Content-Oriented Composite Service Negotiation with Complex Preferences

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ABSTRACT

In e-commerce, for some cases the service requested by the consumer cannot be fulfilled by the producer. In such cases, service consumers and producers need to negotiate their service requirements and offers. Whereas some multiagent negotiation approaches treat the price as the primary construct for negotiation, we consider that the service content is as much important as the price. Therefore, this study mainly focuses on the content of the service described in a common ontology accessed by both agents for common understanding. Acquiring user's preferences and acting upon these preferences are crucial tasks for a consumer agent as far as the negotiation is concerned. Since the size of complete preference information increases exponentially with the number of attributes and size of domain, it is required to keep these preferences in a compact way. There are a variety of ways of representing preferences and using these structures for automatic generation of consumer's request. This research develops an automated negotiation approach in which the consumer takes the preferences of the user in an efficient way and uses these preferences in the generation of request. For this purpose, we design several strategies to generate requests to take the best offer by the producer. On the other side, in order to obtain a more effective negotiation results the producer tries to learn the consumer preferences from the bid exchanges incrementally in order to refine its offer over time. Furthermore, for some complicated services desired by the consumer, a single producer by itself may not meet the consumer's needs. In such cases, the system should allow consumers negotiating with multiple service producers as far as composite services are concerned.

1. INTRODUCTION

Service-oriented architectures (SOAs) are being used extensively to build multiagent systems in which autonomous agents request and provide services to each other [1]. In traditional SOAs, service consumers interact with a service provider to receive a predefined service, which is typically advertised by the provider though the registries. However, in many realistic settings, the content of the service would vary based on the receiving consumer, necessitating a negotiation between the consumer and the producer

When the producer does not provide the exact service requested by the consumer because of lack of resources or some business constraints over the service [2], the consumer and producer negotiate the content of the service [3].

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The content of the service consists of multiple issues. Consider that the service that is being negotiated between producer and consumer is that of selling a wine. Possible issues constructing the service content may be color, region, grape, flavor, body and so on. The preferences may vary from consumer to consumer. Preferences represent the user choices when more than one alternative value exists for a given issue. For example, alternative values for the color are red, rose and white. A preference may be strictly specified. For example, for the color attribute the consumer prefers only red wine. Any other wine whose color is different from red is not acceptable by this consumer. In our previous work [4], the preferences were in this form.

Another important thing is the relative importance degree of the issues. For example, for some consumers the color of wine is more important than the grape whereas the grape may be more significant for other. The importance degree of each issue may be different for each consumer. Thus, assigning different weights to each service component can be useful for evaluation of the services. Some studies take these weights as a priori and uses the fixed weights [5]. However, in many realistic settings, consumer's preferences with the weight values are not known by the producer at the beginning of the negotiation. Hence, it is more convenient for the producer to learn these preferences from the interactions with the consumer.

For more flexible negotiation scheme, more flexible preference representation can be used where the relative preference ordering over the values of the issue can be taken into account. A consumer may prefer red wine to rose wine and prefers rose wine to white wine. Of course, a preference may be in a more complicated form involving the dependency among features. For instance, the consumer may prefer red wine to white wine when the grape of the wine is Chardonnay. For other values of grape, the preference of the consumer may change. To obtain complete preferences from the user may require too many questions to be asked to user in most of the cases. There are some compact preference representations, which require less question such as GAI-nets [8], CP-nets [9] and so on. Even though they are compact, they can represent most practical preference orderings. In our study [7], we use CP-net to represent preferences and construct a preference graph by inferring CP-net. By using a heuristics on this graph, we obtain a complete preference ordering and develop strategies to generate consumer's requests in accordance with these orderings.

2. REPRESENTING PREFERENCES

The concise representation of the user's preferences plays an important role in terms of generating requests and counter offers. Acquiring these preferences from the user in an efficient way and using them in automatic generation of requests and offers are important tasks for negotiation process. To obtain the preferences from the users, using CP-nets may be convenient way since CP-net is known as a tool for representing qualitative preferences in a compact way [9]. Moreover, we can represent conditional preferences such as if the grape is Chardonnay, the user prefers white wine to rose wine by using CP-nets. In [7], for taking the user's preferences, we develop a user friendly interface so the preferences are kept as a CP-net structure. From this structure, a preference graph is obtained. By using a heuristic, we are able to compare some choices, which are incomparable otherwise. The consumer agent uses the user's preferences in automatic generation of request during the negotiation process.

Since the preferences of each agent are kept private in order to prevent the exploitation by the other agent, learning other agent's preferences from the bid exchanges between agents incrementally over the time is necessary to shortening the consensus time. From the point of the agent, learning other agent's preferences may lead to an improvement in the negotiation process. We apply learning process for simplistic preferences [4]. However, it would be more interesting to learn more complicated structures, like CP-net.

3. NEGOTIATION ARCHITECTURE

In our previous work [4], a negotiation architecture supporting only one consumer and one producer agent negotiating in a fully automated way is presented. In this architecture, a shared ontology involving the service description is used by both agents for understanding the semantics of the requests and offers. The consumer agent generates its requests by using its preferences. Through repetitive interaction, the producer learns consumer's preferences incrementally and refines its counter offers by taking the learned preferences into account.

For this purposes, we develop an extension of Version Space [10], which is one of the inductive learning approaches. Here, the producer learns the preference concept from the observed examples during the negotiation process. In this process, all of consumer's requests are taken as positive samples whereas the producer's counter offers rejected by the consumer are considered as negative samples. As an alternative to Version Space, decision trees are also used in order to model the consumer's preferences. If an exactly matched service with the consumer's request cannot be met by the producer, producer has a tendency to offer a service that is most similar service to the service desired by the consumer in terms of consumer's preferences. To see the benefits of using semantic information, we develop a semantic similarity metric and use this metric to find out the most similar service to the service requested by the consumer. This negotiation framework can be easily extended to support multiple producers by adding a mediated agent between consumer and producers. Here, mediated agent behaves as a single producer agent providing a composite service. The coordination and communication between producer agents are provided by this agent.

4. SERVICE COMPOSITION

As specified in [6], a single producer may be inadequate to meet the consumer's request as far as composite services are concerned. Consider a service of organizing a conference. This complex service involves reservation of a meeting room, publishing the tutorials that would be distributed during the conference, arranging the coffee-cookie proffered in the break and so on. This requires the consumer to negotiate with multiple service producers. The coordination and communication among producer agents and mediated agent will be investigated as a future work.

5. FUTURE WORKS

As a future work, we plan to construct an automated negotiation framework in which multiple service producers collaborating with each other in order to have a consensus on the service content with the consumer agent. The mediated agent will coordinate the interaction among the consumer and producers. In order to learn the consumer's preferences, in addition to using the interactions during the current negotiation, it may also useful to use the past information obtained by the previous negotiations because the information gained during the negotiation may be inadequate to model the consumer's preferences. In this case, the past records belonging to previous negotiations may help the mediated agent learn the preferences more accurately. Moreover, the mediated agent can also use ontological information to discover new knowledge from the existing ones during the learning process. Integration of ontology reasoning and learning algorithm may increase the quality of learning.

Another challenge may be to deal with the dynamic preference in that the consumer may changes its preferences during the negotiation. Also, it would be interesting to take the producer's business policy and preferences into consideration.

6. REFERENCES

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