Abstract and Concrete Norms in Institutions

Davide Grossi

Frank Dignum

institute of information and computing sciences, utrecht university

technical report UU-CS-2004-016

www.cs.uu.nl

Abstract and Concrete Norms in Institutions

Davide Grossi and Frank Dignum

Institute of Information and Computing Sciences
Utrecht University,
P.O.Box 80.089
3508 TB Utrecht
The Netherlands
{davide,dignum}@cs.uu.nl

1 Introduction

Electronic institutions, such as auctions and market places are the electronic counterparts of institutions that are established in our societies. They are established to regulate the interactions between parties that are performing some (business) transaction. One of the main roles of institutions is to inspire trust into the parties that perform the transaction (see [10] for more details on the roles of institutions). One way to inspire trust in the parties is by incorporating a number of regulations (norms) in the institution that indicate the type of behavior to which each of the parties in the transaction should adhere within that institution. The main question of this paper consists in understanding what kind of formal relation subsists between the (abstract) norms specified in the regulations and the concrete rules of an institution, such that the agents operating within the institution will operate according to these norms or can be punished when they are violating the norms. Many attempts have been made to formally specify norms in e.g. deontic logic (for example [23, 32]). Although it is possible to capture norms in this way and even give them a certain kind of semantics and reason about the consequences of the norms etc. this kind of formalization does not yet indicate how the norm should be interpreted within a certain institution. For instance, we can formalize a norm like "it is forbidden to discriminate on the basis of age" in deontic logic as "`F(discriminate(x,y,age))`" (stating that it is forbidden to discriminate between x and y on the basis of age). However, the semantics of this formula will get down to something like that the action "discriminate(x,y,age)" should not occur. However, it is very unlikely that the agents operating within the institution will explicitly have such an action available. The action actually states something far more abstract. We claim that the level on which the norms are specified is more abstract and/or general than the level on which the processes and structure of the institution are specified. Therefore we need to "translate" the norms specifically to a level where their impact on the institution can be described directly. This translation is dependent on the domain of the institution and therefore the translation rules depend on e.g. the ontology for that domain.

In this paper we will present a first formalism that can be used to connect norms on the different levels of abstractness in a way that one can verify that a certain organization does indeed implement the norms of an institution. In the next section we will introduce the conceptual apparatus we will be dealing with in what follows, and we will clear our terminology up. In Section 3 we will formally describe levels of abstractness and the connection between them. In Section 5 we discuss abstract and concrete norms in the formalism developed. In section 6 we show how we can describe institutions using this formalism and which derivations can be made. In Section 7 we show how our formalism can be straightforwardly included in defeasible argumentation frameworks conceived to mimic legal reasoning, thus providing a comprehensive theory for reasoning about institutions. Finally we give some conclusions and areas for further research in Section 8.

2 Institutions and Norms

The first concept to describe in this analysis is the concept of **norm**. As we will later in Section 2.2, institutions are defined in terms of norms, which are therefore the basic building block, so to say, of this work. With the term norm we intend whatever in general indicates something ideal and which, consequently, presupposes a distinction between what is ideally the case and what is actually the case. In natural language norms are usually, but not always, expressed by locutions such as: "it is obligatory", "it is forbidden", "it is permitted", etc..

In this paper we will assume the norms to be conditional, because that is the form in which they mostly appear in statutes and regulations governing institutions. In conditional norms we recognize the condition of application of the norm, and its normative effect, i.e. the normative consequence the norm subordinates to its condition. We will refer to norms by means of normative propositions using the dyadic deontic logic notation ([32]): $O(A|B)$, $P(A|B)$ and $F(A|B)$, which mean that B is the condition that should be fulfilled for the obligation (resp. permission or prohibition) A to hold.

Another important concept we will come to take into consideration, though not in detail, is the concept of **procedure**. Here a procedure is seen as an algorithm-like specification describing how a certain activity is carried out. The difference between a norm and a procedure is of extreme relevance for our purposes (see Section 2.2): a norm states that something ought to be the case under certain conditions, while a procedure describes only a way of bringing something about; semantically, norms incorporate a concept of ideality, which lacks in the notion of procedure, where central is rather a notion of transition.

2.1 Normative Systems

In [18] normative systems are defined as follows:

> a normative system is any set of interacting agents whose behavior can [...] be regarded as norm directed.

