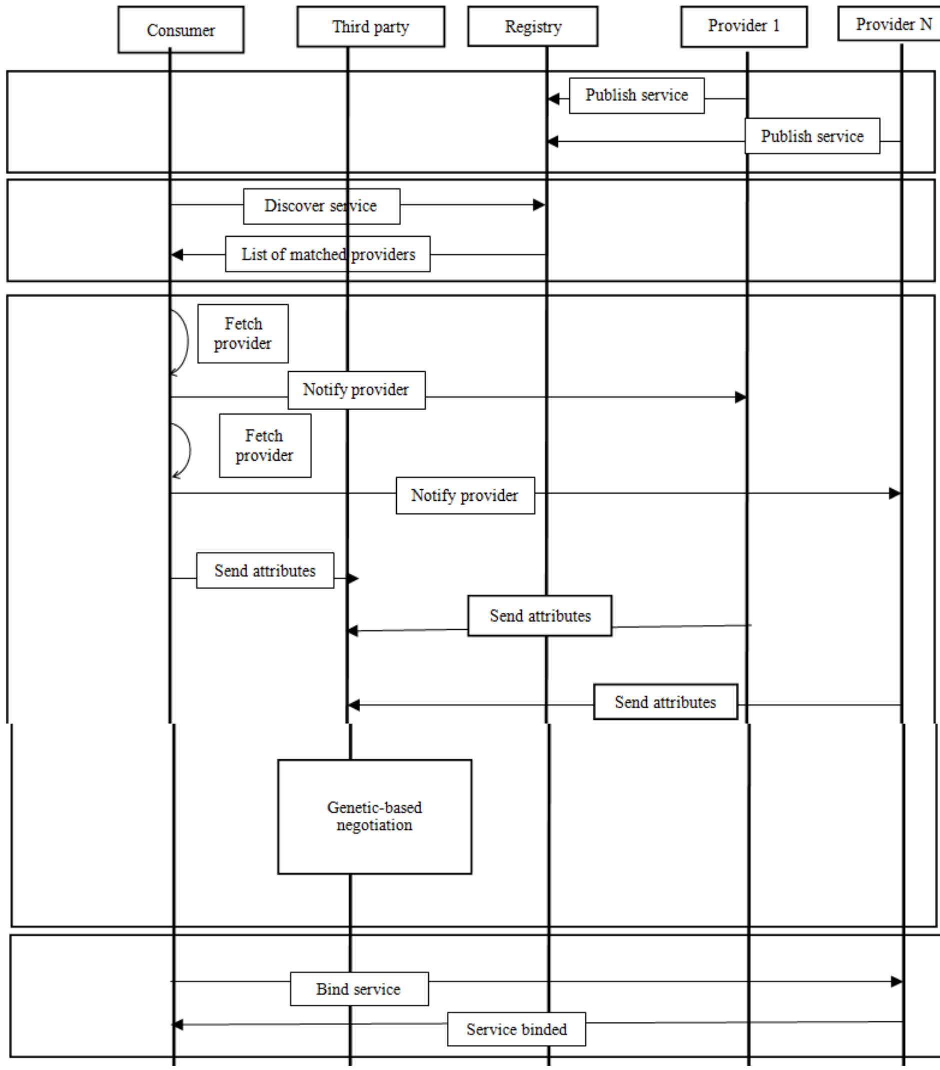

Fig. 4: Adapted traditional time-based negotiation communication

comparison between proposed genetic-based negotiation, traditional time-based negotiation and adapted traditional time-based negotiation is conducted with the experimental results.

EXPERIMENTAL RESULTS AND DISCUSSION

A case study is considered through experimental results. A bank needs to carry out a marketing campaign. The bank outsources the customers' data to a third-party provider. Information includes the name, credit card number, mail; the phone number is needed for marketing activities. The bulk transmission of customers' information to a third-party must meet security demands. Through a web services platform, an end to end security control over the data transmitted is needed. A Web services security negotiation with security levels facilities and provides a suitable interoperation approach for required application-to-application interactions over the Internet. Through our case study, one bank as a consumer negotiated with 50 marketing providers.

