A Multi-agent Negotiation Model Applied in Multi-objective Optimization

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Abstract. Although both multi-objective optimization and agent technology gained a lot of interest during the last decade, many aspects of their functionality still remain open. This paper proposes the multi-agent negotiation model applied in multi-objective optimization. There are three types of agents in the system. The plan agent plans the global best benefit; the action agent plans the best benefit of the single objective; and the resource agent manages the common resource. The agents compete and cooperate to reach the global best benefit through their negotiation. The model is applied in evolutionary multi-objective optimization to realize its parallel and distributed computation, and the experiment on MAGE shows the model is effective.

1 Introduction

With recent growth of need for faster and more reliable systems, interest has grown towards concurrent distributed systems. Multi-agent systems (MAS), in which independent software agents interact with each other to achieve common goals, complete concurrent distributed tasks under autonomous [1, 2]. In MAS, the negotiation not only strengthens agents and MAS's ability to solve problems, but also make the system more flexible to apply in more real problems.

Multi-objective problem is the popular problems in the scientific research and real projects. Evolutionary computation applying in multi-objective problem can provide a set of solutions in one run; the method is called evolutionary multi-objective optimization (EMO). Many multi-objective evolutionary algorithms (MOEA) have been proposed [3].

In this paper, we attempt to apply MAS in EMO. In real world, many agents are competitive to reach their best benefit; at the same time, they are cooperative to reach the global best benefit, since the resource is common and limited. There are three types of agents in the system. We define them in a uniform way, and then propose their negotiation model. Moreover, we apply this negotiation model in the evolutionary multi-objective optimization to demonstrate how to apply this model. At last we do a simulating experiment on MAGE [4], which proof the negotiation model is effective.

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The rest of the paper is organized as follows: in the following section, we review the related work. Section 3 illustrates the multi-agent negotiation model in detail; and then the model is applied in the evolutionary multi-objective optimization in the section 4; at last, the section 5 makes a conclusion.

2 Related Work

This section introduces some related works. We first introduce multi-agent system, and then present some notation used in multi-objective optimization. At last we discuss some work on the combination of multi-agent system and multi-objective optimization.

2.1 Multi-agent System

The growth in networked information resources requires information systems that can be distributed on a network and interoperate with other systems. Such systems cannot be easily realized with traditional software technologies because of the limits of these technologies in coping with distribution and inter-operability. The agent-based technology seems be a promising answer to facilitate the realization of such systems because they were invented to cope with distribution and interoperability [5]. Recently, natural evolution of agent-based technology has led them to migrate from the research laboratories to the software industry. This migration is good news for the entire agent-based technology community, but it also leads to new expectations and new questions about agent-based technology such as MAS methodologies, tools, platforms, reuse, specification and etc. And MAS gains more and more interest in both the research area and the industry [6]. The best example is the brunch of announcements about new multi-agent platforms, such as OAA [7], RETSINA [8] and etc.

MAGE is a Multi-AGent Environment with a collection of tools supporting the entire process of the software engineering based on agents, which is proposed by Prof Shi [3]. It is designed to facilitate the rapid design and development of new multi-agent applications by abstracting into a toolkit the common principles and components underlying many multi-agent systems. The idea was to create a relatively general purpose and customizable toolkit that could be used by software users with only basic competence in agent technology to analyze, design, implement and deploy multi-agent systems.

From fig.1, we can see that MAGE platform consists of the following parts, agent supporting environment and agent development environment. Agent development environment consists of modeling tool AUMP and design and programming tool VAStudio. AUMP is designed for system analysis and design stages. VAStudio is for system design, development and deployment stages. The workflow of MAGE platform is as the arrow shows. We use AUMP to get the system model and then design and programming it in VAStudio, finally we run the multi-agent system under the MAGE agent supporting environment. MAGE has been used by a number of companies and institutions. Further details and documentation can be found at http://www.intsci.ac.cn/agent/mage.html.