Concordia University

Electrical and Computer Engineering Department

Research Proposal

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for the Degree of Doctor Philosophy in Electrical and Computer

Engineering

Efficient Coalition Formation for Web Services

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Abstract

Web services are loosely-coupled business applications willing to cooperate in distributed settings within different groups called communities. Communities aim to provide better visibility, efficiency, market share and total payoff. There are a number of proposed mechanisms and models on aggregating web services and making them cooperate within their communities. However, forming optimal and stable communities as coalitions to maximize individual and group efficiency and income has not been addressed yet. In this paper, we propose an efficient coalition formation mechanism using cooperative game-theoretic techniques. We propose a mechanism for community membership requests and selections of web services in the scenarios where there is interaction between one community and many web services and scenarios where web services can join multiple established communities. The ultimate objective is to develop a mechanism for web services to form stable groups allowing them to maximize their efficiency and generate near-optimal (welfare-maximizing) communities. The theoretical and extensive simulation results show that our algorithms provide web services and community owners, in real-world like environments, with applicable and near-optimal decision making mechanisms.

Chapter 1

Introduction

In this chapter we introduce the context of this research, which is about argumentation-based negotiation dialogue games. We also present the motivations behind this work and the research questions. Also, we discuss the objective of this research and our preliminary contributions. Proposal organization is presented in the last section.

1.1 Context of the research

1.2 Motivations and research questions

Multiagent systems are widely used in everyday life, and to add more value to these systems in the field of software engineering, they supposed to be measurable. Our motivation is to find a way to measure these systems from different aspects such as measuring the dialogues, the performance of the participants in the dialogues, and the protocols governing the dialogues, etc. In order to evaluate dialogues in multiagent systems, we define a new

set of measurements from an external agent's point of view. Defining measures for the participants in the dialogues is another motivation in this thesis. The aim behind developing such measurements is to help engineers and developers of agent-based systems in evaluating these systems and their performances.

When monitoring a dialogue between two or more agents, there are many question that should be answered. In this thesis, we are interested in answering the following questions:

- How much are agents certain about selecting a move at each dialogue step?
- How much are agents certain about their dialogues?
- How good are agents in the real dialogue (i.e. the effective dialogue)?
- How far are agents from the right dialogue (i.e. the best dialogue given the knowledge bases of the participants)?

Answering these questions is undoubtedly complex. Therefore, we do not expect a comprehensive answer to all these questions.

1.3 Research objectives and contributions

The main objective of this thesis is to develop a new set of measurements for negotiation dialogue games to help in evaluating and comparing different negotiation dialogues with different participants for the same topic. The importance of introducing measures for negotiation dialogue games at each step of the dialogue such as measuring how much the agent

is certain about its move is to help in developing intelligent multiagent systems (MAS) and to help evaluating different agents provided by different developers.

Our research aims to ensure that the agents' certainty about their dialogue is fairly represented at each step during the dialogue by making sure that the agent's certainty about selecting the right move is kept in mind and considered as a property of multiagent systems.

The main contribution of this thesis is the proposition of a new set of measures for dialogue games from an external agent's point of view. In particular

1.4 Research outline

The rest of the paper is organized as follows: In Section 4.1

Chapter 2

Background and Relevant Literature

2.1 Types of Dialogue Games

2.2 Negotiation Dialogue Games

Negotiation is a form of interaction in which a group of self-interested agents with conflicting interests and a desire to cooperate attempt to reach a mutual acceptable agreement on the division of scarce resources.

2.2.1 Negotiation Component

2.2.2 Approaches to Automated Negotiation

Chapter 3

Coalition Formation for Autonomous Web Services

3.1 Preliminaries

In this section, we discuss the parameters and preliminary concepts that we use in the rest of the paper.

3.1.1 The Architecture

Our system consists of three main types of entities working together:

1) Web services are rational entities[1] providing services to end users. They aim to maximize their individual income by receiving enough requests from end users. In order to increase their revenue, web services seek for more tasks if they have the capacity and

[1]The term rational is used here in the sense that web services are utility maximizers

throughput to do so. Web services can join communities to have better efficiency by collaborating with others, to have access to higher market share, and to have opportunity of receiving a bigger task pool from end users. Throughout this paper, in our equations, we refer to web services as ws and to the set of web services hosted by a given community as C. To simplify the notation, sometimes we simply write ws instead of $ws \in C$ to go through the elements ws of the set C.

2) Master Web Services or the community coordinators, are representatives of the communities of web services and responsible for their management. Communities receive requests from users and aim to host a healthy set of web services to perform the required tasks. They seek to maximize user satisfaction by having tasks accomplished according to the desired QoS. In fact, higher user satisfaction will bring more user requests and increase the market share and revenue of the community.

3) Users generate requests and try to find the best available services. User satisfaction is abstracted as function of quantity and quality of tasks accomplished by a given service. Higher user satisfaction leads to higher trust of the community by users hence directing more requests towards that service provider.

3.1.2 Web Service Parameters

Web services come with different quality of service parameters. These parameters with a short description are listed in Table 1.

We adopted a real world dataset [1] which has aggregated and normalized each of these parameters to a real value between 0 and 1. Since requests are not shared among web services and are distributed among all of them inside a community, each one of them comes

Table 1: List of web service QoS parameters.

Parameter	Definition
Availability	Probability of being available during a time frame
Reliability	Probability of successfully handling requests during a timeframe
Successability	Rate of successfully handled requests
Throughput	Average rate of handling requests
Latency	The average latency of services
Capacity	Amount of resources available
Cost	Mean service fee
Regulatory	Compliance with standards, law and rules
Security	Quality of confidentiality and non-repudiation

with a given QoS denoted by (QoS_{ws}). We assume that (QoS_{ws}) is obtained by a certain aggregation function of the parameters considered in Table 1. We use this quality output later in evaluating the community *worth* or *payoff* function.

