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The Evolution of Intelligent Agents within the World Wide Web

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Abstract. The definition of an agent still needs to be agreed upon [1] and the use of multiple agents to form a team is being examined by many researchers [2]. The study of Artificial Intelligence (AI) is diverse because of each domain has encountered a bottleneck or some impasse has forced research to look further a field to find solutions [3]. Agent teaming was one of those choices. Each team consists of one or more agent which form a Multi-Agent System (MAS) [4]. Currently these have a fixed hierarchy and predetermined functionality to achieve specified goals [5]. Ideally that teams should seamlessly interoperate within its environment, autonomously adapt to new tasks and rapidly switch context as required. Learning, cooperation, collaboration and trust are other characteristics that deserve discussion and development, however, the above challenge would represent a significant leap in the natural progression to agent oriented programming.

Keywords: Computational Intelligence, Artificial Intelligence, Agents, Multi-Agent Systems, Teaming.

1.1 Introduction

Researchers have been presented with many Artificial Intelligence (AI) challenges as they attempt to increase the level of personification in intelligent systems. These challenges are both technical and psychological in nature. Agent technologies, and in particular agent teaming, are increasingly being used to aid in the design of “intelligent” systems [6]. In the majority of the agent-based software currently being produced, the structure of agent teams have been reliant on that defined by the programmer or software engineer.

Over the last decades, Artificial Intelligence (AI) has made a great deal of progress in many fields, such as knowledge representation, inference, machine learning, vision and robotics [7] [8]. Minsky poses that Artificial Intelligence is the science of making machines do things that would require intelligence if done by man [9]. Many researchers regard Artificial Intelligence as more than engineering, demanding the study of science about human and animal intelligence be included. Intelligence considers cognitive aspects of human behaviour, such
as perceiving, reasoning, planning, learning and communication. AI was initially conceived by Newell and Simon using production systems \[10\]; however, the study quickly divided into two streams with John McCarthy and Nil Nillson considered the Neats (using formal logic as a central tool to achieving Artificial Intelligence), while Marvin Minsky and Roger Schanks where considered the scrufs (using a psychological approach to Artificial Intelligence). Russel and Norvig entered the argument by describing an environment as something that provides input and receives output, using sensors as inputs to a program, producing outputs as a result of acting on something within that program. The Artificial Intelligence community now uses this notion as the basis of definition of an agent \[1\].

Intelligent agent technology has been touted as becoming the paradigm of choice for the development of complex distributed systems and as the natural progression to object oriented programming. Learning has an important role to play in both cooperative and autonomous systems. Agents with predefined behaviours based on a priori knowledge of the system that is modified using feedback from experience will continue to mature. Rather than having purely agent-based applications, we then have cooperative applications involving teams of agents and humans. We expect that intelligent agents will retain their architectural foundations but the availability of more appropriate reasoning models and better design methodologies will see them being increasingly used in mainstream software development. Furthermore, better support for human-agent teams will see the development of a new class of intelligent decision support applications.

1.2 Intelligent Agents and Web

Simply speaking, an Artificial Intelligence application is a system that possesses knowledge about an application domain that takes in data from its environment, and reasons about that data to derive information. The system may be combined with various algorithms for reasoning, learning, planning, speech recognition, vision, and language understanding. For example, knowledge can be represented procedurally or as a set of logical conditions. The rules formed the initial inference conditions in expert systems used to determine a conclusion. If all of conditions are true, then the conclusion holds. When reasoning, an expert system, forward chaining is used. A tree or path is built by which reverse chaining can be used to derive estimates or values from which facts could be extrapolated to validate the conclusions. The conclusion from one rule can be compounded to form part of another condition to build more complex decision support.

A blackboard system may be thought of as a componentized system, where each box could function as a database, series of “pigeon holes” or behave with an unknown black box behaviour that represents a specific aspect of a system or sub-systems engaging a problem. This needs to occur in an environment where experts and modular software subsystems, called knowledge repositories, capable of representing different points of view, strategies, and knowledge formats, required to solve a problem. These problem-solving paradigms may include: