A MULTI-AGENT FRAMEWORK FOR DISTRIBUTED DECISION-MAKING SYSTEMS

Vira Lyubchenko

Abstract: An approach of building distributed decision support systems is proposed. There is defined a framework of a distributed DSS and examined questions of problem formulation and solving using artificial intellectual agents in system core.

Keywords: decision support system, distributed decision making.

ACM Classification Keywords: I.2.11 Distributed Artificial Intelligence

Introduction

Many definitions for decision support system (DSS) are given in research or review papers. Typical for these definitions is that they all require the involvement of computers to produce information to the decision maker. But often the complexity of a decision problem is a hindrance to the rapid development of safe and effective software for DSS. Many tasks are simply too large for one DSS and require the efforts of many DSSs for distributed decision making. Following Brehmer [Brehmer, 1991] a problem requiring distributed decision making is defined as a problem, which requires

- cooperation from a number of decision makers;
- each decision maker owns part of the resources needed to solve the problem;
- no decision maker has a complete overview of the problem as a whole, and therefore the decision makers must communicate to achieve a shared "situational awareness" with respect to the state of the task.

Framework Description

Let's define a framework of a distributed DSS, which is constructed by some domains specializing in concrete problem field. One of the ways to express the result of such knowledge structuring is a task-oriented stance [Cuena, 1999]. A task is an abstract description of how the world needs to be transformed in order to achieve to desired behavior or functionality. Problem solving methods are used to cope with the task. They indicate how a task is achieved, by describing the different steps by which its inputs are transformed into its outputs. The complexity of the decision problem required compound problem-solving methods that decompose the task into subtask. These subtasks may again be decomposed by some methods, giving rise to a task-methods-subtasks tree, whose leave are given by specialized domain. Each of them has own specialized knowledge base (KB). Each domain has a set of the agents, which are capable to simulate behavior of problem field's objects and are used only for solving tasks of this concrete problem field.

Idea of agent-based structuring integrates a collection of functionalities, achieved by the interplay two kind of knowledge: about certain problem types and about the environment in which the agent operates. By this, the agent can react to the environment situation and can interact with other agents to look for solution to its problems. The notion of agents allows a design of modules that balance two aspects:

- specialty level: it is possible to model a detailed functional decomposition by designing agents that specialized in basic functions;
- autonomy level: it is possible to integrate in an agent a significant set of the functions required for the whole application but limited in scope.

The key concept of our approach to the decision of some problem in distributed environment is analogy with group decision making in human community. For this we define an agent in the system as analogue of the man-expert specializing in the solving of the certain class of tasks. The agent can have wide, but superficial knowledge and skills within the bounds of specialization. But skills of the specialized task decision are not obligatory for it. Such type of the agents is useful, because besides participation in the problem solving it can index highly tailored agents and knowledge. Due to this opportunity such agent can delegate authorities of the problem solving to more “qualified” agents or interrogate the agents for realization of an optimal simulation step.

The set of the specialized agents and knowledge, which are stored in the knowledge base, form some area of specialization that further will be called the domain. Domain can be arranged on the separate physical devices that provide for possibility of high-speed interaction between the agents and high-speed access to data and knowledge. There are no restrictions on number of such domains in distributed DSS. The domains form common distributed system with using of Internet infrastructure. The price of data transfer in the Internet is high. But despite of it, it is necessary to realize interaction between domains of system, because the decision problems, which system needs to solve, are seldom highly tailored and exceed the limits of the domain.

The special search mechanism is determined on a network of the specialized domains. This procedure assists to the user during problem's formalization, and searches the information and agents, which are capable to represent objects of problem field and to simulate their behavior [Choi, 1999]. The idea of search consists in broadcasting search keywords of a problem to all domains. The agents of the domain having such information, form the answer from knowledge base, and send an information package with the identifier of the agent and domain, which has given this information. The user separates packages, which are interest, and thus defines the agents, with which he continues interaction in a process of decision making.

When the problem formulation is terminated, the user has some set of the agents, which he intends to use as the actors for the problem solving. The user determines the characteristics and rules of environment, in which agents will participate, sets the goals of each agent, and defines its strategies.

The characteristics, rules, the initial states of environment and termination condition are transferred to domains, whose agents take part in simulation, so the agents have access to the environment. The agents make the plan of actions according to the goal, given them, and/or make query to the knowledge base for a behavioral model, which was defined by the trainer or was made by other agents and was marked as successful. The agent analyzes the information received by sensors about a status of environment and behavior of the agents-participants, makes a decision, and prepares influence on environment. This influence is reflected on own copy of environment. The change of environment is broadcasted to the agents of other domains through communications channels. The change of environment is distributed to the agents of other domains through lines of the communications. After having received changes of environment from all agents participating in modeling, the agent passes on to the following iteration of reception of the information by sensors. Procedure reiterates. Such approach reduces amount of information transmitted between domains.