3.1.3 Web Service Communities

Figure 1 represents the architecture of web service communities. The communities are essentially an abstract model of web services. They aggregate web services and communicate with other entities such as UDDI registries and users, using identical protocols as web services. Web services join communities to increase their utility by having a larger market share and task pool. Community coordinators or master web services are responsible for community development, managing membership requests from web services and distributing user tasks among the community members. Community coordinators try to attract quality web services and keep the community as stable and productive as possible to gain better reputation and user satisfaction which results in having a higher market share for the community. The way the web services reside inside communities and how communities of

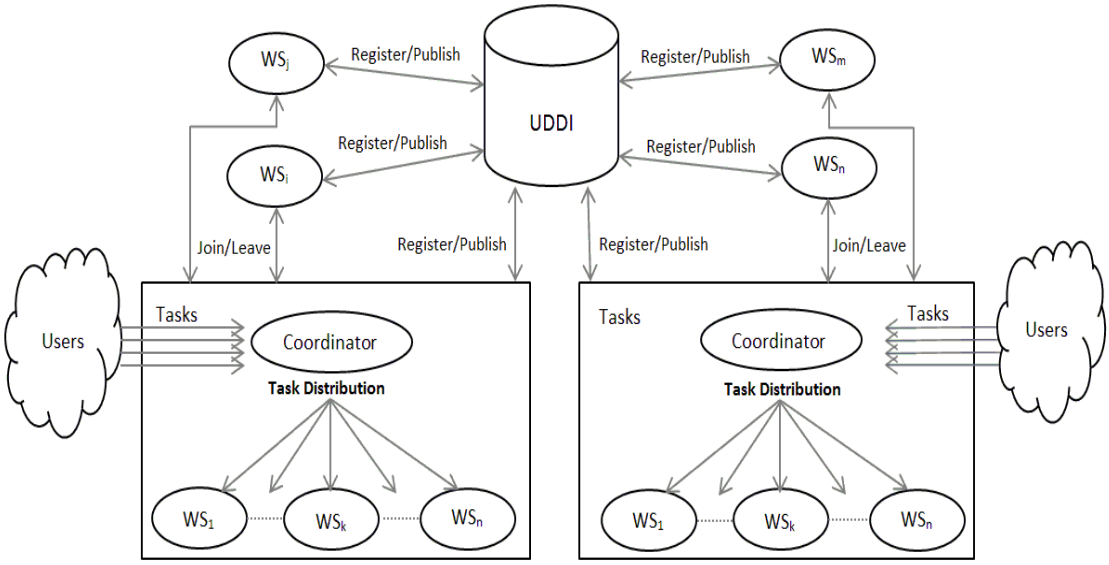

Figure 1: Architecture of Web Service communities

web services are engineered is described comprehensively in [2].

Chapter 4

Cooperative Game Solution Concepts

In this chapter we will introduce the important notions in argumentation-based negotiation,

4.1 Argumentation System and Agent Theory

Chapter 5

Conclusion and Future Work

In this chapter, we describe the phases of our plan for exploring the research challenges and investigating the research issues identified in Chapter 4. This chapter also includes research methodology and future publication plan.

5.1 Conclusion

In this report, we proposed a cooperative game theory-based model for the aggregation of web services within communities. The goal of our services is to maximize efficiency by collaborating and forming stable coalitions. Our method considers stability and fairness for all web services within a community and offers an applicable mechanism for membership requests and selection of web services. The ultimate goal is to increase revenue by improving user satisfaction, which comes from the ability to perform more tasks with high quality. Simulation results show that our, polynomial in complexity, approximation algorithms provide web services and community owners with applicable and near-optimal decision making

mechanisms.

As future work, we would like to perform more analytical and theoretical analysis on the convexity condition and also minimal ϵ values in ϵ-*core* solution concepts based on the characteristic function in web service applications. From web service perspective, the work can be extended to consider web service compositions where a group of web services having different set of skills cooperate to perform composite tasks. Also bargaining theory from cooperating game theory concepts can be used to help web services resolve the instability and unfairness issues by side payments.

5.2 Future Plan and Timeline

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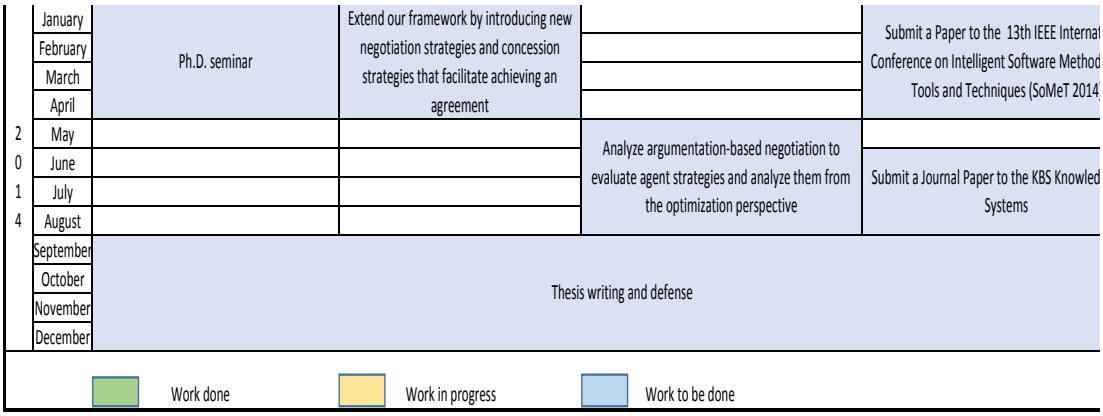

Figure 2: Research milestones and time line

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