MULTICRITERIA DECISION AID USE FOR CONFLICTING AGENT PREFERENCES MODELING UNDER NEGOTIATION

Noria Taghezout and Abdelkader Adla
Computer Science Department, University of Es-Senia Oran, BP 1524, El-M' Naouer, 31000, Oran, Algeria
IRIT - Paul Sabatier University, Toulouse, France

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Abstract: Individual decisions in multi-agent domains are rarely enough for producing optimal plans which satisfy all the goals. Therefore, agents need to cooperate to generate the best multi-agent plan through sharing tentative solutions, exchanging sub goals, or having other agents to satisfy their goals. In this paper, we propose a new negotiation mechanism independent of domain properties to handle real-time goals. The mechanism is based on the well-known Contract net Protocol. Integrated Station of Production agents will be equipped with a sufficient behavior to carry out practical operations and simultaneously react to the complex problems caused by the dynamic scheduling in real situations. These agents express their preferences by using ELECTRE III method in order to resolve differences. The approach is tested for simple scenarios.

1 INTRODUCTION

The next generation manufacturing systems will be more strongly time-oriented (or highly responsive), while still focusing on cost and quality. So, it will be necessary to satisfy requirements such as: (i) quick response to external order changes and unexpected disturbances from both internal and external environments, and (ii) embodiment of human factors into manufacturing systems.

As a consequence, a major research topic in computer science over the past two decades has been the development of tools and techniques to model understand and implement systems in which interaction is the norm.

Recently, agent technology has been considered as an important approach for developing industrial distributed systems. It has particularly been recognized as a promising paradigm for next generation manufacturing systems (Shen, 2006).

In distributed intelligent manufacturing systems, agents can be applied and implemented in different ways, the most interesting for our study are:

(i) Agents can be used to encapsulate manufacturing activities in a distributed environment by using a functional decomposition approach. Examples of such functional agents include order processing, product design, production planning and scheduling and simulation.

(ii) Agents can be used to represent negotiation partners, either physical plants or virtual players; they also can be used to implement special services in multi agent systems like facilitators and mediators. A good discussion on agent technology can be found in (Shen, 2006).

This paper proposes a new negotiation mechanism independent of domain properties to handle real-time goals, and discusses some issues in implementing agent coordination and agent negotiation in real time scheduling. The proposed model is based on multi agent architecture. Agents provide some actions or services including the collecting of data from heterogeneous sources, information integration and analysis, real time scheduling and decision making.

In order to implement Decision Making abilities, the Electre III methodology is chosen for the possibility given to decision makers to treat imprecise and subjective data. The Contract Net Protocol is used because of its facility to implement negotiation protocols

The paper is organized as follows: Section 2 presents the related work. The DSS architecture and the most important agents are given in Section 3 and

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Section 4. In Section5, we present the negotiation protocol and its facilitating techniques. Section 6 is devoted to the integration of the multicriterion method ELECTRE III in the decision-making processes implemented in the internal structure of the negotiation agent (ISP): a scenario will be given. And, finally Section 7 concludes the paper.

2 RELATED WORK

Yee-Ming and al (Chen, 2005) develop a collaborative framework of a distributed agent-based intelligence system with a two-stage decision-making process for dynamic scheduling. Many features characterize the framework; more precisely, the two-stage decision-making process, the fuzzy decision-making process and the compensatory negotiation process are adequate for distributed participants to deal with imprecise and subjective information, to conduct practical operations.

The work presented in (Reaidy, 2007) uses the PABADIS architecture to model a distributed manufacturing system. Basic components in PABADIS are agents and services; they work in cooperation and perform distributed tasks in a networked manufacturing plant.

3 THE APPROACH PROPOSED IN THIS PAPER

In the resolution of real time production management problems, each decision-making process of piloting is generally a multicriteria process (Taghezout, 2006): the task assignment for example, is a decision-making process which results from a study on criteria of costs production, time of change of series, convoying time, production quality, etc.

The multicriteria methodology exploitation allows integrating the set of these constraints, in particular by the fact that the assumptions on which the latter are based are closer to reality than optimization methods. In addition, the multicriteria approach facilitates the integration of human operator to DSS (Adla, 2006).

In real time production management, the DSS memorizes the current state-of the workshop. It knows constantly the whole of the decisions and the possible events involved. A detailed description of the workshop's state was given in our previous work (Taghezout, 2007). We distinguish 3 contexts for the decision-making aid: (1) Decision-making aid in the context of an acceptable sequence; (2) Assistance for the admissibility covering; and (3) Negotiation support among different decision-making centres in a dynamic context.

DSS gives the decision centers the opportunity to make decisions in a dynamical context. A decision aid is then increased by a negotiation support. The system suggests the selected decision in the set of planned solutions. As a conclusion, the proposed DSS in this approach addresses the situations described in levels 1 and 3.