According to this view, a normative system is thus a norm directed agency. In this sense, a set of norms meant to direct an agency constitutes a form of (normative) specification of that agency; in other words, a set of norms addressed to a given agency determines that agency as a normative system. As such, normative systems are therefore amenable of formal description in terms of logical theories containing norm propositions[1].

There is wide agreement upon the fact that all normative systems of high complexity, like for example legal systems, cannot be regarded simply as sets of norms ([1, 20]). They contain both *classifying* components and *regulating* components. Regulating components are nothing but what we called (conditional) norms. Classifying components yield instead a kind of contextual definition. E.g. "consenting to an organ donation can be done by signing form 32". This type of normative component has received much attention in legal and social theory ([16, 25, 31]) and recently also in logic ([19, 13]). In what follows we will refer to this component as constituted by a notion of **supervenience** as it is explained in [21, 15]:

> The state of affairs that John is a thief obtains due to the state of affairs that John has taken away Gerald's car. It is said that the state of affairs that John is a thief supervenes on the state of affairs that he has taken away Gerald's car.

The previous example about consent for organ donation, once interpreted in terms of the notion just introduced, would be readable as follows: "the act of consenting supervenes on the act of signing form 32". In the remaining of the work we will stick to this reading of the classifying component of institutions.

The interaction between the classifying components and the regulating components takes place in two distinct ways.

1. First, some situation can be classified as satisfying the condition of a certain norm. An easy example of this interaction, taken from the Spanish transplant regulation ([22]), can be the

[1] This is precisely how normative systems are conceived in [1], where they are analyzed as sets of sentences deductively connecting normative conditions to normative effects.

following: being at least eighteen years old counts as being of legal age, and being of legal age, conjunctly with some other conditions, gives rise to a permission for an authorized hospital to extract. Therefore being at least eighteen years old, conjunctly with some other conditions, gives rise to that permission.

2. Secondly, the classificatory component can explicate how a certain norm can be satisfied. An example from the transplant regulation could be the following: Signing form 32 counts as a consent for organ donation. Therefore signing this document is fulfilling the obligation of consenting before the transplantation takes place. If signing this form is the *only* way of performing the consent then one can conclude that it is obligatory to sign the form (before the transplantation can take place).

Regulating components and classificatory components will be logically represented, respectively, using a *deontic logic conditional* and a to be defined conditional formalizing the aforementioned notion of supervenience (*supervenience conditional*). By expressing them both in logic we aim at formally accounting for the two forms of interaction sketched above. We will make this more precise in Section 3 and Section 5. For a summary of what discussed in this section see Table 1.

Table 1. Normative systems' components

COMPONENTS	regulating part	classifying part
ELEMENTS	regulative norms	constitutive norms
DESCRIPTION	norm expressions	supervenience expressions
LOGIC	deontic conditionals	supervenience conditionals

2.2 Institutions

The term institution is quite ambiguous. Following [24] we distinguish two senses of the term, which we deem significant for our purposes.

– First, an institution can be seen as a set of agents with specific roles, private and common objectives, the activities of which are procedurally determined. We speak in this case about institutions seen as **organizations**. In this sense, the agents operating Utrecht Hospital, and the set of procedures according to which their activity is planned, constitute an institution.
– Second, an institution can be seen as a set of rules an organization can instantiate accomplishing those rules. We use in this case the term **institutional form**. In this sense the set of regulations holding at Utrecht Hospital defines an institutional form. Also the set of regulations concerning hospitals in The Netherlands defines an institutional form, namely the more general institutional form "hospital". The organization of Utrecht Hospital instantiates both these institutional forms but there can be organizations, like for instance Amsterdam Hospital, instantiating only the form of a hospital in general but not that of Utrecht Hospital.

We use the above insights to underpin a double perspective on institutions, which mirrors the previous distinctions between organizations and institutional forms.

– The first perspective, which will also be the one more widely addressed in this work, is the normative systems perspective as proposed for instance in [20, 18]. According to this view institutions are normative systems, and hence normatively specifiable. From this standpoint, a normative system specification describes an institutional form. Obviously, in such a perspective deontic logic is the most natural formal tool ([20, 17]).
– The second one considers institutions from a procedural point of view, stressing the agency part of them. In this sense institutions consist in the procedures an agency is organized with,

and can therefore be specified through procedures descriptions. In this perspective institutions are described as organizations, leaving the norm complying issue apart. This specification is no more normative, it is simply an algorithm-like description. Consequently no deontic logic is of use at this level.

