Agents Communication

Socities of Agents

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1 Introduction

Agents operate and exist in some environment, which typically is both computational and physical. The environment might be open or closed, and it might or might not contain other agents but as we will focus on multiagent system. At times, the number of agents may be too numerous to deal with them individually, and it is then more convenient to deal with them collectively, as a society of agents. The focus of this report is to analyze, describe, and design environments in which agents can operate effectively and interact with each other productively. The environments will provide a computational infrastructure for such interactions to take place. The infrastructure will include protocols for agents to communicate and protocols for agents to interact.Communication protocols enable agents to exchange and understand messages. Interaction protocols enable agents to have conversations, which for our purposes are structured exchanges of messages.

2 Agent Communication

Fundamentally, an agent is an active object with the ability to perceive, reason, and act. Here they assume that an agent has explicitly represented knowledge and a mechanism for operating on or drawing inferences from its knowledge. They also assume that an agent has the ability to communicate. This ability is part perception (the receiving of messages) and part action (the sending of messages). In a purely computer-based agent, these may be the agent's only perceptual and acting abilities.

2.1 Coordination

Agents communicate in order to achieve better the goals of themselves or of the society/system in which they exist. The goals might or might not be known to the agents explicitly, depending on whether or not the agents are goalbased. Communication can enable the agents to coordinate their actions and behavior, resulting in systems that are more coherent.Coordination is a property of a system of agents performing some activity in a shared environment. The degree of coordination is the extent to which they avoid extraneous activity by reducing resource contention, avoiding livelock and deadlock, and maintaining applicable

safety conditions. Cooperation is coordination among nonantagonistic agents, while negotiation is coordination among competitive or simply self-interested agents. Typically, to cooperate successfully, each agent must maintain a model of the other agents, and also develop a model of future interactions. This presupposes sociability.Coherence is how well a system behaves as a unit. A problem for a multiagent system is how it can maintain global coherence without explicit global control. In this case, the agents must be able on their own to determine goals they share with other agents, determine common tasks, avoid unnecessary conflicts, and pool knowledge and evidence. It is helpful if there is some form of organization among the agents.

2.2 Dimensions of meaning

There are three aspects to the formal study of communication: syntax (how the symbols of comunication are structured), semantics (what the symbols denote), and pragmatics (how the symbols are interpreted). Meaning is a combination of semantics and pragmatics. Agents communicate in order to understand and be understood, so it is important to consider the different dimensions of meaning that are associated with communication.

1. Descriptive vs. Prescriptive:- Some messages describe phenomena, while others prescribe behavior. Descriptions are important for human comprehension, but are difficult for agents to mimic
2. Personal vs. Conventional Meaning:- An agent might have its own meaning for a message, but this might differ from the meaning conventionally accepted by the other agents with which the agent communicates.especially since these systems are typically open environments in which new agents might be introduced at any time.
3. Semantics vs. Pragmatics:- The pragmatics of a communication are concerned with how the communicators use the communication. This includes considerations of the mental states of the communicators and the environment in which they exist, considerations that are external to the syntax and semantics of the communication
4. Identity:- A message might be sent to a particular agent, or to just any agent satisfying a specified criterion.

2.3 Message Types

It is important for agents of different capabilities to be able to communicate. Communication must therefore be defined at several levels, with communication at the lowest level used for communication with the least capable agent. In order to be of interest to each other, the agents must be able to participate in a dialogue. There are two basic message types: assertions and queries. Every agent, whether active or passive, must have the ability to accept information. In its simplest form, this information is communicated to the agent from an external source by means of an assertion. In order to assume a passive role in a dialog,

an agent must additionally be able to answer questions, i.e., it must be able to 1) accept a query from an external source and 2) send a reply to the source by making an assertion. From the standpoint of the communication network, there is no distinction between an unsolicited assertion and an assertion made in reply to a query. In order to assume an active role in a dialog, an agent must be able to issue queries and make assertions. With these capabilities, the agent then can potentially control another agent by causing it to respond to the query or to accept the information asserted. This means of control can be extended to the control of subagents, such as neural networks and databases. An agent functioning as a peer with another agent can assume both active and passive roles in a dialog. It must be able to make and accept both assertions and queries.

