A Web Service Discovery Approach Based on Hybrid Negotiation

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Abstract: An effective discovery system must be able to retrieve services responding to the users' specific preferences in a changing and dynamic environment. Actually, the existing discovery systems have three problems. Firstly, some of them fail to find Web services providing the same QoS as defined in their related description files, since the QoS data are considered as static. Secondly, the discovery systems based on negotiation lack the accuracy in simulating similarly the real humans' interactions. Thirdly, the negotiation based approaches implemented to discover services are static and do not consider contexts as well as characteristics of each provider. These shortcomings affect negatively the systems performance and usability. Consequently, the quality of the returned services as well as the systems' reputation will be deteriorated. In this paper, we propose an hybrid discovery approach based on negotiation that solve these drawbacks. We argue that our approach enhances the discovery system performance and usability by implementing a negotiation process that is closer to humans' interactions. Moreover, by considering the existing dependencies between the concurrent negotiations, the discovery process will be more efficient. Unlike previous work, the negotiation process is dynamic by taking into account the provider's context and reputation.

1 INTRODUCTION

The Web is no longer a simple way to access information, its evolution makes it also a provider of services. Web Services refers to applications exposed by providers over the Web. They provide a standard means of interoperating between different software applications, running on a variety of platforms and/or frameworks. Service discovery is the process of locating Web service, and retrieving Web services descriptions that have been previously published (Bromuri et al., 2009). Often Web services operate in a rapidly changing environment. Consequently, their QoS parameters change quite frequently, either due to the external (e.g., the variance on the service demand, server outages, the congestion at the router (Bannock Consulting, 2000)) or the internal (e.g., poor upstream connectivity (Kouki et al., 2013), the changes of the providers' preferences (Bannock Consulting, 2000)) environment changes. In most studies dealing with the discovery task, QoS parameters are considered as static (Ran, 2003), (Zhou and Chen, 2005), (Lakhal and Chainbi, 2012). Therefore, the non-functional features of the returned services will not be the actual ones that reflect the service functioning. Some studies have tried to find solutions for the static QoS parameters problem (Chen et al., 2010), (Zhou and Chen, 2009), (Platzer et al., 2007). These solutions use respectively statistics (e.g., the sampling method (Zhou and Chen, 2009)) and networks (e.g., sniffing, probing, and interceptors (Platzer et al., 2007)) based methods. These technologies need over resources utilization as well as huge computational and statistical efforts. Recently, other works adopting the negotiation approach in order to dynamize the QoS parameters appeared (Bentahar et al., 2008), (Napoli et al., 2013). The adoption of negotiation while discovering the best service has also several benefits including the discovery time optimization, the resolution of conflicts between the providers' and clients' preferences, and the improvement of the success rate. However, the main weakness of these solutions is related to the difference between humans' behaviors during their interactions and those of agents during the systems functioning. These systems do not simulate some common

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negotiators' behaviors observed during their real life interactions. Simulating these details about negotiators' behaviors will positively impact the system's performance and outputs. During real life negotiation, each client uses his/her experience, competences, and knowledge to negotiate differently his/her goals. Also, negotiators make continuously new offers and give explanations about the reasons of choosing such offers. In our approach, negotiators will generate offers, give explanations and behave differently. Additionally, in these systems the negotiation strategies are static. These strategies are used by all providers without caring about the specific context and characteristics of each one of them. Also the consideration of dependencies between the different negotiation processes is missed. These dependencies are the cooperation relations existing between the different client's instances. These instances exchange information about the providers' offers and use them to propose more attractive offers. Considering these dependencies make more efficient the overall negotiation process. The objective of this paper is to present a discovery approach based on an hybrid and a dynamic negotiation process. Given that they are software components that have autonomous behavior and that try continuously to meet their own objectives, by taking into account their resources, skills and perceptions, agents are suitable entities to be adopted for the simulation of both users' and the providers' behaviors during their interactions (Chaib-draa et al., 2001).

The reminder of this paper is organized as follows. In the second section, we review the existing discovery approaches, and we outline their main characteristics as well as their drawbacks. In the third section, we highlight the main contributions brought by our approach. A buying-selling case study that illustrates our approach is presented in the last section. Finally, we summarize our work and we give hints concerning our future work.