The connection between these two ways of specifying institutions is of definite relevance in relation with the main problem at issue here. It nevertheless forms a separate issue which will not be explicitly dealt with in this paper (see [9] for some first thoughts on this topic).

In this paper we will instead pursue the first line of analysis of institutions, focusing predominantly on formal aspects characterizing exclusively *institutional forms*[2]. We thus state this preliminary informal definition:

Definition 1. (Institutions as Normative Systems)
An institution I is a theory containing deontic conditionals and supervenience conditionals.

In the remainder of the paper we will expand and elaborate upon this first heuristic definition. In particular, we will address a formal characterization of deontic and supervenience conditionality, and following on that characterization we will make clear what kind of logic underlies the notion of theory contained in the definition.

3 Abstract and concrete normative specifications

The issuing of norms as it appears in various statutes or regulations specifying constraints over specific institutions has the characteristic of stating norms at an "abstract" level. The reason for this abstractness comes from the fact that one would like these norms to hold for a large range of situations and be stable for a long period of time. The more vague they are, the easier it becomes to keep them stable. The downside of this abstractness is that norms seem to be less well defined. In law it is even an explicit task of the judges to interpret the law for specific situations and determine whether someone violated it or not.

It is our thesis that abstract and concrete concepts are described in different ontologies. The concrete norms will be described in terms of the concepts that are used to describe (possible) procedural descriptions of the concrete institutions. The abstract levels are described using a more general ontology.

In order to formalize institutions it would be easier to model only those norms that are concrete. They being specified on the same ontology on which the procedures themselves are specified, it is easier to verify whether an organization fulfills all the norms specified by the institution. So, why use abstract norms at all?

- First of all, practice forces us to take them into account. Usually institutions are specified informally, at a very abstract and general level. Moreover, institutions are often rooted in broader normative domains which are intrinsically abstract (like national or even international laws and regulations).

- Secondly, as said above, abstract norms are more stable than the concrete ones. Therefore, it seems good methodology to specify the institution starting from these more stable norms, constituting a kind of normative core of the institution itself.

- Thirdly, representing abstract norms allows for easily grounding relationships among different institutions: different institutions may happen to share a common set of (abstract) norms, bringing them to different concretizations (see Section 5). This is the case, for instance, of two different hospitals which, despite obeying the same national regulation concerning organ

[2] The formal analysis of *organizations*, i.e. procedural description of agencies, is therefore left aside in this work. In what follows, unless stated otherwise, we will use the terms institution and institutional form interchangeably.

transplantation, may be endowed with different set of (concrete) norms regulating the obtainment of the consent of a living donor.

– Fourthly, the more abstract norms are, the easier the logical formalism can be to specify them. If we abstract away from things like temporal aspects, the logic also does not have to be able to represent them. We can thus, in principle, use different formalisms to specify the different levels of abstract norms. On each level we can check consistency of norms and their possible consequences.

Thirdly, the more abstract norms are, the easier the logical formalism can be to specify them. If we abstract away from things like temporal aspects, the logic also does not have to be able to represent these aspects. We can thus, in principle, use different formalisms to specify the different levels of abstract norms. On each level we can check consistency of norms and their possible consequences.

Given the above considerations, we have come to the conclusion to deal with (abstractness) levels in terms of a notion of *contextuality*: each level within an institution is seen as a separate context. Each state of affairs, which is relevant for the institution, is considered to hold at a level, and in this sense to be contextualized with respect to that level: for example, the consenting of a living donor is something that, within an institution, is treated only as holding at a precise level.

3.1 Levels of abstractness

Before presenting a proposal to formally capture the notion of level/context we have in mind, it is necessary to single out, in further details[3], the features of this concept we would like to be able to express in our formalism.

1. In our view, levels constitute a structure ordered according to the relation "i is strictly less abstract than j". This relation is, reasonably, irreflexive, asymmetric and transitive. Moreover, it seems intuitive to assume it to be partial. There might be levels i and j both strictly less abstract than a given level k, but such that they remain unrelated with respect to each other.
2. Levels are such that what holds in a level holds irrespectively of the level from which that fact is considered: if at level i the donor expresses his/her consent, then at level j it holds that at level i the donor expresses his/her consent and vice versa.
3. No inconsistency holds at any level, levels are coherent.
4. Finally, there exists a trivial "outermost level", representing the absence of context, that is, the level of logical truths.