Samples of these data are shown in Table 3. The negotiated attributes; as detailed in the proposed approach; are Identification, Integrity and Confidentiality. For each participant, minimum security level (Min), maximum security level (Max) and weight (W) of the attribute is provided for each attribute for consumer and 50 providers.

The proposed genetic-based approach has been developed using (JADE) Java Agent Development Environment for multi-agent system methodology. The environment conducts the experimental results is specified in Table 4. The proposed architecture can be quickly deployed with only providing Java 6 Runtime Environment for running the JADE platform. Through the genetic-based security negotiation approach, we have implemented software agents to conduct the negotiation instead of participants.

Table 3: Samples of data

Participants	Participant ID	Identification			Integrity			Confidentiality		
		Min	Max	W	Min	Max	W	Min	Max	W
Consumer	0	3	7	0.4	2	6	0.3	3	7	0.3
Provider1	1	1	5	0.4	4	7	0.3	5	7	0.3
Provider2	2	5	7	0.4	4	7	0.3	1	5	0.3
Provider3	3	1	4	0.4	1	3	0.3	6	7	0.3
Provider4	4	6	7	0.4	1	3	0.3	1	4	0.3
Provider5	5	1	4	0.4	2	4	0.3	6	7	0.3

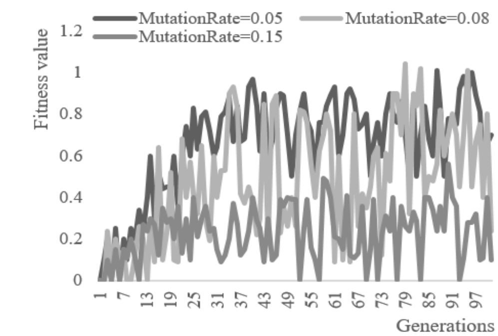

Fig. 5: Mutation rate tuning

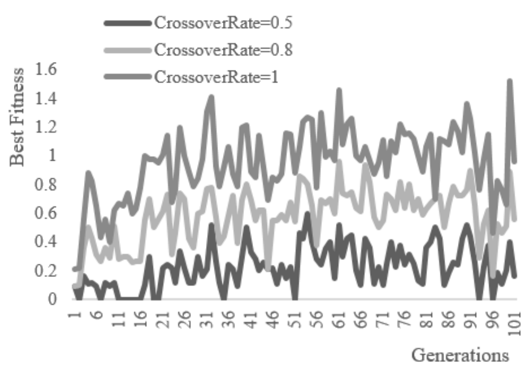

Fig. 6: Crossover rate tuning

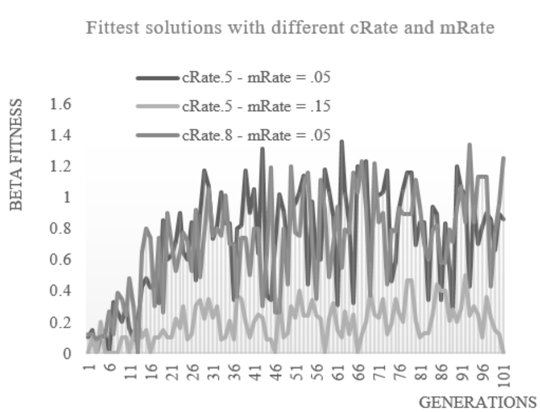

Fig. 7: Fittest solutions with different crossover rate and mutation rate

Table 4: Specifications of the environment

Operating system	Windows 7 professional (64 bit)
CPU	Intel Core i3
Clock Speed	Up to 2.13GHz
Memory	3 GB RAM

Table 5: Acceptable solutions (chromosome)

