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Cooperative Information Agents XI

11th International Workshop, CIA 2007
Delft, The Netherlands, September 2007
Proceedings

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Lecture Notes in Artificial Intelligence 4676

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Preface

These are the proceedings of the 11th International Workshop on Cooperative Information Agents (CIA 2007), held at the Delft University of Technology, The Netherlands, September 19–21, 2007.

In today's world of ubiquitously connected heterogeneous information systems and computing devices, the intelligent coordination and provision of relevant added-value information at any time, anywhere is of key importance to a variety of applications. This challenge is envisioned to be coped with by means of appropriate intelligent and cooperative information agents.

An information agent is a computational software entity that has access to one or multiple heterogeneous and geographically dispersed data and information sources. It pro-actively searches for and maintains information on behalf of its human users, or other agents preferably just in time. In other words, it is managing and overcoming the difficulties associated with information overload in open, pervasive information and service landscapes.

Each component of a modern cooperative information system is represented by an appropriate intelligent information agent capable of resolving system and semantic heterogeneities in a given context on demand. Cooperative information agents are supposed to accomplish both individual and shared joint goals depending on the actual user preferences in line with given or deduced limits of time, budget and resources available. One major challenge of developing agent-based intelligent information systems in open environments like the Internet and the Web is to balance the autonomy of networked data, information, and knowledge sources with the potential payoffs of leveraging them by the use of cooperative and intelligent information agents.

The objective of the international workshop series on cooperative information agents (CIA), since its establishment in 1997, is to provide a small but very distinguished interdisciplinary forum for researchers, programmers, and managers to become informed about, present, and discuss the latest high-quality results in research and development of agent-based intelligent and cooperative information systems and applications for the Internet and the Web. Each event of the series offers regular and invited talks of excellence that are given by renown experts in the field, a selected set of system demonstrations, and honors innovative research and development of information agents by means of best a paper award and system innovation award giving. The proceedings of the series are regularly published as volumes of the *Lecture Notes in Artificial Intelligence* (LNAI) series of Springer.

In keeping with its tradition, this year's workshop featured a sequence of regular and invited talks of excellence given by leading researchers covering a broad area of topics of interest. CIA 2007 featured 4 invited and 20 regular papers selected from 38 submissions. The result of the peer-review of all contributions is included in this volume that is, we believe, again rich in interesting, inspiring, and advanced work on the research and development of intelligent information agents worldwide. All workshop proceedings have been published by Springer as *Lecture Notes in Artificial Intelligence* volumes: 1202 (1997), 1435 (1998), 1652 (1999), 1860 (2000), 2182 (2001), 2446 (2002), 2782 (2003), 3191 (2004), 3550 (2005), 4149 (2006).

This year the *CIA System Innovation Award* and the *CIA Best Paper Award* were sponsored by Whitestein Technologies AG, Switzerland, and the CIA workshop series, respectively. There was also some financial support available to a limited number of students as (co-)authors of accepted papers to present their work at the CIA 2007 workshop; these grants were sponsored by the IEEE FIPA standard committee, and the Belgian-Dutch Association for Distributed AI (BN-VKI).

The CIA 2007 workshop was organized in cooperation with the Association for Computing Machinery (ACM), in particular the ACM special interest groups SIG-Web, SIG-KDD, SIG-CHI and SIG-Art. We are very grateful and indebted to our sponsors for their financial support, which made this event in its convenient form only possible. The sponsors of CIA 2007 were:

ICT Research Center, TU Delft, The Netherlands
Whitestein Technologies, Switzerland
IEEE Computer Society Standards Organisation Committee on Intelligent and Physical Agents (FIPA)
Belgian-Dutch Association for Distributed AI (BNVKI)
Dutch research school for Information and Knowledge Systems (SIKS)

We are particularly thankful to the authors and invited speakers for contributing their latest results in relevant areas to this workshop, as well as to all members of the Program Committee, and the external reviewers for their critical reviews of submissions. Finally, a particularly cordial thanks goes to the local organization team from TU Delft for providing us with a traditionally comfortable and all-inclusive location, and a very nice social program in the beautiful, typically Dutch city of Delft.

September 2007

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Table of Contents

Invited Contributions

Information Search and Processing

Applications

Rational Cooperation

Interaction and Cooperation

Trust

Managing Sensors and Information Sources Using Semantic Matchmaking and Argumentation

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Abstract. Effective deployment and utilisation of limited and constrained intelligence resources — including sensors and other sources — is seen as a key issue in modern multinational coalition operations. In this talk, I will examine the application of semantic matchmaking and argumentation technologies to the management of these resources. I will show how ontologies and reasoning can be used to assign sensors and sources to meet the needs of missions, and show how argumentation can support the process of gathering and reasoning about uncertain evidence obtained from sensor probes.

1 Introduction

Effective deployment and utilisation of limited and constrained intelligence, surveillance and reconnaisance (ISR) resources is seen as a key issue in modern network-centric joint-forces operations. For example, the 2004 report *JP 2-01 Joint and National Intelligence Support to Military Operations* states the problem in the following terms: "ISR resources are typically in high demand and requirements usually exceed platform capabilities and inventory. ... The foremost challenge of collection management is to maximize the effectiveness of limited collection resources within the time constraints imposed by operational requirements."[1]

Our work focusses upon the application of Virtual Organisation technologies to manage coalition resources. In the past we have shown an agent-based VOs can manage the deployment and utilisation of network resources in a variety of domains, including e-business, e-science, and e-response [1,4]. Two distinguishing features of our work are (1) the use of semantically-rich representations of user requirements and resource capabilities, to support matchmaking using ontologies and reasoning, and (2) the use of argumentation to support negotiation over scarce resources, decisions about which resources to use, and the combining of evidence from information-providing resources (e.g. sensors).

