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**Qn:** How do we design agents to interact effectively to solve a wide range of problems in many different environments

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# **CHAPTER 1**

## **INTRODUCTION**

Agent and Multi-Agent Systems (MAS) represent an important and fast-growing area in collaborative networks with the potential to play a crucial role in a larger number of application domains including ambient intelligence, computing, electronic business, semantic web, and computational biology.

MAS researchers study the group behavior of autonomous agents, which are working together towards a common goal. MAS is ideal for solving complex real-world problems with multiple Problem-solving methods, multiple perspectives, and/or multiple problem-solving entities. Addressing complex systems development in distributed environments, the MAS approach to building computational systems promotes conceptual clarity and simplicity of design.

## **1.1 WHAT IS AN AGENT?**

According to Franklin and Graesser define the term “autonomous agent” is “a system situated within and part of an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future”.

But simply an agent is defined as anything (like an entity) that perceives changes from its environment by using its sensors and acts upon the environment by using its actuators.

## **1.2 AGENT PROPERTIES**

**Autonomy**: The ability to operate on its own without the intervention of humans or other systems.

**Reactivity**: The ability to receive its environment and to respond to changes that occur in it.

**Pro-activeness**: The ability to take the initiative in order to pursue its individual goals (goal-directed behavior).

**Cooperation (or social ability)**: The capability of interacting with other agents and possibly mans via an agent-communication language. Involves the ability of an agent to dynamically negotiate and coordinate.

**Learning**: The ability to learn while acting and reacting in its environment. Learning can increase the performance of an agent over time.

**Mobility**: The ability to move around the network in a self-directed way.

**Rationality**: An agent should act so as to achieve its goals and not to prevent its goals from being achieved.

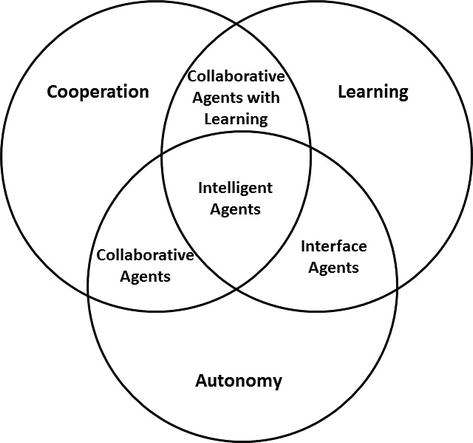


Figure 1 Agents’ categories defined by Nwana

## **1.3 WHAT IS A MULTI-AGENT SYSTEM?**

A MAS is a “loosely coupled network of problem solvers that work together to solve problems that are beyond the individual capabilities or knowledge of each problem solver”. The problem solvers from this definition are autonomous and possibly heterogeneous agents able to interact with each other in order to reach an overall goal. Moreover, each agent within the MAS has a limited set of capabilities or incomplete information to solve the problem. The MAS approach implies that there is no global system control, data is decentralized and computation is asynchronous.

## **1.4 AGENT ARCHITECTURES**

Agent architectures address the issues of designing and creating computer-based systems that satisfy agent properties. “An agent architecture is essentially a map of the internals of an agent its data structures, the operations that may be performed on these data structures, and the control flow between these data structures”. Wooldridge and Jennings identify three classes of agent architectures i.e.

Deliberative,

Reactive and

Hybrid.

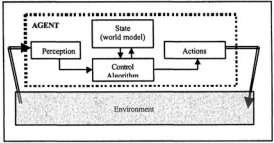
Most agent architectures are dedicated to the fulfillment of precise tasks or to problem-solving, typically requiring reasoning and planning. Other approaches simulate emotions, which direct the agent in a more reactive way.

Figure 2 The general architecture of an agent

## **1.5 PROBLEM STATEMENT**

Emerging enterprise models involve multiple users distributed in a virtual environment who have to cooperate using the software tools available in order to solve problems. Being highly heterogeneous, these users (or teams of people) can be geographically, temporally, functionally and semantically distributed over the enterprise. A computer-based communication network is the work environment where interoperation has to take place.

Computational support is needed for communications and accessibility to knowledge, past records and histories. Any software infrastructure intended to support distributed collaboration should address the following issues:

• Efficient management of the information circulated in a distributed environment by providing content related support.

• Cooperation support through an effective use of communication, co-location, coordination and collaboration processes.