2 RELATED WORK

Two types of discovery approaches have been proposed to solve the static QoS parameters problem, namely, the discovery approaches that are network as well as statistical based methods, and those that are adopting the negotiation. Compared to researches dealing with the first type of approaches, the negotiation based works are fewer.

2.1 Approaches based on Network and Statistical Methods

In (Al-Masri and Mahmoud, 2009) a WSB (Web Service Broker) is used to update the QoS parameters values. More especially, a WSCE (Web Service Crawler Engine) is used to collect dynamically the updated QoS data. In (Julie and Kumar, 2012), a collaborative filtering approach that predicts automatically the QoS parameters values is adopted. An important drawback related to this work is that there are no large-scale real-world Web service QoS data sets available for studying the prediction accuracy. In (Zhou and Chen, 2009) the data related to the users' and the providers' feedbacks are gathered and then processed according to a set of statistical methods. The drawback of approaches which consider the users' and the providers' feedbacks is related to the big statistical efforts computations. Other works use statistical methods to estimate values of the QoS parameters before the reception of feedbacks (Thio and Karunasekera, 2005). In these approaches, the most statistical jobs are executed when original data is received in the service registry. Consequently, this will take up many other hardware resources of the service registry (Zhou and Chen, 2009). In (Chen et al., 2010), the authors present a model for the management and the discovery of services based on two dynamic QoS parameters, namely the response time and the execution time. The monitor that acts as an interceptor during each service invocation is used. Most of the existing works enabling the dynamicity of the QoS data that are discussed above are suffering from general drawbacks. Many of these approaches are restricted in the sense that they can't handle the dynamicity of some QoS parameters types including the service's cost and the service's price. These parameters are of a paramount interest in the cloud computing field, and should be considered as dynamic during the discovery process. Additionally, some of the presented approaches using statistical methods require over resources utilization as well as huge computational efforts. Moreover, since some systems use the gathered information during the service invocation to keep up-to-date, then in the case where a service is not invoked periodically, its related non-functional parameters can't reflect the actual service's performance.

2.2 Approaches Based on Negotiation

Bentahar et al., adopt in the context of the communities' construction, an argumentation based approach (Bentahar et al., 2008). The selection of the best service is done in terms of functionality and QoS (i.e., response time, availability, throughput, reliability, etc.). Agents use knowledge, beliefs, and argumentation capabilities to reason. A persuasive negotiation protocol composed of different dialogue game was used. A dialogue game is the set of moves that are made during the negotiation. This work adopts only one model of negotiation and the complexity of the used protocol depends on the size of the agents' knowledge bases. A negotiation approach that adopts a coordinator between the different Web services based on the MAIS (Multichannel Adaptive Information Systems) architecture is presented in (Comuzzi and Pernici, 2005). The negotiation capabilities related to each provider are presented as policies in the service specification. Services involved in the negotiation are selected, and then one auction based strategy is chosen from the different auction models and applied between these services. In this work, only one negotiation model is used and the implemented system is not based on the agent technology. The work presented by Napoli et al., is close to our work, since it deals with the static QoS parameters problem (Napoli et al., 2013). However, unlike our work, the generation of offer related to the QoS parameters is permitted only in the provider's side, the user has only the role of evaluating offers. In this work, the standard contract net protocol and a unique negotiation model are adopted. The paper presented by Siala and Ghédira use a variant of the contract-net protocol, called the directed contract-net protocol that has the effect of decreasing the number of the negotiation rounds comparing to the standard Contract-Net while composing services. A coordinator supervising the different negotiations is used. Dependencies between the different negotiations strategies are not considered in this work (Siala and Ghédira, 2011). Bromuri et al., present a decentralized multi-agent system that adopts an argumentation based strategy to find the best service. In this work, the best service is firstly selected among a set of the available services, then a negotiation session is started with the chosen service in order to achieve an agreement about the required QoS parameters. This strategy restricts the client's chances to find the best offer since he/she negotiates his/her preference with only one provider, while other providers can have more interesting offers (Bromuri et al., 2009).

