UNIVERSITAT
ROVIRA i VIRGILI

Multi-Agent Systems

Activity 1 Report

Team 2

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1 Introduction

1.1 Report Goal

This report aims to analyze a **generic purpose multi-agent system** that receives queries from the user and provides responses, taking into account the fuzzy nature of data, the information at its disposal and the initial configuration. The report delivers a brief description of each agent, its assigned role, and how agents interact with one another.

1.2 General Overview

The proposed system is composed of three elements (modules or agents). Firstly, we have a **user agent** that acts as an interface between the user and the rest of the modules. A **manager agent** that works as a mediator coordinating interactions between the user agent and the fuzzy agent, and finally a variable number of **fuzzy agents** that are responsible for calculating fuzzy sets in order to come up with an optimal course of action or decision.

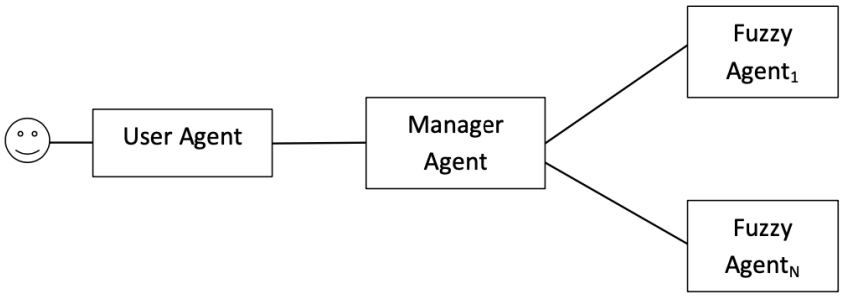

Figure 1: Interaction between agents

1.3 Fuzzy Logic

Fuzzy logic [1] emerged in the context of the theory of fuzzy sets, introduced by Zadeh (1965). A fuzzy set assigns a degree of membership, typically a real number from the interval [0,1], to elements of a universe. Fuzzy logic arises by assigning degrees of truth to propositions. The standard set of truth values (degrees) is [0,1], where 0 represents "totally false", 1 represents "totally true", and the other numbers refer to partial truth, i.e., intermediate degrees of truth.

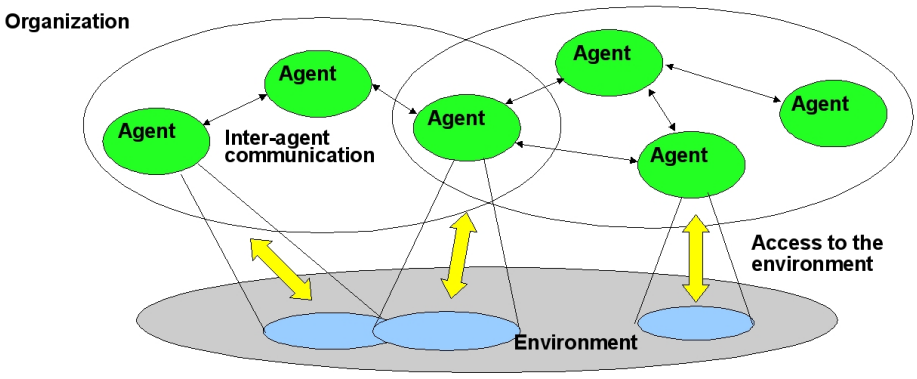

Figure 2: Generic Multi-Agent System [2]

2 Environment Analysis

The general environment of the system in question was discussed in depth. Agents should be able to access parts of environment that are within their scope of operation.It has been agreed that the environment should be able to demonstrate the following characteristics: **Accessible, Deterministic, Episodic, Static, Discrete**.

2.1 Accessible

All agents should be able to obtain somewhat complete, accurate, and up-to-date information about the state of the environment, e.g. configuration, user input, system status, etc. Having an accessible environment could help the fuzzy agent obtain the information and variables it needs to provide actions that are tailored to the user's specifications and anticipated outcome.

2.2 Deterministic

The fuzzy agents are set to be deterministic. Since they work with a set of deterministic fuzzy rules, it is expected that the action of an agent should have a certain outcome, while manager agents aggregate input from different sources in a deterministic manner. This property serves the purpose of eliminating doubt and uncertainty when it comes to suggesting a proper course of action, which is the main goal of the system as a whole.

2.3 Episodic

Sessions or episodes of action have no effect on one another as there is not iteration between the current episode and the previous one. Only the current percept is relevant, since all the decisions are based on the configuration and

the fuzzy input variables. For this reason the agents do not require memory of past actions to determine the next best action.

Future improvements Upon discussion, introducing a non-episodic environment has been suggested to allow the system to learn from past experiences and expand its capabilities. This can be implemented once the modules have been integrated and the system managed to run smoothly in the initial environmental setting.

