Lou Goble
John-Jules Ch. Meyer (Eds.)

Deontic Logic and Artificial Normative Systems

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Lecture Notes in Artificial Intelligence 4048

Edited by J. G. Carbonell and J. Siekmann

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Preface

This volume presents the papers contributed to DEON 2006, the 8th International Workshop on Deontic Logic in Computer Science, held in Utrecht, The Netherlands, July 12–14, 2006. These biennial DEON (more properly, ΔEON) workshops are designed to promote international cooperation among scholars across disciplines who are interested in deontic logic and its use in computer science. They support research that links the formal-logical study of normative concepts and normative systems with computer science, artificial intelligence, philosophy, organization theory, and law.

Papers for these workshops might address such general themes as the development of formal systems of deontic logic and related areas of logic, such as logics of action and agency, or the formal analysis of all sorts of normative concepts, such as the notions of rule, role, regulation, authority, power, rights, responsibility, etc., or the formal representation of legal knowledge. They might also be more concerned with applications, such as the formal specification of systems for the management of bureaucratic processes in public or private administration, or the specification of database integrity constraints or computer security protocols, and more. Of particular interest is the interaction between computer systems and their users. (The DEON 2006 website, `http://www.cs.uu.nl/deon2006/`, contains links to previous workshops and their papers. This history reveals a vibrant interdisciplinary research program.)

In addition to those general themes, the 2006 iteration of the workshop focused also on the special topic of artificial normative systems, their theory, specification and implementation, such as electronic institutions, norm-regulated multi-agent systems and artificial agent societies generally. Here too the concern is both with theoretical work, such as the design of formal models and representations, and also work more oriented toward implementation, such as architectures, programming languages, design models, simulations, etc.

The 18 papers printed here were selected for presentation at the workshop after a thorough process of review and revision. All are original and presented here for the first time. They range from studies in the pure logic of deontic operators to investigation of the normative extension of the computer language C+ to examination of the structure of normative systems and institutions. The titles themselves demonstrate commitment to the themes of the workshop. In addition to these full papers, we present abstracts of the talks of our three invited speakers, José Carmo (University of Madeira), Frank Dignum (University of Utrecht), and Paola Petta (University of Vienna).

We are grateful to all who contributed to the success of the workshop, to our invited speakers, to all the authors of the presented papers, to all who participated in discussion. Special thanks go to the members of the Program Committee for their service in reviewing papers and advising us on the program

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and to the members of the Organization Committee for taking care of all the countless details that a workshop like this requires, especially Jan Broersen for setting up and maintaining the DEON 2006 website and Henry Prakken for financial arrangements, sponsorships, and more. Thanks too to Richard van de Stadt whose CyberChairPRO system was a very great help to us in organizing the papers from their initial submission to their final publication in this volume. We are also very grateful to the several sponsoring organizations for their essential support. Finally, we wish to express our appreciation to Springer for publishing these proceedings in their LNCS/LNAI series. This is the second such volume in this series; the first was from DEON 2004, *Deontic Logic in Computer Science*, LNAI 3065, edited by Alessio Lomuscio and Donald Nute. We hope these volumes may continue into the future to provide a record of research in this rich and growing field.

April 2006

Lou Goble
John-Jules Ch. Meyer

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Table of Contents

Abstracts of Invited Papers

Contributed Papers

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Roles, Counts-as and Deontic and Action Logics

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An organization may be the subject of obligations and be responsible for not fulfilling its obligations. And in order for an organization to fulfill its obligations, it must act. But an organization cannot act directly, so someone must act on its behalf (usually some member of the organization), and this must be known by the "external world" (by the agents that interact with the organization).

In order to account for this, the organization is usually structured in terms of what we may call *posts*, or *roles* within the organization, and the statute of the organization distributes the duties of the organization among the different posts, specifying the norms that apply to those that occupy such positions (that hold such roles), and describing who has the power to act in the name of the organization. But this description is abstract, in the sense that it does not say which particular person can act in the name of the organization; it attributes such power to the holders of some roles. Depending on the type of actions, the power to act in the name of an organization may be distributed through different posts, and the holders of such posts may (or may not) have the permission or the power to delegate such power. On the other hand, those that can act in the name of an organization can establish new obligations for the organization through their acts, for instance by establishing contracts with other agents (persons, organizations, etc.). And in this way we have a dynamic of obligations, where the obligations flow from the organization to the holders of some roles, and these, through their acts, create new obligations in the organization.

On the other hand, a person (or, more generally, an agent) can be the holder of different roles within the same organization or in different organizations (being the subject of potentially conflicting obligations), and can *act by playing different roles*. And in order to know the effects of his acts we must know in which role they were played. Thus, it is fundamental to know which acts *count as* acts in a particular role.

If we want a logical formalism to abstractly specify and reason about all these issues, we need to consider and combine deontic, action and counts-as operators. Particularly critical is to decide which kind of action logic we consider. For some aspects, like that of describing how the obligations flow from the organization to the holders of some posts and how some of the acts of the latter count as acts of the organization, it seems it is better to consider a "static" approach based on the "brings it about" action operators. On the other hand, if we want to be able to describe the dynamics of the obligations deriving, for instance, from the contracts that are made in the name of the organization, it seems that a dynamic logic is necessary, or at least very useful. However, the combination of the two kinds of logic of actions has proven to be not an easy task. This paper addresses these issues.