Iteration number	Chromosome genes
1	18-0-4-2-3-4-2-3
3	5-0-4-2-6-4-2-6
5	1-0-5-4-6-5-4-6
6	20-0-3-2-3-3-2-3
7	17-0-3-2-4-3-2-4
8	1-0-5-5-6-5-5-6
11	16-0-3-2-3-3-2-3
16	1-0-5-4-6-5-4-6
46	11-0-7-6-6-7-6-6
58	19-0-3-3-3-3-3-3
66	5-0-3-2-7-3-2-7

For the proposed genetic-based security negotiation, we address the tuning of mutation rate and crossover rate control parameters within the addressed problem to get the best fitness function. First, different values of mutation rate are tested. We test mutation rate with values “0.05, 0.08 and 0.15” with “100” generations. With each value, we calculate the best fitness function for each generation. The best fitness value is the elitism element from populations. The mutation rate tests of the three different values are presented in Fig. 5.

Besides, the crossover rate values “0.5, 0.8, 1.0” is tested with “100” generations. The fitness function is calculated for the “100” generations. The best fitness (decreased fitness) is a crossover rate “0.5” as shown in Fig. 6.

In addition, combinations of crossover rate and mutation rate were tested and get the value of fitness function of elitism solution of each generation. I have tested different mutation and crossover rate values to get the best value for mutation and crossover rate. We have tested a different number of generations. For 100 generations, The genetic-based approach gets the best (the minimum) fitness values with crossover rate “ cRate = 0.5” and mutation rate “ mRate = 0.15” as presented in Fig. 7. From the figure, the best fitness function is a crossover rate “cRate” and mutation rate “mRate” “0.5 and 0.15” respectively as these values related to the minimum fitness value which represents the best solution.

From the tuned mutation rate and crossover ratevalues; the best solutions are with iterations “1, 3, 5, 6, 7, 8, 11, 16, 46, 58 and 66” from 100 iterations. The chromosome solutions of these iterations are provided in Table 5.

From Table 5 and Fig. 7, the genetic-based negotiation approach starts with good solutions so, we

Table 6: Number of successful providers for β

β value	Success	Fail
β = 2 (50 providers)	27	23
Proposed relation of β (50 providers)	31	19

Table 7: Traditional and adapted traditional successful negotiation

Provider numbers	Successful negotiators	Unsuccessful negotiators
10 providers	8 providers	2 providers
20 providers	9 providers	11 providers
30 providers	14 providers	16 providers
40 providers	22 providers	18 providers
50 providers	31 providers	19 providers

Table 8: Negotiation success percentage

Number of providers	Genetic-based negotiation (%)	Traditional negotiation (%)	Adapted traditional negotiation (%)
10 providers	100	80	80
20 providers	100	45	45
30 providers	100	47	47
40 providers	100	55	55
50 providers	100	62	62