2.4 Static

The system is given a bounded field of operation. We assume that the environment remains unchanged or affected by actions while an agent is deliberating, thus making it static. This is our assumption, since for some specific use cases maybe a dynamic environment is more suited, but we prefer to consider a static one to simplify the approach.

2.5 Discrete

The environment is perceived to be discrete, as there is a fixed, finite number of actions e.g. preparing the fuzzy agent-based system, and handling requests from users in order to percept the fuzzy set.

3 Architecture Analysis

The main goal of the system is to take input under fuzzy circumstances and suggest an action based on a set of predefined rules. The architecture of the agents reflects the interaction between the manager (decision making) and the fuzzy agents (computing data).

Since the system will be composed of different types of agents, it is considered to be a heterogeneous system.

The table below specifies the architecture type chosen for each agent. An explanation of the reasons leading to these choices is provided in the following section.

Agent	**Architecture**
User Agent	Reactive
Manager Agent	Hybrid
Fuzzy Agent	Deliberative

3.1 User Agent

This agent is set to have a **reactive architecture**. This is due to its simple interaction (handle requests / configurations from the user). It is capable of reacting quickly to events without complex reasoning, as depicted in Figure 3.

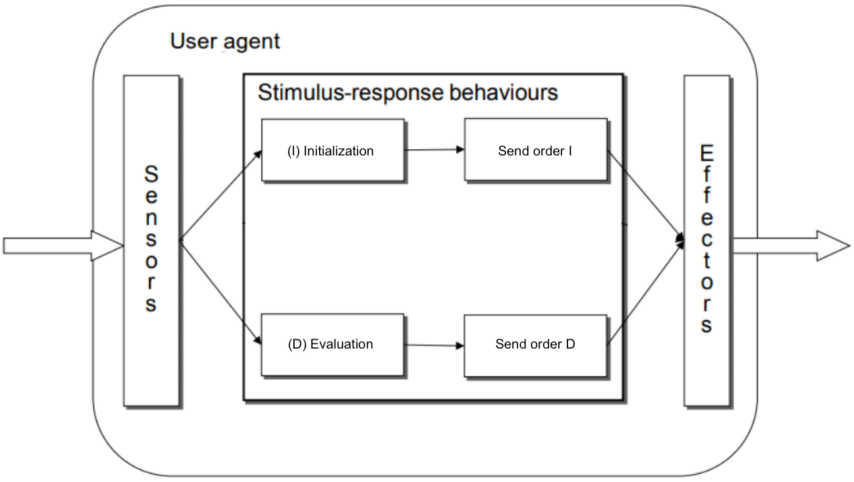

Figure 3: User Agent Architecture

3.2 Manager Agent

The Manager Agent should act as a coordinator/controller between other agents of the system, in particular fuzzy agents. It functions by aggregating responses from all the other fuzzy agents. It then chooses a proper answer based on a set of decision rules. It was suggested at first that this agent should be set up as a deliberative [3] one. However, the manager agent also has the role of creating other fuzzy agents, when requested. This lead to it being a **hybrid agent** by definition, as depicted in Figure 4.

3.3 Fuzzy Agent

The agent is set to have a **deliberative architecture** as it computes the fuzzy set and makes decisions via (fuzzy) logical reasoning, as depicted in Figure 5.

4 Agents Properties

With a view to achieve the system's goal, it is crucial for the agents involved to have the properties elaborated below for each component.

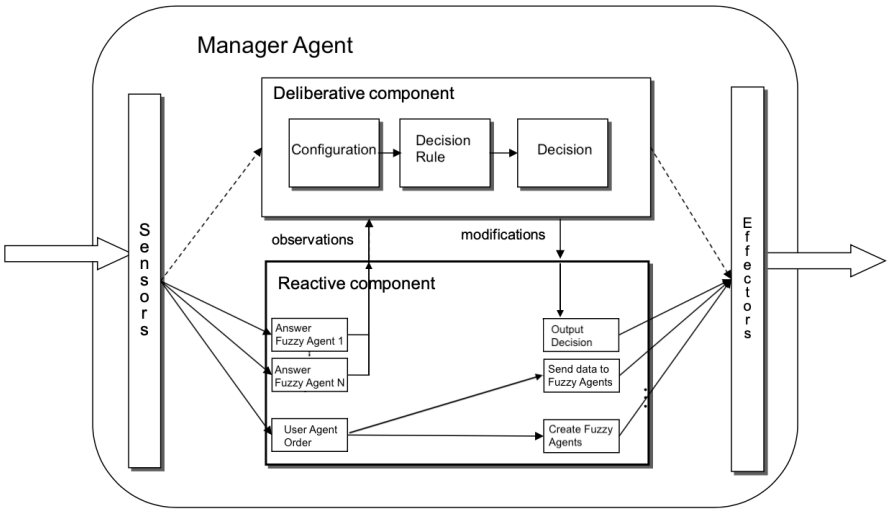

Figure 4: Manager Agent Architecture

4.1 User Agent

The User Agent is the gateway for the human user with the rest of the agents in the system.