To capture this features we use a KD45 multi modal logic corresponding to a propositional logic of contexts (PLC) with: consistency property (corresponding to feature 3), flatness property (feature 2), outermost context (feature 4) and total truth assignments (see [4, 6, 7])[4].

The alphabet $\mathbb{A}$ of the system is an expansion of that of propositional logic and is defined as follows:

$$\mathbb{A} := \{\neg, \wedge, \vee, \rightarrow\} \cup \mathbb{P} \cup \{\Box_i\}_{i \in L}$$

where L is the set of indexes denoting levels of abstractness. We define a partial ordering Abs on L: $Abs \subseteq L \times L$. We will write $i < j$ for $(i, j) \in Abs$ This ordering is irreflexive, asymmetric and transitive and its intuitive reading is: $i < j$means that i is less abstract than j (feature 1).

[3] Notice that these are precisely the properties also of the *conventional generation* relation analyzed in [14].

[4] We deemed a multi modal formalism to be better readable than a propositional context logic one. This is the reason why we chose for using a modal logic formulation instead of a contextual logic one. The correspondence result we claimed is guaranteed by results proved in [6]. A word must be spent also about the use of propositional context logic with total truth assignments. In fact, partial truth assignments are one of the most relevant features of context logics as introduced in [6, 7]. However, it has been proved in [4] that every propositional context logic system with partial truth assignments is equivalent to one with total truth assignments. For this reason this aspect has been here disregarded.

The set of well formed formulas $\mathbb{F}$ is defined as follows:

$$\mathbb{F} := \mathbb{P} \cup (\neg\mathbb{F}) \cup (\mathbb{F} \wedge \mathbb{F}) \cup (\mathbb{F} \vee \mathbb{F}) \cup (\mathbb{F} \rightarrow \mathbb{F}) \cup (\Box_i\mathbb{F})$$

The axiomatization is the following one[5].

$$\Box_i(A \rightarrow B) \rightarrow (\Box_i A \rightarrow \Box_i B) \quad (1)$$
$$\neg\Box_i\bot \quad (2)$$
$$\Box_i A \rightarrow \Box_j\Box_i A \quad (3)$$
$$\neg\Box_i A \rightarrow \Box_j\neg\Box_i A \quad (4)$$

Axioms 1 and 2 are the usual modal logic axioms K and D. Axioms 3 and 4 are multi modal versions of the axioms known as 4 and 5. The system at issue is then a multi modal homogeneous $KD45$ with the two interaction axioms 3 and 4 ([11]).

As a semantics for this system we can use very simple models $M = (W, L, c, v)$ such that for every level of abstractness (or context) $i \in L$ function c associates a non-empty subset of W ($c : L \longrightarrow Pow^+(W)$), v is the usual valuation function assigning truth values to propositions in worlds. Using these models we can define the semantics of the levels of abstractness as follows:

$$M, w \vDash \Box_i A \textbf{ iff } \forall w' \in W_i : M, w' \vDash A$$

Notice that the truth value of $\Box_i A$ does not depend on the world where it is evaluated. This reflects the intuition that whether A is true at level i does not depend on the place from which you evaluate it. It only depends on the truth of A in that specific level (in this precisely consists the aforementioned flatness property). The same feature is captured by axioms 3 and 4. Notice also that axioms K and D are valid with respect to this semantics [6].

Another thing worth noticing is that the ordering of the levels does not play any role in the semantics. One could imagine that the ordering on L imposes an ordering on the sets W_i. E.g. $i < j \Rightarrow W_i \subseteq W_j$. This would imply the following axiom:

$$\Box_j A \rightarrow \Box_i A \text{ iff } i < j$$

i.e. a kind of inheritance from more abstract levels to more concrete levels. We have chosen not to include this property because it would impose many restrictions on the relation between levels, which are not really necessary. We will come back to this point in the conclusions where we will indicate some ideas about more subtle relations between levels of abstractness. We do, however, connect the levels by defining explicit relations between levels in which we state that some formula is a more concrete formulation of another formula. We claim this relation to be the exact content of what the classifying components of normative systems express, and we therefore use the supervenience conditional to describe it.

3.2 Connecting different levels using the notion of supervenience

Informally B *supervenes to* A iff A at level i determines the truth of B at level j, where $i < j$. Using the arrow introduced in [13], we formally represent our definition as follows: $\Box_i A \Rrightarrow \Box_j B$.

E.g. Consenting (in the context of transplant regulations) *supervenes to* signing form 32 (in a specific hospital), means that when form 32 is signed in the hospital then consent has been given according to the transplant regulations.

