

Scientific Report

Visitor: Toni Moreno (Technical University of Catalonia) Host institution: Helsinki University of Technology (Systems Analysis Laboratory)

PURPOSE OF THE VISIT

The objective of this week visit to the Systems Analysis Laboratory of the Helsinki University of Technology was to explore their more recent tools and methods in decision and negotiation support systems and contribute to their current research in the area.

I wanted to study the tools and methods that they are currently implementing for their *Decisionarium* site, which is a global space for decision support that includes software for decision analysis (see, for example, R. P. Hämäläinen, *Decisionarium – Aiding decisions, negotiating and collecting opinions on the web*, Journal of Multi-criteria Decision Analysis, 2003).

I was especially interested in their work in multi-party negotiation support, where they have developed the method of improving directions for reaching efficient search of joint gains from a given initial solution (H. Ehtamo, E. Kettunen and R.P. Hämäläinen, *Searching for joint gains in multi-party negotiations*, European Journal of Operations Research, 2001).

I was also interested in their work in Multicriteria Decision Analysis, for which they have developed also software (for example, Web-HIPRE: J. Mustajoki and R.P. Hämäläinen, *Web-HIPRE: Global decision support by value tree and AHP analysis*, INFOR, 2000)

With this visit I expected to get ideas for my PhD thesis. I would like to focus my PhD thesis in negotiation support systems, but I haven't decided yet which specific topic I will address. This visit has given me interesting ideas that will allow me to make a more informed decision on that.

My host, Jyri Mustajoki, is a researcher at the Systems Analysis Laboratory, and one of his research interests is "Computer Support in Decision and Negotiation Analysis". The director of the Systems Analysis Laboratory, Prof. Hämäläinen, is well known for his work in dynamic game theory and decision analysis.

DESCRIPTION OF THE WORK CARRIED OUT DURING THE VISIT

The problem of searching for joint gains in multi-party negotiations with computer support has been widely studied in the last years. The Systems Analysis Laboratory of the Helsinki University of Technology has made significant contributions to this field. However, the literature has been focused in studying the case of computer support to human negotiations and has not studied the applicability of these techniques to unsupervised systems, i.e. software agents that negotiate among them.

During my visit to the Systems Analysis Laboratory, I intended to analyse how the techniques designed to work in a computer supported scenario can be applied in an unsupervised environment where software agents negotiate among them. For this purpose, I tested the JADE¹ Java-based agent environment, and some of the ideas behind the method of improving directions will be deployed over the system.

Workplan

Week 1

Review of the literature
Setting up the JADE Environment

Week 2

Implementing improving directions methods over JADE Environment

Week 3

Experiments

Weeks 4 and 5 (in Barcelona)

Analysis of the results

Week 6 (in Barcelona)

Presentation of the results

During the first week, I studied the publications of the Systems Analysis Laboratory in the area of negotiation analysis. I also set up the JADE Environment and got familiar with its features to deploy multi-agent systems.

During the second week, I focused on implementing improving directions methods over agents operating through the JADE Environment. Two alternatives were included: the

¹ JADE (Java Agent DEvelopment Framework) is a software framework fully implemented in Java language. It simplifies the implementation of multi-agent systems through a middle-ware that complies with the [FIPA specifications](#) and through a set of [graphical tools](#) that supports the debugging and deployment phases. The agent platform can be distributed across machines (which not even need to share the same OS) and the configuration can be controlled via a [remote GUI](#). The configuration can be even changed at run-time by moving agents from one machine to another one, as and when required. JADE is completely implemented in Java language and the minimal system requirement is the version 1.4 of JAVA (the run time environment or the JDK). <http://jade.tilab.com/>

multi-party negotiation with centralised orchestration and the distributed peer-to-peer negotiation schemes. Different strategies of peer-to-peer allocations were tested.

During the third week, I worked on specific applications and made several experiments. First of all, I identified some suitable applications where the automatic negotiation can be interesting. Possible applications are:

- Negotiation of schedules (for example, doctors and patients can have agents that negotiate for them to agree on the time of a visit)
- Negotiation of the distribution of resources (for example, threads in a server can negotiate among them to achieve a better distribution of hardware resources, basically memory and CPU)

Most of the experiments were focused on the distribution of resources. The basic scenario consists of a multi-agent environment with N agents, and no orchestrator. Each of the agents has a utility function with the same shape but different parameters. The initial allocation of resources is done by a neutral mediator. Starting from the initial allocation, two agents can decide to exchange a certain quantity of the resource if it leads to a better overall distribution of resources, subject to the condition of individual rationality, i.e. no agent accepts an exchange if it results in a worse utility function for itself.

During weeks 4, 5 and 6, in Barcelona, I continued the study of the experiments and the analysis of the results. More research is needed, but the results seem to indicate that it is possible to reach a distribution of the resources near the optimal situation in the case of rational agents that negotiate peer-to-peer.

I gave a presentation of my work in a research seminar of the Systems Analysis Laboratory.

DESCRIPTION OF THE MAIN RESULTS OBTAINED

- JADE multi-agent environment set up
- Improving directions methods implemented on a multi-agent system
- Resource distribution experiment developed over the JADE environment
- Implementation of a heuristic to make the peer-to-peer negotiation
- Familiarisation with the Decisionarium tools

PROJECTED PUBLICATIONS/ARTICLES RESULTING OR TO RESULT FROM YOUR GRANT

My ongoing PhD thesis will benefit of my visit to the Systems Analysis Laboratory.

I also intend to prepare a paper, but more research is needed.

FUTURE COLLABORATION WITH HOST INSTITUTION

I expect to keep an active collaboration with the Systems Analysis Laboratory. One of the most important points of collaboration can be the dissemination of their decisionarium. I will demonstrate their applications in my lectures of Decisions Models in the Technical University of Catalonia.

Another field of possible collaboration emerging from my visit to the Systems Analysis Laboratory is the networking with Jesús Ríos, from the “Universidad Rey Juan Carlos”, who was also visiting the Systems Analysis Laboratory in the same period. We were collaborating in some aspects of his and my research interests and I expect this collaboration to increase in the future.

OTHER COMMENTS

Finally, I am grateful to the TED project and to the ESF for giving me this grant that has allowed me to make an important step in the development of the topic for my PhD thesis.