2.4 Communication Levels

Communication protocols are typically specified at several levels. The lowest level of the protocol specifies the method of interconnection; the middle level specifies the format, or syntax, of the information being transferred; the top level specifies the meaning, or semantics, of the information. The semantics refers not only to the substance of the message,but also to the type of the message.There are both binary and n-ary communication protocols. A binary protocol involves a single sender and a single receiver, whereas an n-ary protocol involves a single sender and multiple receivers (sometimes called broadcast or multicast). A protocol is specified by a data structure with the following five fields:

1. sender
2. receiver(s)
3. language in the protocol
4. encoding and decoding functions
5. actions to be taken by the receiver(s).

2.5 Knowledge Query and Manipulation Language(KQML)

The knowledge query and manipulation language (KQML) is a protocol for exchanging information and knowledge, The elegance of KQML is that all information for understanding the content of the message is included in the communication itself. The basic protocol is defined by the following structure:

(KQML-performative
:sender (word)
:receiver (word)
:language (word)
:ontology (word)
:content (expression)
...)

The syntax is Lisp-like; however, the arguments—identified by keywords preceded by a colon—may be given in any order.In effect, KQML "wraps" a message in a structure that can be understood by any agent. KQML is part of

a broad research effort to develop a methodology for distributing information among different systems. One part of the effort involves defining the Knowledge Interchange Format (KIF), a formal syntax for representing knowledge. Described in the next section, KIF is largely based on first-order predicate calculus. Another part of the effort is defining ontologies that define the common concepts, attributes, and relationships for different subsets of world knowledge. The definitions of the ontology terms give meaning to expressions represented in KIF. For example, in a Blocks-World ontology, if the concept of a wooden block of a given size is represented by the unary predicate Block, then the fact that block A is on top of block B could be communicated as follows:

(tell
:sender Agent1
:receiver Agent2
:language: KIF
:ontology: Blocks-World
:content (AND (Block A) (Block B) (On A B))

The language in a KQML message is not restricted to KIF; other languages such as PROLOG, LISP, SQL, or any other defined agent communication language can be used.Interestingly, KQML messages can be "nested" in that the content of a KQML message may be another KQML message, which is self contained. For example, if Agent1 cannot communicate directly with Agent2 (but can communicate with Agent3), Agent1 might ask Agent3 to forward a message to Agent2. There are some issues also in KQML such as The sender and receiver must understand the agent communication language being used; the ontology must be created and be accessible to the agents who axe communicating. KQML must operate within a communication infrastructure that allows agents to locate each other.[**?**]

2.6 Knowledge Interchange Format (KIF)

Symbolic logic is a general mathematical tool for describing things. Rather simple logics (e.g., the first order predicate calculus) have been found to be capable of describing almost anything of interest or utility to people and other intelligent agents. These things include simple concrete facts, definitions, abstractions, inference rules, constraints, and even meta knowledge (knowledge about knowledge). KIF, a particular logic language, has been proposed as a standard to use to describe things within expert systems, databases, intelligent agents, etc. It is readable by both computer systems and people. Moreover, it was specifically designed to serve as an "interlingua," or mediator in the translation of other languages.KIF is a prefix version of first order predicate calculus with extensions to support nonmonotonic reasoning and definitions. The language description includes both a specification for its syntax and one for its semantics. KIF provides for the expression of simple data. For example, the sentences shown below encode 3 tuples in a personnel database (arguments stand for employee ID number, department assignment, and salary, respectively):

(salary 015-46-3946 widgets 72000)

(salary 026-40-9152 grommets 36000)
(salary 415-32-4707 fidgets 42000)

The semantics of the KIF core (KIF without rules and definitions) is similar to that of first-order logic. There is an extension to handle nonstandard operators (like backquote and comma), and there is a restriction that models must satisfy various axiom schemata (to give meaning to the basic vocabulary in the format).

3 Agent Interaction Protocols

Interaction protocols govern the exchange of a series of messages among agents—a conversation. Several interaction protocols have been devised for systems of agents. In cases where the agents have conflicting goals or are simply self-interested, the objective of the protocols is to maximize the payoffs (utilities) of the agents. In cases where the agents have similar goals or common problems, as in distributed problem solving (DPS), the objective of the protocols is to main-rain globally coherent performance of the agents without violating autonomy, i.e., without explicit global control. For the latter cases, important aspects include how to determine shared goals and common tasks etc...

