

Risk Management Methods for Speculative Actions

Yasuhiko Kitamura
Department of Informatics
Kwansei Gakuin University
ykitamura@ksc.kwansei.ac.jp

Takuya Murao
Graduate School of Engineering
Osaka City University

Abstract

In multiagent systems, a cooperative action requires a mutual agreement among multiple agents and the agreement is generally reached by exchanging messages between them, but the delay of message may cause the delay of agreement, and the delay of agreement may reduce the effect of the cooperative action. A speculative action is an action that is taken before agreement not to reduce the effect of cooperative action, but it has to be cancelled by paying a penalty if the agents do not reach an agreement. In this framework, we have two risks; a risk to reduce the effect of cooperative action and a risk to cancel the speculative action, and need risk management methods. In this paper, we propose two risk management methods called the hybrid method and the leveled method, which are viewed as a single agent approach and a multiagent approach respectively, and discuss their advantages using a meeting room reservation problem.

1. Introduction

Generally speaking, a cooperative action in multiple agents requires an agreement and the agreement is normally achieved by exchanging messages among the agents. However, the agreement may delay because of two reasons; (1) message delay caused by congestions or interruptions of communication channel that connects the agents and (2) that caused by the agents themselves. In multiagent systems, we often assume that each agent behaves autonomously and rationally to maximize its profit. When the profit to the agent depends on the reply, it may take a time to gather information as much as possible to maximize its profit.

In this paper, we mainly discuss the delay of agreement caused by the second reason. Especially, we have interest in cases where the delay of agreement reduces the effect of cooperative action among multiple agents. For example, let us consider a meeting room reservation problem in which an agreement between a host agent and a member agent is required to have a

meeting in a room, which should be reserved in advance by the host agent. When they succeed to have a meeting, the host agent receives a reward from the outside and the member agent receives a share from the host agent. We assume that the more time the agents take to reach an agreement, the more difficult it is to reserve a room, and that a cost is charged when an agent cancels a reserved room. In this problem, if the agents take a long time to reach an agreement for a cooperative action (having a meeting in a room), they may fail to reserve a room for meeting and have a risk of reducing the effect of cooperative action.

Speculative action [2] is a remedy to cope with the delay of agreement. It is an action taken before an agreement as if the agents surely reach it later. If they reach an agreement later, the speculative action is effective because it does not reduce the effect of cooperative action. On the other hand, if they fail to reach, the action should be cancelled or rolled back and the host agent may be charged some amount of cancel fee. For example, in a meeting room reservation problem, let us assume that the host agent reserves a room as a speculative action before an agreement with the member agent. If the member agent replies with an agreement, the two agents can have a meeting without caring about the difficulty of reserving a meeting room. On the other hand, if the member agent disagrees, the host agent has to cancel the reserved room by paying a cancel charge. When the agent takes a speculative action, it has to take a risk when the action needs to be cancelled.

When we can use a speculative action to cope with the delay of agreement, we need to consider both risks of failing to take a cooperative action and of canceling a speculative action, and need a risk management method to take a speculative action effectively according to the situation.

2. Risk Management Methods for Speculative Actions

The speculative method does not take a risk of failing cooperative actions caused by delayed messages, but it has to take another risk of canceling the speculative

action. We here propose two risk management methods called the hybrid method and the leveled method to balance two risks according to the situation.

2.1. Hybrid method: a single agent approach

The speculative method works well in cases where the probability of the member's agreement is large, and the basic (non-speculative) method works well in cases where it is low because the probability of canceling a reserved room is low. The hybrid method switches between the speculative method and the basic method by estimating the probability of the member's agreement. If the probability is estimated to be large, it uses the speculative method for forming an agreement, and if it is estimated to be low, it uses the basic method. Because it is based on the estimation of the host agent, it can be viewed as a single agent approach.

In this method, it is important to decide the boundary to switch from one to another. The condition in which the speculative method is superior to the basic method is given as

$$\begin{aligned} & \text{The expected profit of the speculative method} \\ & \geq \text{The expected profit of the basic method.} \end{aligned}$$

2.2. Leveled method: a multi-agent approach

In the leveled method, the host agent and the member agent make a pre-agreement, and each of them can cancel it by paying a penalty [1]. By making a pre-agreement, the host agent can reduce the risk of canceling a speculative action when the member agent disagrees. The leveled method is a risk management method based on a pre-agreement made by both of the host and member agents and can be viewed as a multi-agent approach.

In the leveled method, the condition in which the host agent makes a pre-agreement is given as

$$profit_{LM}^h \geq 0,$$

that is the expected profit of the host agent is greater than 0 when it adopts the leveled method, and the condition in which the member agent makes a pre-agreement is given as

$$profit_{LM}^m \geq E[b],$$

that is the expected profit of the member agent is greater than that given without the agreement with the host agent by the leveled method

3. Conclusions and Future Work

To reduce a risk of failing a speculative action, we proposed two methods; the hybrid method that switches

between the speculative method and the basic method based on the estimated probability of agreement, and the leveled method in which the host and the member agents make a pre-agreement and pay a penalty when they break the pre-agreement. We show the host agent's expected profit of the methods including the basic and the speculative methods in Figure 1. The hybrid method returns the better performance between the basic method and the speculative method if the probability of agreement is correctly estimated. The leveled method shows a better performance than the speculative method, but it is not good enough when the probability of agreement is low. To improve it, we can develop a new hybrid method which switches between the basic method and the leveled method.

For our future work, we need to deal with cases where more than two agents exist.

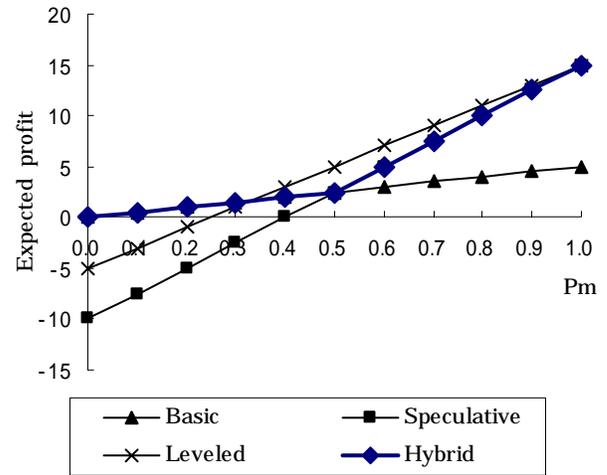


Figure 1. Expected profit of the host agent depending on the probability of agreement (Pm).

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