The DSS architecture is composed of several modules. Each module has its own functionalities and objectives. The DSS architecture is described in Figure 1. The analysis and reaction module is developed thanks to a multi-agent technology. The agent based system is decomposed into a supervisor agent and several ISP agents. Each ISP agent has the possibility to use resources. A detailed description is given in (Taghezout, 2006) and (Taghezout, 2007).

4 DESCRIPTION OF THE DECISION LEVELS

The decision-making takes place in two steps:

1. In the first step, ISP agents recognize the encountered problems, and start the local decision-making processes. In case of success, they adopt the adequate behaviors. The basic principle of resolution has been described in (Taghezout, 2007).
2. In the second step, delays in the planned task execution or a conflicting situation cause a failure in the complex problem resolution. ISP agents open negotiation then. The protocol is based on the classical contract Net approach. ISP agents express their initial preferences, priorities and data in the evaluation matrices. The decisional processes use the multicriterion assistance method, ELETRE III. ISP Agents, which are in several cases the most important, correspond to:

   - An ISP agent, which meets the problem during its task execution, should make a decision in collaboration with other ISP agents; it is called the initiating ISP agent and is noted as IISP (Initiating Integrated Station Production).
   - An ISP agent, which undergoes the delay consequences or disturbance in its task execution because of a conflict on the common resource or another unpredicted event, is called participating ISP agent and is noted as PISP (participating ISP).

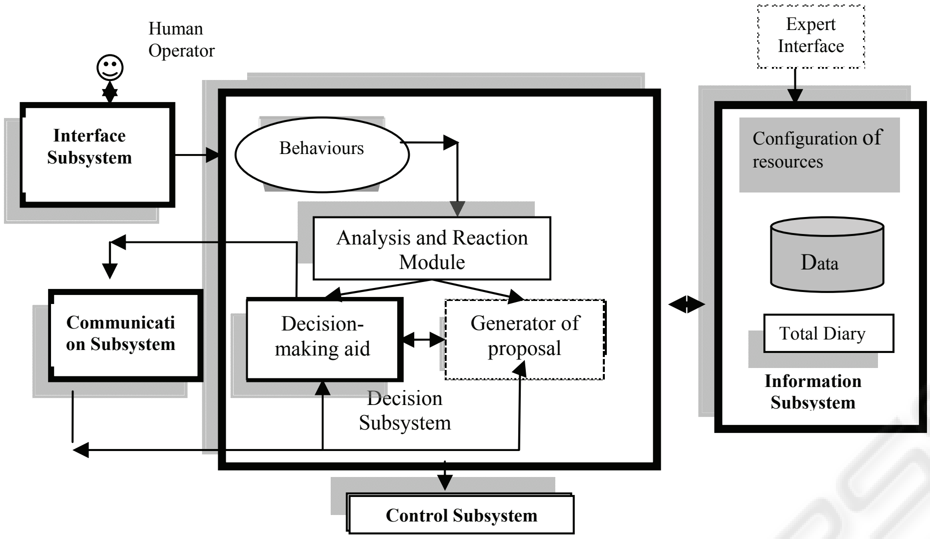

Figure 1: Structure of negotiation Agent (ISP).

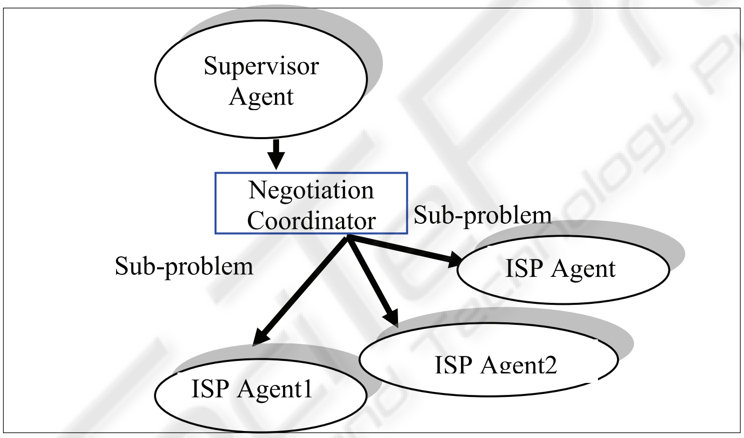

Figure 2: The negotiation model.

5 THE NEGOTIATION AID

Generally speaking, the outcome of a negotiation depends on many parameters-including the agent's preferences, their reservation limits, their attitude toward time and the strategies they used.

Although in most realistic situations it is not possible for agents to have complete information about each of these parameters for its opponent, it is not uncommon for agents to have partial information about some of them. The purpose of our study is not to allow the agent select the optimal strategy, Some Works do it for example the approach given in (Shaheen,2001), but it helps to treat some uncertainty.

