

Communication Model for a Process Planning System Based on a Multi-agent

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Abstract: This paper introduces a process planning system communication model based on a Multi-agent and all levels of the communication process are in described in detail. The KQML(Knowledge Query and Manipulation Language) language communication is introduced emphatically using the communication performatives of the KQML language to achieve communication between the agents among the process planning.

Key words: multi-agent system; process planning; KQML; performative

1 Introduction

The appearance and development of Multi-agent technology is inevitable result of the distributed artificial intelligence technology development and the network technology development. In recent years , Multi-agent research has become a hot topic of the network-based distributed artificial intelligence research. Some studies say that agent technology is a meaningful outbreak in network software. A Multi-agent system studies how does a group of self-agent solve the original distribution issues through interaction. Because of the distribution and internal correlation , a Multi-agent system is a key issue in the communication. Communication is necessary among the agents for the exchange of information , coordination and cooperation to complete the task. The agent communication capability is the basis of its autonomy and social embodiment. It is the external appearance of an intelligent tool box. Agent communication is the basis for coordination , communication , cooperation and competition between it and its environment (it refers to the surviv-

al of the system , including an other agent) .

Traditional CAPP , including mutation type , record type and hybrid type , can't meet the new manufacturing system's needs of agile manufacturing , network manufacturing , virtual manufacturing etc. It has the unresolved difficult problems in system flexibility , expansibility , intelligence , human-computer interaction , resource sharing of a multiple heterogeneous environment etc. Application of Multi-agent technology carries on the rational functions of convoluted and classification with a process design system; each function module is classified according to the task or goal , forming a single agent , thereby reducing the difficulty and complexity. Through the proper system structure to organize the agents , it meet the function of CAPP with distribution , autonomy , interaction and the opening of characteristic requests. Because each agent is a relatively independent module and the process design process is a repeated coordination process , so that the communication and coordination between the agents is the core issue of the Multi-agent process design system^[1] .

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2 Agent communication hierarchical model

In the Multi-agent system , because of the distribution of the system and the dispersion of information , communication between the agents is a basis for multiple agent cooperation. According to the agent's perform-

ance of inherent hierarchy and computer network protocol hierarchy in the communication process, the communication behavior can be divided into three levels, namely the transport layer, communication layer and collaboration layer. The realization of the upper

behavior established in the realization of the lower behavior, the lower behavior serves for the upper behavior. Figure 1 supposing two agent (agent A and agent B) communications as an example, gives the agent communication hierarchical model structure.

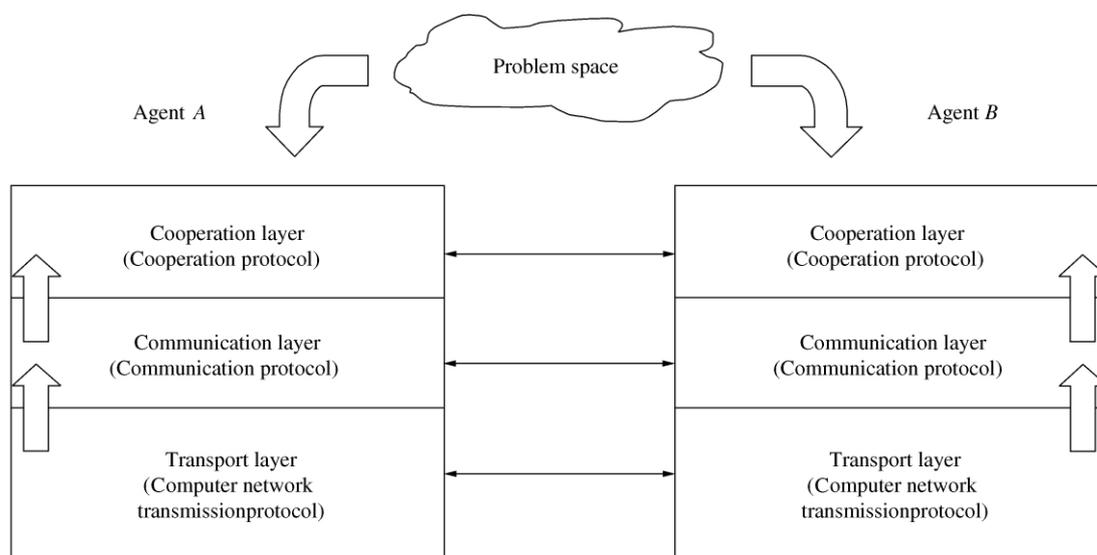


Figure 1 Multi-agent system communication hierarchical structure

The bottom is the transport layer, namely, the computer network transport protocol layer. The protocol layer is responsible for the information of communication protocol layer realizing network transmission through a computer network transmission agreement, thus ensuring the eventual realization of communication between agents. The network protocol can be TCP/IP, HTTP or IOP.