• Integration of the heterogeneous software tools used in the distributed environment enabling the flow of information.

The proposed architecture employs multi-agent systems for interoperation among distributed resources and ontologies for knowledge sharing, reuse and integration.

# **CHAPTER 2**

## **MAIN BODY**

The following are the ways how to design the agents to interact effectively to solve a wide range of problems.

## **2.1 Coordination in MAS**

Agents have to coordinate their activities in order to determine the organizational structure of a group of agents and to allocate tasks and resources. Coordination has been defined as “a process in which agents engage in order to ensure a community of individual agents acts in a coherent manner”. Agents may have to communicate in order to achieve the necessary coordination. Coordination is necessary for a MAS because agents have different and limited capabilities and expertise. Furthermore, interdependent activities require coordination (the action of one agent might depend on the completion of a task for which another agent is responsible). Coordination prevents anarchy or chaos during conflicts.

The foremost techniques to address coordination in MAS include organizational structuring, Contract Net (CNP), multi-agent planning, social laws, and computational market-based mechanisms

## **2.2 Negotiation in MAS**

Representing the focus of many research studies, negotiation is essential within a MAS for conflict resolution and can be regarded as a significant aspect of the coordination process among autonomous agents.

Research shows that an effective negotiation process may be achieved by having agents’ reason about the beliefs, desires, and intentions of other agents. This approach motivates the interest in other research areas such as logic, case-based reasoning, belief revisions, distributed truth maintenance, model-based reasoning, optimization, and game theory.

## **2.3 Communication in MAS**

In order to achieve a beneficial agent interoperation, communication in a MAS is a requirement because agents need to exchange information and knowledge or to request the performance of a task since they only have a partial view over their environment. Considering the complexity of the information resources exchanged, agents should communicate by having identified the relevant concepts of that phenomenon”.

## **2.4 Organization**

Issue raised whereby system works together and should be well arranged in order to perform tasks to reach a goal.

Therefore, the framework itself can be used as a tool for communication, setting direction and focus, defining results, leveraging new resources/diagnosing problems and designed to assist multi-agent systems.

## **2.5 Cooperation**

The multi-agent system in collaborative networks increases performance level when interacting agents cooperate well. We now turn to the case of cooperation among the agents. In this case the agents exchange information regarding partial results that may be helpful to others in their subsequent search. We must specify how information is shared as well as the organizational structure, i.e., which agents communicate with each other.

Cooperative agents, working together to solve complex problems with local information

Partial Global Planning (PGP): A planning-centric distributed architecture

Shared Plans: A formal model for joint activity

Joint Intentions: Another formal model for joint activity

STEAM: Distributed teamwork; influenced by joint intentions and Shared Plans

## **2.6 Interaction**

This occurs between two or more agents brought into a dynamic relationship through a set of reciprocal actions, hence multi-agent systems help to attain their objectives and to pay attention to the resources available.

Agents and Interaction form the basis of an agent’s collaborative problem-solving capabilities. –Agents are designed to operate in tandem with one another.

–This includes sharing and requesting knowledge, negotiating services, and coordinating activities, … Key to the realization of such activities is the implementation of an underlying communication mechanism

Two broad approaches to communication:

–Shared space communication

–Communication by message passing

Message Passing General Principle:

–Messages sent directly receiver agent (communication).

–Message transmission handled by a communication channel.

–Message format based on an agreed communication language.

–Interaction consists of several messages where the agents take their turns as sender and receiver.

–This is called a dialog or a protocol

# **CHAPTER 3**

## **ADVANTAGES OF MULTI-AGENT SYSTEMS**

1. ability to solve large and complex problems as opposed to a single centralized agent that might fail the same task;
2. (ii) interconnection and interoperation of multiple existing legacy systems;
3. (iii) ability to provide solutions to efficiently manage domains in which the information resources are spatially distributed; and
4. (iv) ability to handle domains in which the expertise is distributed

# **CONCLUSION**

Agents and multi-agent systems have the potential to manage the complexity inherent in distributed software systems and therefore form an important new agent-oriented software engineering paradigm. However, software agent research still lacks in universally accepted concepts from definitions, architectures, methodologies, and languages to protocols for coordination, negotiation and communication. Ongoing research focuses on the development of agent-oriented methodologies and languages, the study of interoperation and trust models as well as the establishment of agent standards.

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