Before trying to give a formal definition of supervenience we will first explore the features that we intuitively expect this relation to have in our perspective. Some of these features were hidden behind the expression "determines". In this section we try to single out all these relevant features.

---

[5] For a more exhaustive exposition see Section 4.

[6] It can be proved that validity on these models is equivalent to validity on standard models for multi modal $KD45$. The result follows once our models are interpreted as standard Kripke models with a family of accessibility relations R_i such that wR_iw' iff $w' \in c(i)$.

Supervenience relation seems to exhibit a property according to which, intuitively, if consenting supervenes on signing a document, this does not imply that consenting supervenes on signing that document and burning it,nor that consenting or apologizing supervenes on signing that document. The point is that "only" consenting supervenes on "only" signing the document, that is to say that laws of strengthening the antecedent and of weakening the consequent are not appropriate for modelling supervenience conditional. It is really important to note that this inadequacy of the law of strengthening the antecedent does not depend on defeasibility issues, but simply on the same reasons that make the strengthening of the consequent unsound for material implication. The point is that supervenience seen as a conditional seems to imply somehow a sort of bi-conditionality. This characteristic is not indeed so surprising, because this supervenience link is often understood as a kind of definition (see e.g. [3]) and according to some even implies a normative conditionality in a reversal form: if B supervenes on A then, somehow, it ought to be the case that if B then A (see [20]).
We do not concur with this view because the same thing can supervene on several different things. And of course two or more supervenience conditionals cannot all be seen as definitions at the same time. They rather seem to imply, together, a definition having as antecedent the disjunction of the antecedents of the different conditionals. If consenting supervenes on signing a document, and it supervenes also on signing via internet an e-form but on nothing else, then signing a document or e-signing imply consenting and conversely consenting implies signing or e-signing. We give right below a rough and naive representation of these considerations.

$$\text{if } \Box_i A \Rrightarrow \Box_j B \text{ then } \Box_i A \rightarrow \Box_j B$$
$$\text{if } Only(\Box_i A \Rrightarrow \Box_j B) \text{ then } \Box_j B \rightarrow \Box_i A$$

The relevant aspect worth stressing here is that what can be derived from a supervenience conditional depends on the presence of other different relations of that kind. The *Only* operator indicates that no other supervenience relations exist with the same consequent. Notice that this behavior closely resembles Clark's closure used to complete logic programs ([8]).

Another basic feature is defeasibility. This depends on the fact that different supervenience conditionals could have contradictory consequents. Reconsidering the previous example, it can be the case that retaining consent supervenes on signing a document and subsequently signing a document of annulment. The law of strengthening the antecedent does therefore not hold for supervenience conditionals also for defeasibility reasons:

$$\text{not if } \Box_i A \Rrightarrow \Box_j B \text{ then } \Box_i(A \wedge C) \Rrightarrow \Box_j B$$

A law reasonably holding for our conditional is instead at least a weak form of transitivity.

$$\text{if } \Box_i A \Rrightarrow \Box_j B \text{ and } \Box_j B \Rrightarrow \Box_k C \text{ then if } \Box_i A \text{ then } \Box_k C$$

A pure form of transitivity does not instead seem straightforward. The point is that if $\Box_i A \Rrightarrow \Box_j B$ and $\Box_j B \Rrightarrow \Box_k C$, a derivation from $\Box_i A$ to $\Box_k C$ is subjected to a double chance of being defeated, differently from derivations from $\Box_i A$ to $\Box_j B$ and from there to $\Box_k C$ considered in isolation. Similar considerations can be found in the literature about transitivity of deontic defeasible conditionals (see for example [27]).

3.3 Supervenience, institutional and abstract states of affairs

The notion of supervenience we use here shares many similarities with the notion of counts-as first introduced in [31] and then formally discussed in [19, 13] and [31]. In this section we briefly summarize these approaches trying to single aspects out which might be relevant for our purposes.

The notion of counts-as, as presented in the aforementioned works, is strictly linked to those of *concrete fact*, or non institutional fact, and *institutional or institutionally significant fact*, i.e. a fact that holds not unconditionally but only within an institution ([19]). In [19] counts-as is a non normal conditional for which the following principle holds:

$$A \Rightarrow_s B \rightarrow D_s(A \rightarrow B). \tag{5}$$

where D_s is a normal D modality expressing the idea that something holds institutionally within s.