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Norms and Electronic Institutions

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Abstract. The term *Electronic Institution* seems to be well accepted in the agent community and to a certain extent also in the e-commerce research community. However, a search for a definition of an electronic institution does not yield any results on the Internet. This is different for the term *institution.* North [9] defines institutions (more or less) to be a set of norms that govern the interactions of a group of people. Examples are *family* and *government.* Here we are not so much interested in giving a very precise definition of an institution, but just want to note that the concept refers to a very abstract notion of a set of norms or social structure.

It is not immediately clear how such an abstract set of norms can be "electronic". The term electronic institution is therefore a bit misleading. It actually refers to a description of a set of electronic interaction patterns that might be an instantiation of an institution. E.g. an electronic auction house (which can be seen as an instantiation of the auction institution). So, it is not referring (directly) to a set of norms or a social structure. However, because the term is widely used by now, although it is not entirely appropriate, we will stick with using the term "electronic institution" to refer to such a kind of specification.

In contrast to the situation in human society, where these interaction patterns might emerge over a long period of time and the institutionalization follows after the stabilizing of these patterns, the electronic institutions are specifically designed by humans to fit with existing institutions. E.g. an electronic market can be designed to instantiate the auction institution. So, the mechanism and interactions to be used in the electronic market can be designed such that they comply to the norms specified in the auction institution (e.g. following a bidding protocol to ensure a fair trade).

If the electronic institution is specified and implemented using a tool like AMELI [5] then the agents interacting in the institution can only follow precisely the pre-specified interaction patterns. Any attempt to perform a deviating action is caught by the so-called governors and has no effect. Thus if the interaction patterns are such that agents always interact in a way that keeps the system in a non-violation state according to the norms of the institution then by definition the agents will never (be able to) violate any of the norms of the institution.

However, this is not the only way to "instantiate" the set of norms that define the institution. One of the main characteristics of norms is that they can be violated. So, how does this relate to the design of electronic institutions? Should they also allow for violations? If they allow for violations, what should happen in these violation states?

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What we are actually looking for is what it means for an electronic institution to *instantiate* an (existing) institution (seen as a set of norms) in this context. And subsequently what are the concepts necessary to describe all elements of the electronic institution such that one could "prove" that it actually instantiates the abstract institution.

One obvious way to go ahead is to use (a) deontic logic to specify the norms and use the same formalism to specify the electronic institution. This specification can then be used to describe ideal vs. real behavior. It can also be used to verify compliance to norms and/or to reason about the combination of norms. We can even use it to check whether the system has means to return from any possible violation state to a permitted state.

However, although this approach is a good first step, it does not capture all the subtleties involved. We will briefly touch upon a few of these issues in the following.

One immediate problem is the connection of an abstract set of norms with a concrete specification of interaction patterns. Almost by definition, the terms used in the norm specification are more abstract than the terms used in the specification of the electronic institution. E.g. a norm might mention a prohibition to "reveal" certain information. Because agents will not have a specific action "reveal", they will by definition comply to this norm. However, there is of course a connection between (sets of) actions that an agent can perform and the abstract action of revealing. This relation is usually given using the *counts-as* relation. Some important groundwork on this relation has already been done in [8] but much work still needs to be done to capture all aspects of it (see e.g. [7]).

Another issue that is also related to levels of abstraction are the temporal aspects of norms. Often norms are abstracting away from the use of temporal aspects. E.g. the winning bidder in an auction has to pay for the item she has won. However, in order to compare a norm with a concrete specification of interactions the temporal aspects are of prime importance. Does the winning bidder have to pay right away, before some deadline, at some time in the future,...? So, it seems to be important to specify the norms at least with some kind of temporal logic in order to establish this relation. Some first steps in this direction are taken in [2, 1], but no complete formal analysis is as yet given of a temporal deontic logic.

A third issue that arises is that some norms seem to relate to the behavior of a complete organization. E.g. the auction house should ensure the payment of auctioned items. The question is which agents of the auction house should take care of this? Should it be only one agent or more than one? Should there be backups for if an agent fails? In general this is the question on how a norm for an organization dissipates over the members of that organization. This depends, of course, on the organizational structure(s), power relations, knowledge distribution, etc. Some preliminary work is described in [6, 10].

A fourth issue is that of norm enforcement within the electronic institution. Basically this can be done in two ways: Preventing a norm from being violated or checking for the violation of a norm and reacting on the violation. A decision on which method to choose depends on

aspects such as efficiency and safety of the electronic institution. It also reveals another important aspect, if an agent has to enforce a certain norm it should be able to "know" whether the norm is violated or not. Often this aspect leads to certain additional interactions which have as only purpose to gather information necessary to check a violation of a norm [11]. E.g. if a participant of an auction should be at least 18 years old, the auction house might institute a registration protocol in which a participant has to prove he is over 18.

A last issue I would like to mention here is the influence of the existence of the norms themselves on the behavior of the agents. In human situations the existence of the norms alone influences the decision process of the persons. In an electronic institution one might have a more complicated situation where some agents are software agents, while others are human agents. How does this influence the interactions? Can we effectively build norm aware agents? Some theory does exist (e.g. [4, 3]), but no practical implementations yet. Does this function better, more efficient, or not?

In the above I have risen more questions than given answers. However, I think they are interesting questions and very relevant if one considers the more general relation between deontic logic and computer science. The relation between deontic logic and computer science is also a relation between the abstract (philosophical logic) and the concrete (engineered processes). So, besides giving an idea of the place of norms in electronic institutions, I hope this presentation also encourages some people to (continue to) perform research in the areas mentioned above.

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