Chapter 4
Towards a Formal Language in Law

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ABSTRACT

In today's globalized society, the generation of digital information grows exponentially along with the technological innovations in all aspects of everyday life. In order to cope with gathering, administering, sharing information, planning, and automatization of many human activities including some human reasoning tasks, multi-agent systems in the form of language programming scripting have become an important aspect in dealing with those problems. Thus, the agent-based programming language has become an important line of research in artificial intelligence from a theoretical and practical point of view. In this chapter, the authors review some already implemented languages and theoretical aspects toward a formal proposal of a language that deals with human reasoning in law. In particular, the authors present as an example a language, based on topoi theory, that deals with the problem of defining ontology as specified by FIPA as a requirement for agent-based programming language.

INTRODUCTION

The expansion of programming language paradigms, in communications, data transfer and the increase in volumes of information has led to attempts to assist in the resolution of legal disputes, such as patent or intellectual property, between large companies, which in many cases leads to expenditures of resources, both human and economic. Having an automated tool could contribute to efficient resolution, optimizing resources for these companies. Extend to other processes for other types of social activity that require massive data manipulation, whether public or private.

The goal of this chapter as the title is intended to reflect, is to contribute to the development of an agent-based programming paradigm for multi-agent systems. Multi-agent systems, in artificial intelligence, are not intended to tackle a specific problem; neither are solely intended to develop a language to be applied in jurisprudence or law. There is, however, a common ground among all range of applications that multi-agent systems might have to define a practical agent-based programming language, that is logic, which is the formalism to achieve such a goal for the bad or for the better. This is one of the reasons for the authors to choose law to be modelled by Beliefs, Desires, and Intentions (BDI) systems to explain some of the key features in this endeavor. The need for a formal language to model human reasoning with no ambiguities has been an idea present since Aristotle; with Leibniz closer to our times, with its characteristic language following Frege and Lesniewski. The system with such characteristics could be subsumed as building a perfect system of deductive theories that correctly codify our knowledge of the world. This, however, is a rather ambitious plan, and therefore in recent times, in Artificial Intelligence, it has been addressed the idea of developing an abstraction called an agent which in theory will address some of the problems in the original idea, that could resolve some of the issues about human reasoning. One of the topics to be discussed in this chapter will be what best describes an agent. One could loosely say that an agent is "one or what which, exerts power or produces an effect". But what gives the power that would eventually produce an effect on an agent? This depends on the context, the problem is that agent is dealing with regarding human behavior which means that all has to do with cognition, logic, reason, psyche, and philosophy of course, which is about everything and nothing. To fix the idea of the material to be discussed, let us say that an agent is an abstraction that has autonomy and rationality (not limited to) that naturally any human being has. A possible line of future research, in addition to legal disputes, is the possibility of generating a model that allows to establish a situation as a dispute, not necessarily legal, where a solution model can be found.

To bring logic into the picture, as well as the formalization of the theory that will serve to get insight into the language for multi-agents, the authors are taking as a guide the ontology service specification provided by the Foundation for Intelligent Physical Agents (FIPA) (Agents 2001). The reason for choosing FIPA is based on the review of agent-based programming languages (Cardoso and Ferrando 2021). The authors give an extensive and very informative state of the art on agent-based programming languages; in the paper, the authors provide a comprehensive review of the languages already implemented as well as the methodology used for that purpose. It seems that the BDI systems approach is more suitable for theoretical reasons and also since it is directly related to the design and study of programming languages in general. BDI systems, which stands for belief, desire, and intentions to model multi-agents; are hard on their own since there is ongoing research on how to describe these particulars within a logical framework. The trend is to use modal logic such as KD45 as a baseline for representing belief (Ding 2021; Wooldridge 1992), as well as intentions and desires as introduced by Cohen and Levesque (Meyer, Broersen, and Herzig 2012). It is impossible to review all fundamentals behind BDI systems, but one

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