3 THE HYBRID NEGOTIATION APPROACH CONTRIBUTIONS

Given the promising solutions brought by negotiation, recent discovery approaches based on negotiation models arise. A set of these works have been already presented in the related work section. These works have three common problems. Firstly, the negotiation systems presented by these works lack the realism in simulating perfectly the real human interactions and behaviors during the negotiation process. In fact, only a unique negotiation strategy based on one negotiation model is adopted for simulating providers' and clients' behaviors. In real life each client and provider has his/her own strategy to negotiate. In these works, all negotiators are obliged to follow the same strategy in order to reach their different goals. In this paper, our aim is to relax this assumption by introducing a system which applies more than one strategy based on different negotiation models. In our work, we adopt the argumentative and the heuristic models. The formal description of the adopted strategies is out of the scope of this paper, since our main interest is to present our discovery process based on hybrid negotiation. Secondly, all these works assume that the negotiation process is static i.e., once the negotiation strategy is defined by developers it will be applied similarly with all providers without considering their different context and/or characteristics. Finally, dependencies between the different negotiations are missed. Each bilateral negotiation involved in the whole negotiation process is conducted regardless to other processes which result in longer negotiation process and sub-optimal offers. In our study, we solve these problems by considering three main contributions. The first contribution is to make more realistic the negotiation process by simulating some details observed during the real humans' interactions. The second contribution is to make dynamic the negotiation process. The final contribution is to consider dependencies between the concurrent bilateral negotiations.

3.1 The Simulation of the Real Humans' Interactions

The simulation of humans' interactions implies the creation of an artificial world of agents that are in interaction and that have humans' capabilities to interact with their environment and to react according to their own perception, goals, and beliefs.

Since systems are substituting the real human interactions, they have to be as much as possible close to the humans' behaviors as well as to their strategies during the negotiation. The second feature observed in human interactions, but that is missed in the current systems dealing with the discovery of the best service is the exchange of explanations between the different parties. In our work, we solve conflicts among negotiators by enabling the two parties to exchange explanations through arguments. In works dealing with the service discovery based on argumentative based models the explanatory role is not yet studied. The third feature characterizing the real human interactions that is missed in some of the existing works is related to the providers' and clients' role in generating offers. Information about the opponent's offers is used to propose more attractive offers during the next negotiation rounds.

3.1.1 An Hybrid Strategy

During their daily real business interactions, sellers and buyers are using different strategies to convince each others about their offers and preferences. Each negotiator has his/her own way to convince his/her opponent and to generate offers. Obliging all providers and all clients to adopt the same strategy is not possible since some of them haven't essential information and backgrounds to use systems based on some kind of negotiation models. For example, if the negotiation system implements an experience based strategy, users who haven't yet experience and who want to purchase the service for the first time, will find problems in using this system. Also other models such as the argumentation based model require a predefined set of knowledge and arguments. However, sometimes users aren't able to formulate readily suitable arguments to convince their opponents and to express fluently all their preferences. Implementing different strategies will improve the discovery system usability level. Usability is defined by three features namely, the system's effectiveness, the system's efficiency, and the user's satisfaction (Frøkjær et al., 2000). Effectiveness is related to how much the system is able to respond the users' requests. Satisfaction is related to the comfort and subjective user's evaluation of the interaction. The efficiency is related to how the system is able to achieve the best result with less effort and the minimum time. A system qualified by a high usability level is better suited to be consumed by different types of users. Along with such a system, users having different requirements are more luckily to find the functionalities and the conditions helping them to discover their services. Consequently, the reputation of the discovery system will be improved. When adopting different strategies we try to balance between the cost and the effectiveness. The argumentative model is powerful enough to achieve an agreement but it's costly in terms of consumed resources and complexity. While a less powerful model such as the heuristic model can improve the complexity and decrease the chances to achieve an agreement. Moreover, contexts and attitudes of each provider are different, so it's difficult to apply the same strategy with all providers. The client has to collect information about the provider's attitude and accordingly he/she must choose the adequate strategy that complies with the providers' characteristics.

3.1.2 The Role of Clients and Providers in Giving Explanations

The provider's role in bringing explanation for users about some aspects that may be not obvious for them is missed within the existing discovery approaches. This is possible with the negotiation via the adoption of the explanatory arguments. For example, the client can ask the provider if it's possible to have a discount or a higher service availability level. Also he/she can inquire further details about the service functionalities and about the reason of uttering a given offer. Within the negotiation mechanism, the provider is able to respond to such requests and to give additional explanations. In works adopting the argument based models in order to select the best service, other types of arguments are used, including rewards and threats. These arguments have the effect of inducing and convincing negotiators rather than giving explanations. In the case of an explanatory argument about the last offer, the opponent examines firstly the argument and accordingly he/she can decide if he/she will accept or refuse it. If the opponent's beliefs and preferences comply with the explanatory argument then he/she will accept it. Otherwise, this explanation will be used by the opponent during the building of his/her next offers. The opponent will have an idea about the proponent's preferences and beliefs, and accordingly he/she can formulate more attractive offers to him/her. Explanatory arguments have the role of resolving conflicts among the negotiators' preferences. Clients and providers use them to explain the reason of refusing the opponent's offer. This information will be then retained by the opponent and used to exchange more attractive offers. This will make faster the discovery process and helps to resolve gradually conflicts. Also, the quality of the last offer will be improved, since it will be the result of exchanging more attractive proposals.

3.1.3 The Role of Clients and Providers in Generating Offers

In some existing works, the provider has the role of generating offers, while the user has only to evaluate offers (Napoli et al., 2013). In our work, users and providers generate and evaluate offers. Our main interest is satisfying the users' goals. To do so, users must have their own strategies and tactics to generate offers reflecting their preferences as is done during the real human interactions. These proposals will be used by providers as basis to the construction of their next offers. Both parties must evaluate and generate offers because this will make smarter and faster the negotiation process. Evaluating only offers doesn't show the preferences of the negotiators, rather it reveals only their positions. Thus, a rational client respectively (provider) who wants to gain the negotiation and to reach as faster as possible an agreement must generate offers rather than evaluating only the provider's (the client's) offers. This will help both negotiators to construct faster an idea about each other's preferences, and then to reach more rapidly an agreement.

3.2 The Dynamic Negotiation Process

Most of works dealing with the selection of the best service by adopting a negotiation approach assume that the negotiation process is static. In our work, we make dynamic the negotiation process by selecting the appropriate negotiation strategy to be adopted with each provider. In fact, the choice of the best strategy depends on different parameters including the provider's context, reputation, and preferences. Before starting the negotiation, the system must gather information about providers. Accordingly, the best strategy to be adopted with these providers is selected. For example, systems must have an idea about the provider's context such as, if the provider is selling during a high or a sale season. In the latter case, the provider is willing to make more concession. Accordingly, the system can choose a negotiation strategy that doesn't need big efforts in convincing the provider such as a heuristic based strategy. However, if the provider is in a high season which means that there is a big competition among providers, then the system may choose a stronger strategy such as an argument based strategy. Reputation is also important. Reputation is determined based on the attitude of the provider during his/her past interactions. The system should know if the provider is a stubborn negotiator or a collaborative one. Accordingly the appropriate negotiation strategy is adopted. Moreover, knowing the provider preferences toward the values of the QoS parameters can give us an idea about the distance between the user's offers and those of the provider. This distance represents evidence about how will be difficult the conversation with one provider. If this distance is large, the client will find difficulties to convince the provider. It will be easier to convince each other if they have closer preferences. In the first case, convincing the provider will be a hard task; a negotiation strategy based on strong arguments must be adopted. However, in the second case, an experience or a heuristic based model can sufficiently make the task. By considering one of the latter information about each provider, the best strategy that must be applied with each provider is determined. Choosing the best strategy that fits the provider's profile, avoids for example the adoption of less powerful negotiation model with the more stubborn providers as well as a heavy strategies with the less stubborn ones. In the first case, we are increasing the chance of achieving an agreement. However, in the second case we are reducing the consumption of unnecessary resources.

3.3 The Dependency among the Bilateral Negotiations

In the existing works, dependencies between the different negotiations involved in the whole negotiation process are not considered. In our work, the relation between the concurrent bilateral negotiation processes is ensured through an intermediate party. During each negotiation round, the intermediate party gathers information about offers proposed by each provider from each client's delegate and communicates this information to other client's agent instances. In our work, we assume that there is a competition between providers and also cooperation relation between clients' agent delegates. Each provider's aim is to present a more attractive offer to the user. Each client's agent is able to be informed about other providers' offers through their correspondent clients' agent instances. The client's agent will use this information to induce the provider's agent to make better offers than those of its agent's competitors. For example, if one of the client's agents knows that the other providers' agents offered more attractive proposals, it will then refuse the offer proposed by the provider's agent with which it is currently dealing. Also, it will induce the provider to make more attractive offers. Consequently the competition between providers will be more intense. This competition will be in the favour of the user and will accelerate the negotiation process progression. Each provider will try to make more interesting offers in order to get the deal. Thus, providers and clients will exchange more and more attractive offers until achieving an agreement. This will speed up the negotiation process and scale down distances between the negotiators' preferences. When the cooperation among clients' instances and the competition among providers are adopted together, clients are luckiest to get at the end the best offer.

4 A CASE STUDY

In this section, we give an example of a buying-selling transaction that illustrates how the negotiation protocols presented by Moschoyiannis et al., (2009), and Venugopal et al., (2008) are applied. We make some modification in these protocols to show benefits of considering dependencies between the bilateral negotiations. In future papers, we will demonstrate through different types of experiments the other contributions.

In this example, we consider that the client's agent aims is to benefit from a service with a low price and high levels of availability, and reliability. However, providers' agents' ambition is to have the opposite.

4.1 the Protocols Description

In order to illustrate our hybrid approach, we use the standard alternating-offers protocol and also the protocol presented by Moschoyiannis et al.. The latter protocol is composed of a set of moves which are respectively, m1:request(negotiation), m2:refuse (negotiation), m3: accept(negotiation), m4: offer(x), m5: accept(x), m6: refuse(x), m7: challenge(x), m8: argue(x), m9: withdraw(x). It specifies also when a particular move is made in the course of a negotiation dialogue by defining the pre-condition and the post-condition of each move. For instance, the move challenge can be uttered if only there is beforehand an offer move. The post-condition of the challenge move is to utter an argue message or a withdraw message. We extend this protocol to make possible the proposal of more than one message at once. For example, for the message m4 we can reply by an m7 and m4 messages, instead of m7 only. Also we enable the utterance of an offer move after an argue move. Also, we make changes in order to adapt the protocol to the negotiation over the QoS parameters rather than it is presented in the context of the resource allocation. In the following, we denote by A1 the first client's delegate agent, and by P1 its correspondent provider's agent.

The standard alternating-offers is a bilateral negotiation protocol. Negotiators exchange only proposals, counter-proposals, accept and reject messages. We denote by A2 the second client's delegate agent, and by P2 its correspondent provider's agent. Since the presented negotiation protocols cover more than one potential alternative scenario, we will be restricted to the more principal negotiation scenario. Furthermore, we only describe informally the proposals, arguments, and messages. In this example, we keep static the availability and the reliability parameters values and we focus only on the price.

4.2 The Main Scenario

Step1
Negotiation 1
A1
m1:Request(negotiation)
Negotiation 2
A2
Offer (50 $, 0.8, 0.9)
Step2
Negotiation 1
P1
m3:Accept(negotiation)
Negotiation 2
P2
Counter-offer (59$, 0.8, 0.9)
Step3
Negotiation 1
A1
m4:Offer(50 $, 0.8, 09)
Negotiation 2
A2
Refuse(59 $, 0.8, 0.9)
Step4
Negotiation 1
P1
m7: challenge (50 $, 0.8, 0.9).
-Why do you proposed as price 50 $, as availability 0.8, and as reliability 0.9?
- What argument you can give to let me believing about this offer?
m4:Offer (58$, 0.8, 0.9)

Negotiation 2
P2
Offer (58 $, 0.8, 0.9)
Step5
Negotiation 1
A1
m8:argue(I need it for a daily use. I would like to have a high availability and reliability level with a reasonable price).
Negotiation 2
A2
Counter-offer(54$, 0.8, 0.9)
Step6
Negotiation 1
P1
-IF the m8 complies with the P1' goals then it will accept the P1' offer. And the process ends with an agreement.
-ELSE, P1 refuses the A1' offer. End of the process without agreement. P1 can give a proposal.
m4: Offer (57 $, 0.8, 0.9)
Negotiation 2
P2
Offer (56 $, 0.8,0.9)
Step7
Negotiation 1
A1
m7: challenge (57 $, 0.8, 0.9)
-Why do you proposed as price 57 $, as availability 0.8, and as reliability 0.9?
Negotiation 2
A2
Accept(56 $, 0.8,0.9)
Step8
Negotiation 1
P1
m8: argue ({If you accept this proposal, you will have a discount}).
Step9
Negotiation 1
A1
m4: Offer (55 $, 0.8, 0.9)
Step10
Negotiation 1
P1
m5:Accept (55$, 0.8, 0.9).

