

# A Social Reasoning Mechanism Based On Dependence Networks

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**Abstract.** This paper describes the fundamental concepts of a *social reasoning mechanism*, designed to be part of an agent's internal model, in a multi-agent systems (MAS) context. It enables an agent to reason about the others using information about their goals, actions, resources and plans. Every agent stores this information in a data structure called external description. We have formally defined and implemented the concepts of *external description*, *dependence relation*, and *dependence network*. One of the main contributions of this work is that an agent can infer his dependence on others using either his own plans or those of the others. As a result, we have defined a preliminary taxonomy of *dependence situations* regarding the goal being analysed (unilateral, mutual or reciprocal) and the sets of plans used in this reasoning mechanism (mutually or locally believed). We have used this model to build a dependence network simulator, called DEPNET, which is also briefly described in this paper.

**Keywords:** multi-agent systems, cognitive modelling, communication and cooperation, integrating several AI components.

## 1 Introduction

The main goal of this work, developed in a scientific cooperation program between the LIFIA/IMAG and the IP/CNR, was to combine the complementary expertise of these groups in the multi-agent systems (MAS) domain. In particular, we have designed and implemented a computational model of the Social Power Theory [4], using the concept of dependence relation [3]. This model, as well as some of its extensions, will be used in some modules of the LIFIA's MAS platform [2] and agent models [10], mainly involving conflict management in MAS. On the other hand, we have used this model to build a dependence network simulator, called DEPNET. This simulator will enable the IP/CNR's research staff to experiment and validate some future theoretical results.

The ability of reasoning about the others is an essential issue in a so called "intelligent" agent. Moreover, if we consider a MAS as an open system [7], this feature enables an agent to adapt himself to an evolving environment, to take into account information about new members of the agency (as an example, one can think of a robot's agency, when new robots may arrive and robots may leave due to failures). Therefore,

in our point of view, an agent must have a *social reasoning mechanism* in order to react properly when faced to such situations. On the other hand, structural analysis approaches have been extensively used in the last years, specially in social and political sciences [8]. More recently, these approaches are beginning to be used in Computer Science. An interesting work, closely related to this paper, is described in [12], where a model of dependence was designed to treat business reengineering problems. The difference between this work and the one presented in this paper is that in the former some of the types of dependences introduced are closely related to the target domain, while our approach claims to be domain-independent.

In section 2, we present the concept of *external description*, a data structure where an agent stores the information he has about the others. This information may be used to infer his *dependence relations* and to construct his *dependence networks*, as it is shown in section 3. Once constructed such networks, an agent may identify which is his *dependence situation* regarding the other agents for a specific goal. A preliminary taxonomy of these dependence situations is described in detail in section 4. Section 5 briefly presents the DEPNET simulator, a software tool we have built in order to test our ideas. Finally, we present in section 6 our conclusions and further work.

## 2 External Description

As presented in [2] [10], we consider that an essential functionality an agent has to have in order to be really autonomous (in a broader sense) is a *social reasoning mechanism*. We call social any reasoning mechanism that uses *information about the others* in order to infer some conclusions. Therefore, any agent (despite the possible different internal models an agent may have) must have a data structure where this information about the others is stored. At the LIFIA/IMAG, we call such data structure an *external description* [6]. In this paper, we define it as composed of the following elements:

- *goals*: the goals an agent wants to achieve. An agent may have more than one goal, and in this point we do not make any reference if a goal is currently active or not, this discussion is out of scope of this paper;
- *actions*: the actions an agent is able to perform;
- *resources*: the resources an agent has control on;
- *plans*: the plans an agent has, using any actions and resources, in order to achieve a certain goal. These actions

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