6 DECISION AID THROUGH ELECTRE III

Decision making is a difficult process due to factors, such as information about incompleteness, imprecision, and subjectivity factors which tend to be resent in real life situations to lesser or greater degree (Taghezout,2007). The multicriteria methodology Electre III allows sorting out actions likely to solve a decision problem, on the basis of arguments on several criteria (Roy, 1977).

6.1 The Proposal of Negotiation Model

At the second stage of resource allocation decision-making process, the IISP agent will open negotiation with PISP agent that is concerned with the result of ELECTRE III execution. The latter consists in searching the best resource. The framework of the negotiation model consists in various components such as:

- **The Alternatives:** This component gathers all the resources classified from the best to the less good according to the classification performed by ELECTRE III. It corresponds to the multicriterion decision-making process application in resolving the problem of allocation of the best resource in case of breakdowns.
- **Criteria Updating:** Each agent is equipped with a module allowing it to calculate the function production cost at any time.
- **Selection Function:** Each negotiation agent possesses a selection function to evaluate the proposals and counter-proposals for the negotiation strategy.

Each negotiation agent needs to consult the supervisor diary to know the state of execution of the activities of each agent ISP. Agents execute method ELECTRE III before making their strategic and/or tactical decisions.

6.2 Listing Retained Criteria

The most relevant criteria in our study are gathered in Table1 (Taghezout, 2006). We can consider that a Failure or breakdown event is defined by the following items in Figure 3.

Table 1: List of Criteria Retained for the Allocation.

Code indicator	Entitled	Signification Axe	Min/Max
C1	Production cost	Cost	Min
C2	Time of a resource preparation of an operation	Delay	Min
C3	Potential Transfer Time	Delay	Min
C4	Next date of availability	Delay	Min
C5	Machine reliability indicator	Delay	Max
C6	Attrition rate	Quality	Max
C7	Characteristic tool	Quality	Max
C8	Level of specialization	Quality	Max

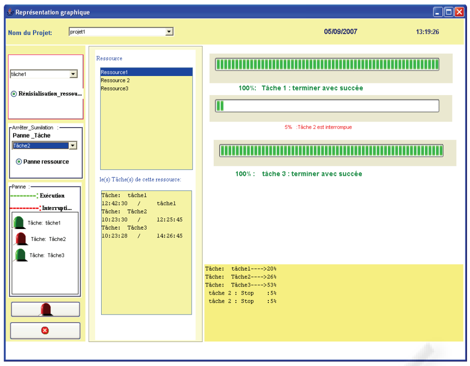

Figure 3: A breakdown event.

6.3 Negotiation Scenarios

We use the resource allocation problem to demonstrate how the agents solve problems by interactions among agents.

<u>**Scenario: Breakdown of a Resource**</u>

1. Resource n°1 controlled by agent 3 breaks down. The analysis and reaction module discerns this event and triggers off the associated behavior; if the process fails; ISP agent n°3 re-redirects the re-affectation request to the supervisor. This triggers off behavior named as the second behavior at the supervisor level.
2. The agent supervisor transmits the request towards other ISP agents (ISP 1, ISP 2) and treats the received answers to choose the best substitution machine.
3. The result will be announced to the chosen ISP agent as well as to the ISP agent applicant.
4. The ISP1 Agent answers favorably the supervisor request (end of the first phase of the decision-making process).
5. The required resource is also programmed for the ISP4 agent according to the initial production planning, ISP3 and ISP4 agents are found in a conflicting situation.
6. The negotiation is then open: ISP3 agent becomes <u>ISSP</u> and ISP4 agent becomes <u>PISP</u>.
7. IISP agent activates the proposal generator, and formulates a new contract proposal. It sends the latter to PISP agent.
8. The agent formulates its contract, evaluates the received proposals simultaneously thanks to the set of preferences and priorities, contained initially in the evaluation matrix (the decision-making module presented in Figure 2 intervenes in the realization of this step). The proposal or counter-proposal evaluation is made by ELECTRE III. This is according to the outclass algorithm.

7 CONCLUSIONS AND FUTURE WORK

In this paper, we have addressed an agent architecture-based model in order to present a multicriteria DSS which can be applied to solve some uncertainty problems in dynamic production system scheduling. The established negotiation contract thus deals with certain exceptions; it is based on the agent concept. The major advantage with this modeling consists in facilitating access to the executed tasks carried out by entities ISP. ELECTRE III is a tool that allows learning information about the opponent's preferences and their relative weights.

For the future, the research will be extended according to three important directions. Firstly, given that scheduling robustness characterizes its performance, we would like to extend the decision support given by this approach to treat uncertainty. Secondly, we propose to integrate software agents and Web services at both the design level and implementation level. Thus, we can treat a Web service as a semi-autonomous agent. Finally, we intend to integrate the human operator in the decision support, several co-operation modes have been defined with the decision support system.

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