In this talk, I will examine the application of (1) and (2) to the management of ISR resources in the context of coalition operations. The first part of the talk describes an ontology-based approach to the problem of assigning sensors and sources to meet the needs of missions. The second part then looks at how argumentation and subjective logic can facilitate the process of gathering uncertain evidence through a series of sen-

[1] http://www.dtic.mil/doctrine/jel/new_pubs/jp2_01print.pdf, pages III–10–11, accessed April 27, 2007.

M. Klusch et al. (Eds.): CIA 2007, LNAI 4676, pp. 1–4, 2007.

sor probes, and combining that evidence into a set of arguments in support of, and in opposition to, a particular decision.

2 Semantic Matchmaking of Sensors and Missions

The assignment of ISR assets to multiple competing missions can be seen as a process comprising two main steps: (1) assessing the fitness for purpose of alternative ISR means to accomplish a mission, and (2) allocating available assets to the missions. Our work draws upon current military doctrine, specifically the Missions and Means Framework (MMF) [5] which provides a model for explicitly specifying a *mission* and quantitatively evaluating the utility of alternative warfighting solutions: the *means*.

Figure 1 shows how missions map to ISR means. Starting from the top left the diagram sketches the analysis of a mission as a top-down process that breaks a mission into a collection of operations (e.g. search-and-rescue), each of which is broken down further into a collection of distinct tasks having specific capability requirements (e.g. wide-area surveillance). On the right hand side, the diagram depicts the analysis of capabilities as a bottom-up process that builds up from elementary components (e.g. electro-optincal/infrered (EO/IR) camera) into systems (e.g. camera turret), and from systems up into platforms equipped with or carrying those systems (e.g. an unmanned aerial vehicle (UAV)).

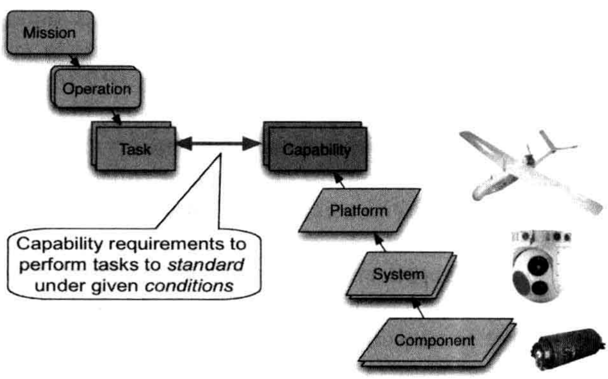

Fig. 1. Overview of the Mission and Means Framework (MMF)

In particular, we propose the use of ontologies to support the following activities:

- specifying the requirements of a mission;
- specifying the capabilities provided by ISR assets (sensors, platforms and other sources of intelligence, such as human beings);
- comparing — be a process of automated reasoning —the specification of a mission against the specification of available assets to either decide whether there is a solution (a single asset or combination of assets) that satisfies the requirements of a mission, or alternatively providing a ranking of solutions according to their relative degree of utility to the mission.

Although one can envisage a single ontology supporting the entire sensor-mission matchmaking process, actually we adhere to the Semantic Web vision of multiple interlinking ontologies covering different aspects of the domain. First, we provide an ontology based on the MMF, which is basically a collection of concepts and properties that are essential to reason about the process of analyzing a mission and attaching the means required to accomplish it (mission, task, capability, or asset). Then we provide a second ontology that refines some of the generic concepts in the MMF ontology so as to represent the ISR-specific concepts that constitute our particular application domain. This second ontology comprises several areas frequently organized as taxonomies, such as a classification of sensors (acoustic, optical, chemical, radar) and information sources, a classification of platforms (air, sea, ground and underwater platforms), a classification of mission types, or a classification of capabilities. As noted in the previous section, there are existing ontologies covering at least part of each of these domains.

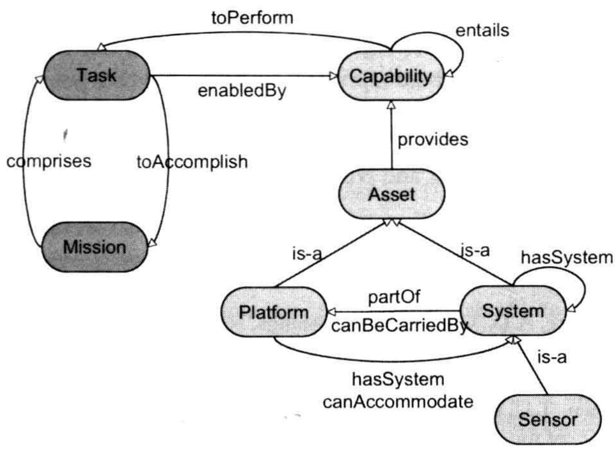

Fig. 2. Main ontological concepts and their relationships

Figure 2 shows a high level view of the main concepts and relationships that support our semantic matchmaking approach. On the left hand side, we find the concepts related to the mission: a mission comprises several tasks that need to be accomplished. On the right hand side we find the concepts related to the means: a sensor is a system that can be carried by or constitutes part of a platform; inversely, a platform can accommodate or have one or more systems, and both platforms and systems are assets; an asset provides one or more capabilities; a capability can entail a number of more elementary capabilities, and is required to perform certain type of tasks and inversely, a task is enabled by a number of capabilities.

The talk will give further details of the ontology and its application.

3 Arguing About Evidence in Partially Observable Domains

In this talk, we also show how argumentation can be used to manage the process of gathering and reasoning about evidence from sensors and sources [2]. Because such