In [13] counts as is defined as follows:

$$A \Rightarrow_s B =_{def} A \Rrightarrow D_s B \wedge D_s A \Rrightarrow D_s B. \quad (6)$$

where $\Rrightarrow$ is a defeasible conditional and D_s is a non normal modality.

Both 5 and 6 see the counts-as as somehow connecting an antecedent which is non-institutional to a consequent that is an institutional state of affairs.

We deem this link to be essential also for understanding supervenience, and we therefore follow at some extent this view, but instead of considering the antecedent of a supervenience conditional to be a non-institutional fact, we consider it to be a formula at a more concrete abstraction level. The most concrete level could be seen as a state of affairs which does not seem to need any institution in order to hold, like e.g. "signature of a particular document". This is true but it nevertheless may be seen as holding within an institution if there is an institution containing a rule stating that something else supervenes to that state of affairs. In this sense we consider it an institutional fact, even if it could perfectly hold also in case no institution would exist at all. The point is that this state of affairs is, in our perspective, institutional but not constituted, i.e. concrete. It is important to note that in [19] an axiom is stated, which expressed a similar idea: $(A \Rightarrow_s B) \rightarrow (A \rightarrow D_s A)$. This axioms says exactly that, if there is a counts-as linking A to B, then if the "concrete fact" A occurs, then also the "institutional fact" A occurs.

A supervenience conditional is then, in our view, a sort of counts-as operating between levels of abstractness within a specific institutional form. For this reason it makes sense to represent it, as we already did in section 3.2, as an object of this kind: $\Box_i A \Rrightarrow \Box_j B$ (where i and j are level of abstractness indexes). Contextualization of the supervenience relation to one or more institutional forms is straightforwardly achieved via levels of abstractness: the supervenience relation holding between two levels is part of the institutional forms those levels belong to.

3.4 Formalizing supervenience

In this section we present a formal account for the conditional $\Rrightarrow$, so far only informally introduced, using normal prioritized default logic ([12, 2]), and, on that basis, a formalization of supervenience.

Theoretically, our proposal is to understand the supervenience link as a *bridge rule* in the sense of theory of contexts (see for example [5]). Supervenience link connects truth among different levels of abstractness, and more precisely from more concrete to more abstract levels. It can be modelled therefore as a rule operating on the platform, so to say, of the abstractness layering depicted in Section 3, which, given a fact at a certain level, establishes, in a defeasible way, a fact on a more abstract one.

On the ground of these considerations, we propose to treat $\Rrightarrow$ as a normal default.

Definition 2. (Supervenience Conditionals)
Supervenience conditionals are defined as follows:

$$\Box_i A \Rrightarrow \Box_j B \quad =_{def} \quad \Box_i A \rightsquigarrow \Box_j B \quad \textit{with} \quad i < j.$$

Here "$\Box_i A \rightsquigarrow \Box_j B$" is a shorthand for $\Box_i A : \Box_j B / \Box_j B$, i.e. a normal default, the meaning of which is that the truth of B can be derived on level j from the truth of A at level i if the truth of B on level j is not leading to an inconsistency. This account has several advantages: it has a clear theoretical grounding; it enables easy non monotonic derivations (the defeasibility requirement is then fully met); it enables the kind of transitivity we required; it can rely on a broadly investigated logic. Thus, the fact that "signing form 32" is a way of "consenting for organ donation" in a certain hospital can now be formally represented as:

$$\Box_i signing\_form\_32 \rightsquigarrow \Box_j consent$$

where i is a more concrete level of abstraction within the institution of "hospital" than j.

In order to deal successfully with defeasibility we also need to define an explicit prioratization on the set of defaults being supervenience conditionals liable to conflict:

$$d_1 : \Box_i A \rightsquigarrow \Box_j B$$
$$d_2 : \Box_i (A \wedge C) \rightsquigarrow \Box_j \neg B$$

One prioratization criterion is that more specific defaults have the precedence according to a strict partial ordering. So, this means $d_2 \prec d_1$.

Note that this prioritization orders only conflicting defaults such that either the prerequisites of the first imply the prerequisites of the second or vice versa. It does not supply a tool for deciding among conflicting defaults the prerequisites of which are logically unrelated. It may be useful, for example, to include a prioritization based on concreteness of the antecedent. This can be used in the following case:

$$d_1 : \Box_i A \rightsquigarrow \Box_j B$$
$$d_2 : \Box_k A \rightsquigarrow \Box_j \neg B$$
$$k \prec i$$

Also in this case we have that $d_2 \prec d_1$. We refer the case where one rule is more specific and the other is more concrete to further research.