3.1 Coordination Protocol

To produce coordinated systems, most DAI research has concentrated on techniques for distributing both control and data. Distributed control means that agents have a degree of autonomy in generating new actions and in deciding which goals to pursue next. The disadvantage of distributing control and data is that knowledge of the system's overall state is dispersed throughout the system and each agent has only a partial and imprecise perspective. There is an increased degree of uncertainty about each agent's actions, so it is more difficult to attain coherent global behavior.

3.2 Cooperation Protocol

A basic strategy shared by many of the protocols for cooperation is to decompose and then distribute tasks. Such a divide and conquer approach can reduce the complexity of a task: smaller subtasks require less capable agents and fewer resources. Task decomposition can be done by the system designer, whereby decomposition is programmed during implementation, or by the agents using hierarchical planning. Once tasks are decomposed, they can be distributed considering some factors such as avoid overloading critical resources or assign tasks to agents with matching capabilities, etc. There are some mechanism which can be used to distribute tasks but contract net is very popular and widely and is discussed in next section.

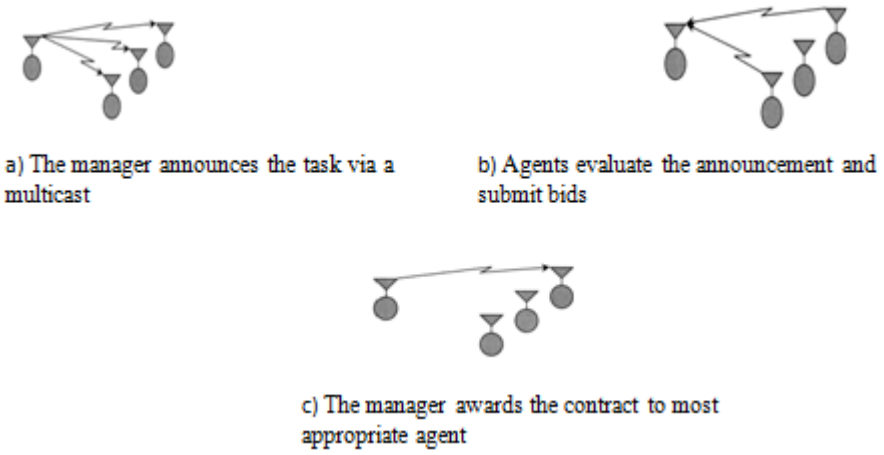

Fig. 1. Contract Net Mechanism

Contract Net The contract net protocol is an interaction protocol for cooperative problem solving among agents. It is modeled on the contracting mechanism and provides a solution for the so-called connection problem: finding an appropriate agent to work on a given task and explained in fig 1.

4 Societies of Agents

A group of agents can form a small society in which they play different roles. The group defines the roles, and the roles define the commitments associated with them. When an agent joins a group, he joins in one or more roles, and acquires the commitments of that role. Agents join a group autonomously, but are then constrained by the commitments for the roles they adopt. The groups define the social context in which the agents interact. Social agency involves abstractions from sociology and organizational theory to model societies of agents. Since agents are often best studied as members of multiagent systems, this view of agency is important and gaining recognition.Although mental primitives, such as beliefs, desires, and intentions, are appropriate for a number of applications and situations, they are not suitable in themselves for understanding all aspects of social interactions. Further, economic models of agency, although quite general in principle, are typically limited in practice. This is because the value functions that are tractable essentially reduce an agent to a selfish agent argue that a self-interested agent need not be selfish, because it may have other interests than its immediate personal gain. This is certainly true in many cases when describing humans, and is likely to be a richer assumption for modeling artificial agents in settings that are appropriately complex.

5 Conclusion

This chapter described elements of a computational environment that are needed for the interaction of multiple software agents. The elements enable agents to communicate, cooperate, and negotiate while they act in the interests of themselves or their society. This is what is needed for negotiation, cooperation, coordination, and multiagent learning.

6 References

[1].Huhns, Michael N., and Larry M. Stephens. "2 Multiagent Systems and Societies of Agents." (1999).