In step1, the agent A1 makes a request move. Simultaneously, the client's agent A2 makes an initial offer. In the second step, P1's agent accepts the A1's request, and the negotiation starts. In the second bilateral negotiation, agent P2 doesn't agree with the A2's offer and makes a counter-offer. In step 3, the A1's agent generates an offer according to its preferences and beliefs. In parallel, A2 refuses the last offer of P2. In step 4, P1 makes a challenge move, and it proposes a first offer. In parallel, P2 proposes a cheaper price than that it offered in the previous step. In step 5, A1 sends to P1 an explanatory argument in which it explains its reason of making such an offer. Indeed, the client's agent wants to have a high availability and reliability levels in addition to a low price since the client will consume daily the service. This explanatory argument helps provider's agent to change its anterior beliefs to be more flexible and closer to the client's preferences. In fact, closer the agents' preferences, the least conflicts are. In the second negotiation, the A2's agent makes a concession and proposes 54 $ as a price. In step 6, the intermediate party's agent gathers information about the last providers' offers and communicates them to the other clients' delegates. Each delegate, during each round must inform its opponent's agent about this information and induce it to make more interesting offers. It also tells its opponent about the offers that were refused by the other client's agents. According to its policies and strategies, each provider's agent decides which offer to propose. For example, in the step6, P2 proposes as a price 56$ which is lower than 58$, proposed by P1 during the step4. It's a time lost for the provider's agent to propose an offer that is less pertinent to the client. By knowing the offers refused by the other clients' instances, the provider's agent can understand better the client's preferences. Consequently, it can propose more interesting offers. For example in the step4, P1 avoids to offer as a price 59 $, since this proposal was refused by the other client's agent in the step3. The consideration of the relation between the two bilateral negotiations makes faster the achievement of an agreement. In step 7, A1 makes a challenge move. In parallel A2 accepts the P2's offer, and the second negotiation process ends. In step 8, P1 makes a reward argument in which it promises A1 a discount if it accepts the offer. According to its goals, A1 can either accept or refuse this argument. If it accepts the argument, then an agreement is achieved, and the client will have a discount. In step 9, A1 doesn't accept the P1's argument, and it proposes 55$ as a price. In step 10, P1 examines the A1's last offer and according to its preferences and beliefs it decides if it will accept, refuse the offer or make a withdraw move. In our case, P1 accepts the A1's offer, and an agreement is achieved. Between the two final offers, the coordinator's agent will choose the one which decrease the price, which is in this case the P1's offer.

5 CONCLUSION

Changes on the Web service environment and on users' requirements have led to new works having as goal the establishment of discovery systems that can respond to users' requests and assure the credibility of results. In this context, several approaches have been applied including the negotiation which leads to significant results related mainly to the improvement of the success rate and the optimization of the search time. In this paper, we have introduced new aspects which are missed in these approaches. The first aspect is related to the consideration of the real life negotiation characteristics during the simulation. These characteristics are the use of different negotiation strategies during interactions, the exchange of explanations between negotiators, and the role of clients and providers in generating offers. The adoption of an hybrid strategy makes the discovery system more realistic and oriented to the largest number of users. The second contribution is to make dynamic the negotiation process. This has the effect of making the negotiation more efficient by choosing for each provider the most suitable negotiation strategy that fits his/her reputation, preferences and context. The third contribution is the consideration of dependencies among the concurrent negotiations. This will impact the quality of the final offer which will be also the result of the competition between providers. Moreover, this will make faster the discovery process since the client will avoid the evaluation of offers that weren't accepted by other clients' instances during the past rounds. Also the providers will avoid proposing offers that were refused by the other clients' instances during the previous rounds. Our future work, will be devoted initially to the presentation of a formal definition of our negotiation approach and secondly for the development and the experimentation of our system.

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