We deem important to stress that specificity and concreteness are only two of the many ways of deciding about conflicting defaults. If the contents are norms we mention specifically authority hierarchies on the agents issuing the norms and the time of enactment of a norm ([27]). The specificity and concreteness criteria should therefore only be seen as examplifying this range of criteria.

We have now specified how the different levels of abstractness can be connected using the supervenience link. However, we have not defined any limitation to the occurrance of this link which is based on the content of antecedents and consequents. It would be perfectly right to state:

$$\Box_i killing\_donor \rightsquigarrow \Box_j consent$$

saying that killing the donor is a way of getting consent. This is certainly not how we would like the hospital to fill in the abstract terms! In order to avoid these types of supervenience one should somehow constrain the link to cases where the semantics of the antecedent and consequent can be linked in a "correct" way. However, it seems not easy to specify these restrictions within our current approach and we therefore refrain from doing so in this paper, but only mention some ideas in the conclusions.

3.5 Norms

Having defined levels of abstractness and their relations in the previous section, we now turn to defining the norms themselves that operate on levels.

We use a formalization of conditional norms obtained by mixing standard deontic logic (SDL) and normal default logic as proposed in [27].

First we have to expand the language of our multi modal $KD45$ introducing deontic expressions. We allow deontic modalities to operate only within $\Box_k$-formulas and we do not allow deontic operators to have $\Box_k$ formulas in their scope if they are not under the scope of another $\Box_k$-operator. Intuitively we do not want deontic operators to occur if not in the scope of a $\Box_k$-operator. This to capture the idea according to which normative consequences of certain conditions are supposed to be always holding at certain levels of abstractness: normative consequences are always localized. The set $\mathbb{F}$ of well formed formulas is then defined as follows:

$$\mathbb{F} := \mathbb{P} \cup (\neg\mathbb{F}) \cup (\mathbb{F} \wedge \mathbb{F}) \cup (\mathbb{F} \vee \mathbb{F}) \cup (\mathbb{F} \rightarrow \mathbb{F}) \cup (\Box_i \mathbb{F}) \cup (\Box_i O(\mathbb{F}))$$

Adding SDL to multi modal $KD45$, a multi modal heterogeneous logic without interaction axioms between O-operator and $\Box_k$-operators is obtained ([11]). The Kripke model that determines the semantics is consequently expanded with a serial ideality relation R.

Definition 3. (Semantics of O-operator)
The semantics of obligations is defined as usual:
$M, w \vDash \Box_i O(A)$ **iff** $\forall w' \in W_i, \forall w'' \in W : R(w', w'') \Rightarrow M,'' \vDash A$

We can define permission (P) and prohibition (F) in the standard way in terms of obligation: $P(A) \equiv \neg O(\neg A)$ and $F(A) \equiv O(\neg A)$.

Definition 4. (Conditional Obligations)
Conditional obligation is defined as follows:

$$\Box_i(O(A|\Box_j B)) \quad =_{def} \quad \Box_j B \rightsquigarrow \Box_i O(A)$$

Conditional permission and prohibition are easily defined by replacing the O operator by the P and F operator respectively. All remarks underlined in Section 3.4 about prioritization for defaults formalizing supervenience conditionals hold also for defaults formalizing conditional norms.

Given the above definition we can describe the norm that a hospital, if it wants to perform a transplant, it has to get consent from the donor as follows:

$$\Box_i(O(consent|\Box_i transplant))$$

Note that we abstracted away from the agents in the consent. So, at a more concrete level j, the same norm could be described as:

$$\Box_j(O(consent(donor, hospital)|\Box_i transplant))$$

and if we also fill in the agents for the transplant:

$$\Box_j(O(consent(donor, hospital)|\Box_j transplant(hospital, donor, recipient)))$$

At this point, it is worth remarking that supervenience conditionals and conditional norms share the same type of defeasibility. This representational choice captures an important analogy which we deem to subsist between the two types of rules composing institutions:

- Supervenience conditionals *connect* truth on a level to truth on a more abstract level, and this connection takes place, so to say, at an outermost level and in a defeasible way.
- Conditional norms *connect* truth on a level to ideality on another, possibly the same, level, and also this connection takes place defeasibly and at an outermost level.