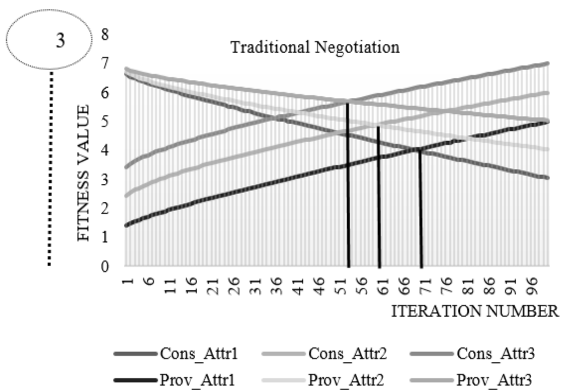

Fig. 8: Traditional negotiation case having a solution

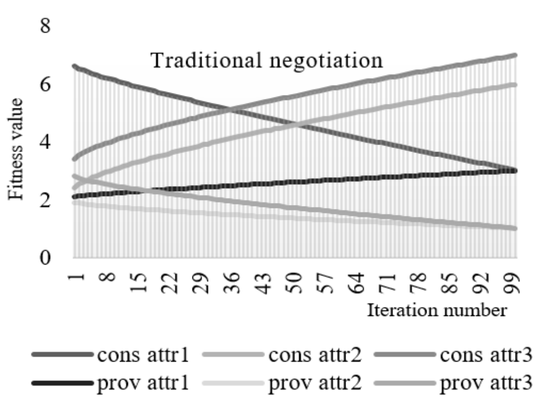

Fig. 9: Traditional negotiation case having no solution

get a lot of acceptable solutions within a start set of iterations. This is one of the advantages of the proposed approach, which is getting acceptable solutions within the start iterations and we have not to wait until final iterations.

With the traditional time-based negotiation approach, we test how many success negotiation

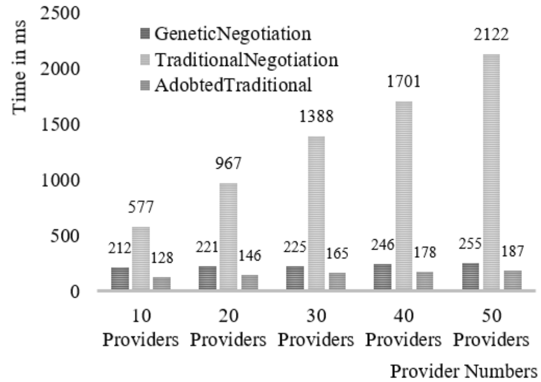

Fig. 10: Execution time of the three techniques with communication time

providers from 50 providers with β = 2 and the proposed relation of β. With β = 2, greater number of providers has an agreed solution with consumer. So, the proposed relations gets a more success. Number of successful and unsuccessful providers with β = 2 and the proposed relation of β is presented in Table 6.

A number of successful negotiators with traditional time-based negotiation approach and adapted traditional time-based negotiation approach are tested with a different number of providers "10, 20, 30, 40 and 50"and presented in Table 7.

Besides the number of successful negotiators, we have measured the negotiation success percentage of genetic-based negotiation and the other two approaches as presented in Table 8. From experiments, genetic-based negotiation always has a solution. In contrast to other two approaches, they have a negotiation percentage less than 80%.

The traditional and adapted traditional negotiation approaches not always has solutions. The two approacheshave the same results except for the message communication structure. We present a case (consumer and provider bids) that has a solution. The consumer and the provider negotiate about three attributes represented by three lines of offers for the two sides as presented in Fig. 8. In that figure consumer attribute1 and provider attribute 1 intersect on "71" bid (time). For attribute 2, they intersect on "61". For attribute 3, they intersect on "54". Two sides agreed bid number "39" where a tradeoff between the three attributes is reached. This is because a tradeoff must exist between the three attributes and this point that has values that are acceptable to all sides of the three attribute.

For the three attributes, a tradeoff may lead to non-acceptable offer acceptable to both sides for the three attributes. This is presented in a case in Fig. 9. Consumer and provider agreed only on attribute as they intersected on bid "96". They have no intersection point for attribute1 and attribute2. So, it is impossible to get a tradeoff between the three attributes.

The execution time for the three approaches has been computed for "10, 20, 30, 40 and 50" providers and presented in Fig. 10. The execution time of the traditional time-based security negotiation approach exceeds the other two approaches. This is because of the communication structure of the traditional time-based security negotiation approach and the increasing number of messages. The execution time increases linearly with increasing number of negotiated providers. In contrast to the adapted traditional time-based security negotiation approach that works with the same method but not the same communication structure. The genetic-based security negotiation approach has an acceptable execution time compared to the traditional time-based approach. The traditional time-based security negotiation and the adapted traditional time-based negotiation approach not always has a solution. In contrast to the genetic-based security negotiation approach that always has a solution with the start set of iterations. The genetic-based security negotiation approach always has acceptable solutions within start 20 iterations. So, there is no need to complete thenegotiation process. With the genetic negotiation approach, for "10, 20, 30, 40 and 50" providers need only "42 MS, 44 MS, 45 MS, 49 MS and 51 MS" respectively. So the genetic-based approach has the best execution time compared to other two approaches.