- **Reactivity**: This agent will act as a reactive interface that takes input from the user to provide answers (decisions).
- **Communication and social abilities**: The agent interacts with the human, receiving commands and giving answers, in addition to communicating with the Manager Agent, broadcasting and receiving data.
- **Temporal continuity**: The agent is sleeping/passive in the background until the human user interact with the system.

4.2 Manager Agent

This agent will be architected as a collaborative one with the following properties taken into consideration:

- **Reactivity**: As the main role for the agent is to coordinate between modules, it must be able to respond to requests, commands, and changes in the environment.
- **Proactiveness and Autonomy**: This property will grant the agent to create other agents when the need arises.

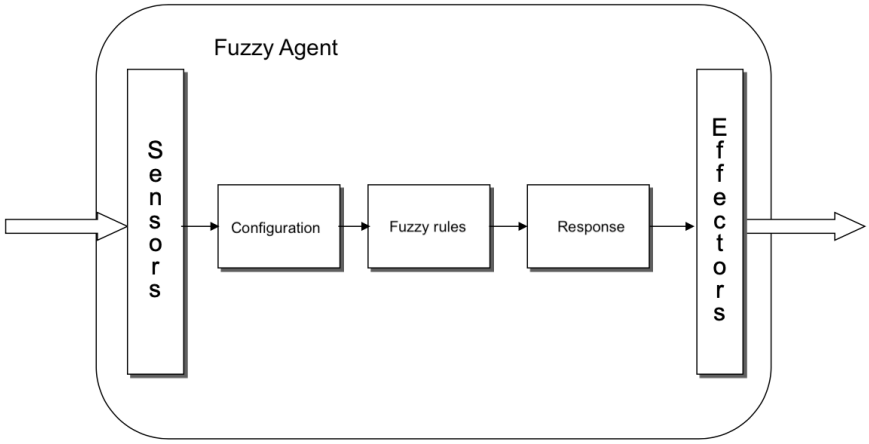

Figure 5: Fuzzy Agent Architecture

- **Rationality and Reasoning**: Given these properties, the agent will have the ability to train other agents, and coordinate between them efficiently.
- **Flexibility**: It is assumed that allowing the agent to be flexible will facilitate learning and communication between agents and other systems.
- **Temporal continuity**: The agent will continue to run in the background awaiting requests and prompts.

4.3 Fuzzy agent

It is presupposed that the Fuzzy Agent should be an intelligent one that is able to negotiate and infer knowledge using fuzzy rules.

- **Reactivity**: The agent has to compute quickly answer based on fuzzy rules as a response to Manager Agent input.
- **Rationality and Reasoning**: The agent is rational since its behaviour is based on logical rules, and use the logical set to reason on the answers.

Some features were considered difficult to incorporate within the fuzzy agent e.g. temporal continuity which would require independence from the manager agent, and autonomy which cannot be achieved due to the agent relying on the other agents.

In regards to the behaviour of agents, it cannot be predicted with certainty that they will behave in a benevolent manner. Character and veracity shall depend on the initial configuration during the programming phase, in addition

to later configurations that may be made by the user. As a result of these two factors, a single agent will not be trusted to behave benevolently on its own. Instead, the integrity of the system will rely on the collective effort of the fuzzy agents composing it.

5 Agent Types

5.1 User Agent

Which is to be set up as a reactive **interface** that can play the role of a secretary or a personal assistant.

5.2 Manager Agent

Which should be a **collaborative** agent that is capable of communication, autonomy, and reasoning.

5.3 Fuzzy Agent

Which is perceived to be a **logic module that has been agentified** as an adaptive rule-base agent, that is capable of providing information when supplied with data and allowed to collaborate with other fuzzy agents.

e-Portfolio

All information about the project can be found on the GitLab repository [4]. In particular:

- **Meeting Activities**, recorded on a Markdown file.
- **Task Distribution**, tracked on a Trello board.
- **Youtube Video**[5]

References

[1] *Fuzzy Logic*. Stanford Center for the Study of Language and Information. 2017. URL: https://plato.stanford.edu/entries/logic-fuzzy/.

[2] Viviana Mascardi. *Multi Agents System - Lecture*. UniGe - University of Genoa. 2017. URL: https://2018.aulaweb.unige.it/course/view.php?id=1793.

[3] Michael Wooldridge and Nicholas R. Jennings. "Intelligent Agents: Theory and Practice". In: *Knowledge Engineering Review* (1994), pp. 130–131. URL: bit.ly/3jcq5sh.

[4] *Team 2 Repository on GitLab*. URL: https://gitlab.com/Sarah.a.f/msy-practical-exercise.

[5] *Team 2 Video on Youtube*. URL: https://youtu.be/KPXi5nKayBo.