

Multi-agent Communication: Literature Survey

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I. INTRODUCTION

The field of Artificial Intelligence (AI) holds a major role in Computer Science. There are countless researches on this concept. Its primary aim is to reduce the problems and risks of general human operation of the physical world by automatizing and improving the manual work with AI techniques. Years of researches caused a major growth and improvement on the concept of AI and its techniques. This growth has created the necessity to acquire more information about the machines which the AI techniques will be applied on. This information includes the communication of such machines.

A system consisting of multiple interacting intelligent agents is called a multi-agent system. On this note, multi-agent communication is the interaction between these agents. There are plenty discussions and researches on how to create a multi-agent communication module.

II. LITERATURE REVIEW

An investigation was done by Balch and Arkin (1994) through experiments on both simulated and real robots focusing on the communication between the robots which act as an agent in the multi-agent system [1]. Three different communication types with three different tasks were used for the measurements of the experiment. The three tasks are forage, consume and graze. The aim was to evaluate the effect of communication type on performance on each of these tasks. The first type of communication does not use any direct communication which they generalized it as no communication. The robots are able to identify any other object such as another robot or an obstacle but this data is not shared with other agents. The second type of communication is called the state communication in which the robots can acquire the information of the state of the other robots with only one bit of data. The third type of communication is called the goal communication. This type involves sending and broadcasting information for the sender agent. However, only the transmitting agent involved the goal is informed.

A report for a programming contest which is called the Multi-Agent Programming Contest 2011 (MAPC) was written by Ettienne, Vester, and Villadsen (2012). In this report they documented their solution to the contest. Their algorithm heavily relies on the communication between the agents in the system [2].

In a paper written by Díaz, Earle, and Fredlund (2013), they described the framework Jason in Erlang programming language [3]. They also focused on the communication between agents in a multi-agent communication system.

In a paper written by Lillis, Collier, and Jordan (2013), an evaluation was done to test the effectiveness of the Agent Conversation Reasoning Engine (ACRE) in which a group was assigned to implement a solution to a problem scenario with the use of ACRE and another group was assigned to implement a solution without the use of ACRE. ACRE's purpose is to help developers with the reliability of the communication between the agents in a multi-agent communication system [4].

In a paper done by Memon, Jalbani, Shaikh, Memon, and Ali (2018), the multi-agent communication was researched through chatbots. Their aim was to formulate the conversation among agents in order to aid future problems that might arise for a single agent [5].

III. RESEARCH METHODS & RESULTS

In the investigation done by Balch and Arkin (1994), the method used for communication was building a baseline database. Since their focus was on the effect of the communication type on performance of different tasks, they came up with the result that more complex strategies for communication such as the goal communication only offer little benefit over the basic communication strategies such as the state communication for these kind of tasks. The communication improves the performance on the forage and consume tasks because they have little implicit communication and since the graze task has implicit communication, communication appears unnecessary [1].

In the report done by Ettienne, Vester, and Villadsen (2012), they explained how on their previous contest, they used an existing framework Jason. Although Jason had some advantages with agent communication they decided to implement their own framework written in Python because they thought their own implementation would have more control over the general aspect of the implementation of their system. To simulate the communication, they used a shared database of bids between the agents. To support this communication, they started out by using the Apache ActiveMQ as a messaging server. Later on, they were not able to implement their own messaging server with a simple text-based protocol due to lack of time, therefore they decided to use shared data structures for agent communication [2].

In the paper created by Díaz, Earle, and Fredlund (2013), the multi-agent communication is asynchronous due to the use of Erlang programming language. This asynchronous communication is explained as a point-to-point communication in which one agent is sending a message to a second one and the second one processes it. The communication is implemented using Erlang message passing [3].

In the evaluation managed by Lillis, Collier, and Jordan (2013), existing protocols and frameworks were explained provided by ACRE. ACRE's protocols use finite state machines (FSMs) to orchestrate the communication between the agents. The transitions between the states are stimulated with the sending and receiving of messages [4].

In the paper done by Memon, Jalbani, Shaikh, Memon, and Ali (2018), they focused on the client-server socket technique to illustrate the multi-agent communication system with chatbots. They also used Natural Language Processing (NLP) and Knowledge Recognition (KR) techniques to achieve their results [5].

IV. CONCLUSION

Communication is a key aspect of multi-agent systems. Thus deciding on the method to implement such a communication system is crucial. The methods for multi-agent communication used in the researches mentioned in

this literature survey report are using or building a database, using existing frameworks' communication system such as the Jason framework, using shared data structures, using the existing programming languages' methods such as Erlang message passing, using FSMs, and using a client-server socket system.

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