The middle layer is a communication layer, namely the communication protocol layer, the layer used to ensure that agent can mutually exchange and understand the messages. Here, the news is with a clear purpose, such as the proposal, promise, instructions, refusal, etc. The current international famous agent communication languages include the Foundation for Intelligent Physical Agents (FIPA) Agent Communication Language (ACL) and the United States Defense Advanced Research Projects Agency (DARPA) Knowledge Query and Manipulation Language (KQML) and Knowledge Interchange Format (KIF).

The top layer is the cooperation layer, namely, the cooperation protocol layer, the layer through a series of organization and structure of the information exchange to achieve agent collaboration intent, reflect the agent collaboration strategies and rules. At present the relatively successful collaboration protocols are blackboard structure, contract net protocol, voting protocol and auction protocol.

This paper mainly discusses the KQML of the agent communication hierarchical model^[2, 3].

3 Agent communication process model

The actual two agents' communication process is as follows: first, the sender translates its own thoughts into the format used by the communication language, and then loads the format into the transmission carrier. The carrier transmits it to the receiver, the receiver reads the carrier's language code, and then translates it into thoughts and understands the sender's

state of mind. Therefore, the basic agent communication process model is shown in Figure 2.

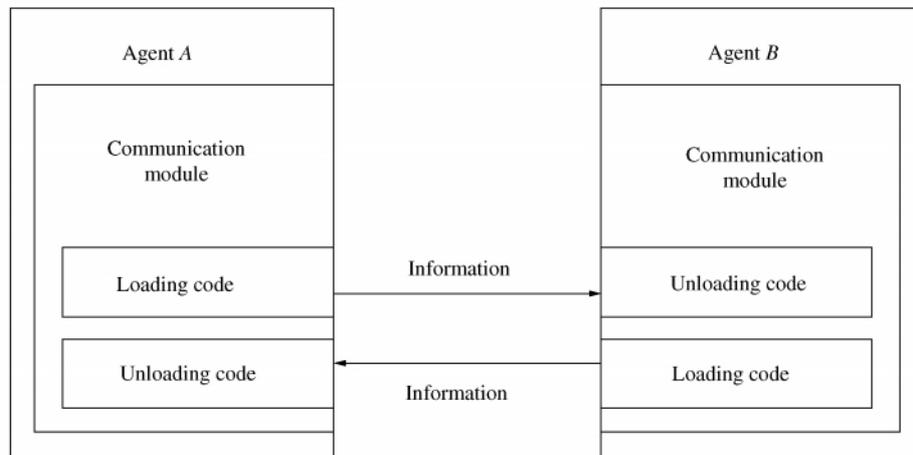


Figure 2 Basic agent communication process model

In Figure 2, the sender will encode its ideas in languages such as KQML format, load into the XML and other communication carriers, spread through the network to the receiver. The receiver will unload and read the information KQML message, and then decode it into the receiver's thoughts, to complete the communication^[4, 5].

4 KQML language

KQML is a kind of agent communication language based on message. It is the expression format of the message and also the message handling protocol. The KQML language, currently one of the most common agent communication languages, provides a message format and message transmission system, provides a set of identification, connection establishment and message exchange protocol. KQML is a hierarchical structure language. It can be divided into three layers: communication layer, message layer and content layer.

The communication layer describes the attribute parameters of communicating parties, such as the sender and the recipient's identity and communication behavior associated with this unique identification. The message layer is the core of KQML language. Its basic function is to determine the message transmission

protocol used by the sender, and the sender specifies a behavior primitive, and optional parameters describing connotation of the original language. The content layer is the real content of the message and uses its own program representation language to express. All KQML language implementation has nothing to do with the specific content of the message.

The KQML message can be thought of as a function: each message has a term (i.e., a function name (parameters) and more parameters (attribute/value)). Function name is the behavior naming and message parameter is the behavior description.

With a KQML message for example:

```
( ask-one
  : sender A
  : receiver B
  : in-reply-to q
  : reply-with m
  : language KIF
  : ontology motors
  : content ( val ( torque m ) ) )
```

The explanation of this message is that the sender A enquires of the recipient B about the torque value m , make a response to the previous message q and this message's label is m , the parameter 'content' must meet the grammar set by 'language'. 'Ontology'

defines entity set(terms definitions set) name which is used in the content information of ‘content’. ‘Sender’、‘receiver’、‘in-reply-to’ and ‘reply-with’ belong to communication layer, ‘ask-one’、‘language’、‘ontology’ belong to message layer, ‘content’ belongs to content layer^[6 7].