In addition to a number of successful negotiators and execution time, the complexity of the three approaches is computed. The complexity measurement of a distributed algorithm is computed by one of the three distributed measures: Time complexity, bit complexity and message complexity (Pandurangan *et al*., 2016). The addressed negotiation problem is mainly affected by communication complexity. Communication complexity is measured by message complexity.

The traditional negotiation problem involves two types of parties; consumer and N number of providers. The consumer receives a message with a fixed length; which contains the proposal r. And N providers sends a message with a fixed length to the consumers. The consumer checks each providerproposal separately and then replies to each provider separately with accepting or a proposed solution f(r,s). The negotiation process can be terminated in <= M message times for each provider. The Traditional Negotiation problem (Trad.NEG) requires communicating M message times in the worst case to determine if the proposal messages or r is accepted or the time t exits without finding an accepted proposal message from any participant. The negotiation problem continues between one consumer and N providers separately. The worst case communication time of that negotiation communication problem, donated by D(f), can be defined to be D(f) which is the minimum number of messages exchanged between one consumer and N providers in the worst case. The traditional negotiation problem message complexity can be represented as the following:

$$D(Trad.NEG) = 2(M \times N) + (N - 1)$$

The genetic negotiation problem of this study involves three different types of parties; consumer, N providers and the third party that conducts the negotiation problem as a service. The N providers as participants and one consumer; the opponent participant; sends their attributes p through a message to the third party. The negotiation process conducted by the third party and the best suitable provider from N providers is chosen to be the suitable opponent with the consumer. Message complexity of the genetic-based negotiation can be defined to be the minimum number of messages between participants in the worst case. It can be donated as the following:

$$D(Gentic.NEG) = 2 + N$$

The negotiation process of the adopted traditional negotiation is the same as traditional negotiation. But the communication structure is not the same. Its' communication structure is the same as genetic negotiation communication with the same variables. The adopted traditional negotiation can be donated as the following:

$$D(Adopt.NEG) = 2 + N$$

From the above message complexity analysis, the message complexity of the traditional negotiation exceeds the message complexity of the two other approaches. The message complexity of the genetic-based approach has a less message complexity like the adapted traditional time-based approach.

CONCLUSION AND FUTURE DIRECTIONS

In this study, an efficient genetic-based web service security negotiation approach is proposed. This approachmakes use of genetic algorithm technique to be considered as a negotiation strategy. Genetic techniquedescribes the problem as a search space of solution and the target of the negotiation problem is to get an acceptable solution for both web service entities; consumer and provider. The visibility of the solutions/populations is considered in the proposed approach. Tuning of the results is conducted by using different mutation rate and crossover rate values to get a better fitness function. In addition, we claimed that mutation rate "0.15" and crossover rate "0.5" are the best values to get better fitness values for the proposed approach. Besides, a traditional time-based negotiation approach is provided. Also, an adaption to the traditional time-based negotiation approach is proposed.

The proposed approach is tested against traditional time-based negotiation approach applied to many works of literature and adapted traditional time-based approach. Experimental results show that the genetic-based approach is always successful with a percentage 100% on the contrary to other two approaches that are successful with less than or equal to 80%. In addition, the proposed approach gets a good solution at the beginning of generations; which are generations number "0, 3, 5, 6, 7, 8, 11, 16, 46, 58 and 66". In addition, the execution time is measured for the three approaches with "10, 20, 30, 40 and 50" providers. As the proposed approach gets acceptable solutions with the start set of 20 iterations, the execution time of that approach is 51 ms for 50 providers. A message complexity is evaluated for the three approaches. A less number of messages transferred and execution time used by the proposed approach.

As future directions, we intend to address privacy negotiation between web service participants. Besides to that, we need to integrate security negotiation requirements on a web service composition as there is a significant need for composed services.

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