During the process of decision making the agent can consult with other agents of the domain. The agent keeps a history of environment states for improved decision making, taking into consideration features of agents' behavior. It can also transfer history to other agents, which take part in problem solving. When agent deviates from the chosen plan, decision about changing the strategy of behavior can be made.

The agents are realize with applications of neural networks and evolutionary technologies, that allows to train them for solution of some class of the tasks, and allows them to store experience and evolutionary in the process of problem solving. Besides this the agents index the information of their domain KB and other agents having the necessary information.

The agent architecture for distributed DSS in such case is built around three major components

- a perception subsystem allows the agent to be situated in the environment by data acquisition and in the society by perceiving agent messages;
- an intelligent subsystem manages the different aspects of information processing as well as full or partial decision making;
- an action subsystem enact the decisions produced by intelligent subsystem, displaying messages to the control personnel or sending messages to other agents.

The agents' dynamic beliefs about the world itself and the others are stored in the KB. We can distinguish two types of information in this KB:

- problem-solving information refers to inputs, outputs and intermediate results of tasks;
- control information specifying in an agenda what is intended to be done.

The task solution is carried out in the domains' network without separation of the agent from the domain, in the virtual environments, which is unique for each separate task. The agents interact due to the special communication protocol that makes illusion of working in common space. The stopping moment for the task solution is the moment of achievement by the environment of some state, which was defined by user as final. After that the analysis of behavior of the agents, interesting for user, is carried out.

Conclusion

This paper has outlined the potential of multiagent framework for decision support. From an abstract point of view, the concept of an agent has been used as modularization principle for the DSSs' software and knowledge. The results of such modularization are specialized domains. The presented framework is flexible and easily scalable, because domains are independence.

Bibliography

[Brehmer, 1991] Brehmer, B.: Time scales, distributed decision making and modern information technology. In (Rasmussen, J.; Brehmer, B.; Leplat, J. Eds): Distributed decision making: Cognitive models of cooperative work. Wiley, New York, 1991.

[Choi, 1999] Choi, Y.S.; Yoo, S.I.: Multi-Agent Learning Approach to WWW Information Retrieval Using Neural Network. Intelligent User Interfaces, 1999; pp. 23-30.

[Cuena, 1999] Cuena, J.; Ossowski S.: Distributed Models for Decision Support. In (Weiss, G. Ed): Multiagent Systems: A Modern Approach to Distributed Artificial Intelligence. MIT Press, London, 1999.

Authors' Information

Vira Lyubchenko - Odessa National Polytechnic University, Shevchenko av., 1, Odessa 65044, Ukraine; e-mail: vira.lyubchenko@gmail.com

CONNECTION OF NETWORK SENSORS TO DISTRIBUTED INFORMATION MEASUREMENT AND CONTROL SYSTEM FOR EDUCATION AND RESEARCH

Sergey Kiprushkin, Sergey Kurskov, Eugene Sukharev

Abstract: The development of the distributed information measurement and control system for optical spectral research of particle beam and plasma objects and the execution of laboratory works on Physics and Engineering Department of Petrozavodsk State University are described. At the hardware level the system is represented by a complex of the automated workplaces joined into computer network. The key element of the system is the communication server, which supports the multi-user mode and distributes resources among clients, monitors the system and provides secure access. Other system components are formed by equipment servers (CAMAC and GPIB servers, a server for the access to microcontrollers MCS-196 and others) and the client programs that carry out data acquisition, accumulation and processing and management of the course of the experiment as well. In this work the designed by the authors network interface is discussed. The interface provides the connection of measuring and executive devices to the distributed information measurement and control system via Ethernet. This interface allows controlling of experimental parameters by use of digital devices, monitoring of experiment parameters by polling of analog and digital sensors. The device firmware is written in assembler language and includes libraries for Ethernet-, IP-, TCP- u UDP-packets forming.

Keywords: distributed information measurement and control system, network sensors, Ethernet Interface, client-server technology, distance education.

ACM Classification Keywords: H.3.4 Systems and Software: Distributed systems

Introduction

Up-to-date systems of experiment automation are recently built on modules of software-controlled devices or digital measurement hardware, connected to interface bus. In all cases, hardware is connected to computer with interface device.