5 KQML in multi-agent process design system

Figure 3 presents the Multi-agent based process design system, which includes five types of agents. The administration agent mainly takes charge of managing

login information of different agents: The task agent mainly takes charge of creation and release of a process design task; The document agent mainly takes charge of process document preservation in process design; The process agent mainly takes charge of selection and optimization of process parameters and the generation of process routes; The database agent mainly takes charge of data record, and storage on task agent and document agent, and selection of process parameters and data generated by process routes support.

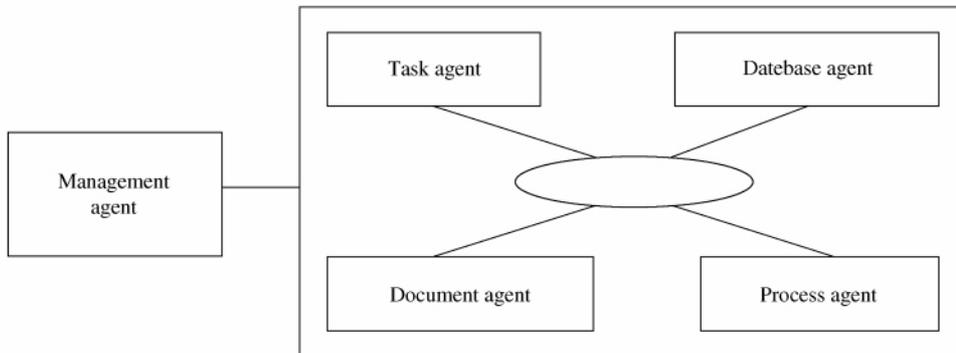


Figure 3 Multi-agent process design system

This system will employ KQML primitives to realize communication and coordination.

Achieve, ‘sender’ hopes ‘receiver’ could make a true state in the environment.

Advertise, ‘sender’ declares that it could deal with certain terms properly.

Ask-all, ‘sender’ hopes to obtain the whole instances of ‘content’ from the ‘receiver’.

Ask-if, ‘sender’ hopes to know whether the content of ‘content’ is true in KB of ‘receiver’.

Insert, ‘sender’ asks ‘receiver’ to write ‘content’ to KB.

Forward, ‘sender’ hopes ‘receiver’ could retransmit a message to another agent.

Monitor, ‘sender’ hopes to update the ‘content’ of

KB from ‘receiver’.

Recommend-all, ‘sender’ hopes to know all agents name which could respond to ‘content’.

Recruit-one, ‘sender’ hopes ‘receiver’ could arrange an appropriate agent to respond to ‘content’.

Tell, ‘sender’ declares to ‘receiver’ that ‘content’ in KB of ‘sender’ is true.

Untell, ‘sender’ declares to ‘receiver’ that ‘content’ in KB of ‘sender’ is not true.

Transport-address, ‘sender’ establishes the connection between symbol names and transfer addresses^[8~10].

The following gives the agents’ communication protocol based on KQML in tabular form.

Table 1 Communication protocol of the function agent and agent

Communication purpose	Function agent	Management agent
Function agent sends the login request to the management agent	ask-if	transport-address
Management agent sends the login error feedback to the function agent	ask-if	untell
Function agent sends modifying password request to the management agent	ask-if	achieve
Function agent sends obtaining the specific function agent username request to the management agent	ask-all	tell
Function agent sends obtaining the specific agent address request to the management agent	ask-one	tell

Table 2 Communication protocol of the task agent and process agent

Communication purpose	Task agent	Process agent
The task function sends task notice to the function agent	recommend-all	advertise
The task function sends information accepted task request to a certain function agent	ask-one	tell

Table 3 Communication protocol of process agent and document agent

Communication purpose	Process agent	Document agent
Process agent sends the read document request to the document agent	ask-one	tell
Process agent sends the stored document request to the document agent	ask-one	tell

Table 4 Communication protocol of process agent and agent database

Communication purpose	Function agent	Database agent
Process agent sends a query information request to the database agent	ask-all	tell
Process agent sends a modifying the information request to the database agent	monitor	advertise
Process agent sends a writing information request to the database agent	insert	advertise

5 Conclusions

According to the inherent hierarchy shown in the process of transferring information, and the combination hierarchical protocol structure of a computer network, the paper gives the agent communication model and agent communication process model, introduces the most widely used KQML communication language

at present to satisfy the process design system communication needs based on KQML communication primitives. The next step will be to KQML primitives and specific programming languages (such as C # etc.) one-one mapping, to complete the system communication realization.

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