That *connect* is what they share and what we here represented by means of normal defaults [7].

4 The Logical Framework

In this section we summarize the formal framework we sketched, providing a rigorous exposition of it.

Language. The language is a propositional logic language expanded with an O-oparator and a set of indexed $\Box_k$-operators. Well found formulas are defined as follows:

$$\mathbb{F} := \mathbb{P} \cup (\neg\mathbb{F}) \cup (\mathbb{F} \wedge \mathbb{F}) \cup (\mathbb{F} \vee \mathbb{F}) \cup (\mathbb{F} \rightarrow \mathbb{F}) \cup (\Box_i \mathbb{F}) \cup (\Box_i O(\mathbb{F}))$$

For the reason why we do not admit $O\Box_k$ formulas (see Section 3.5).

Semantics. Models are structures of this kind: $\mathcal{M} = (W, L, R^O, c, v)$ where:

[7] In this respect, our approach is close to the proposal in [13], though we carried it out by means of different formal tools.

- W is the set of worlds;
- L is the set of levels of abstractness or contexts;
- R^O is a serial accessibility relation defined over W;
- c is a function s.t. $c : L \longrightarrow Pow^+(W)$;
- v is the usual evaluation function s.t. $v : \mathbb{P} \times W \longrightarrow \{1, 0\}$.

The meaning of a formula in a world w in structure $\mathcal{M}$ is defined as follows:

$$\begin{array}{rcl} \mathcal{M}, w \models p & iff & v(w,p) = 1 \\ \mathcal{M}, w \models \neg A & iff & \mathcal{M}, w \not\models A \\ \mathcal{M}, w \models A \wedge B & iff & \mathcal{M}, w \models A \;\&\; \mathcal{M}, w \models B \\ \mathcal{M}, w \models OA & iff & \forall w' \in W, wR^O w' \Rightarrow \mathcal{M}, w' \models A \\ \mathcal{M}, w \models \Box_k A & iff & \forall w' \in c(k), \mathcal{M}, w' \models A. \end{array}$$

Validity of a formula on a structure and general validity of a formula are defined as usual.

Axiomatization. The axiomatization contains a $KD45$ system extended with KD and without interaction axioms.

$$\begin{array}{ll} (A1) & \text{all tautologies of propositional calculus} \\ (A2) & \Box_i(A \rightarrow B) \rightarrow (\Box_i A \rightarrow \Box_i B) \\ (A3) & \neg\Box_i \bot \\ (A4) & \Box_i A \rightarrow \Box_j \Box_i A \\ (A5) & \neg\Box_i A \rightarrow \Box_j \neg\Box_i A \\ (A6) & O(A \rightarrow B) \rightarrow (OA \rightarrow OB) \\ (A7) & \neg O\bot \\ (R1) & \dfrac{A \quad A \rightarrow B}{B} \\ (R2) & \dfrac{A}{\Box_i A} \\ (R3) & \dfrac{A}{O\ A} \end{array}$$

This system constitutes the logical basis on which to define the normal default theory we claim to formalize deontic and supervenience conditionals, that is a structure:

$$\langle F, D, \prec \rangle$$

where F is a (possibly empty) set of assumptions, D is a set of defaults, $\prec$ is a priority ordering on defaults of D. Notice that default theories we are interested in contain two types of normal defaults, namely: $\Box_i A \rightsquigarrow \Box_j B$ with $i < j$, and $\Box_i A \rightsquigarrow \Box_j O\ B$.

On the ground of the framework just exposed, we can state formal definitions of abstractness and concreteness of norms.

Definition 5. (Concrete Norms)
A concrete norm is a default $\Box_i A \rightsquigarrow \Box_j O\ (B)$ s.t. there is no default $\Box_h C \rightsquigarrow \Box_k D$ with $h < k$ s.t. $A \equiv D$ and $i = k$ or $B \equiv D$ and $j = k$.

Definition 6. (Abstract Norms)
An abstract norm is a non concrete norm.

In the next section we discuss a partial solution to the main topic of this work, i.e. the problem of concretization of abstract norms.

5 Concretizing abstract norms

Let us first recall what we mean by "concretizing" a norm. The problem of concretization of norms can be divided in the two subproblems *abstract condition problem* and *abstract content problem.* These two problems correspond to the two relations between norms at different levels singled out in Section 2.1. We can informally describe those relations now as follows:

$$\frac{\Box_i A \Rrightarrow \Box_j B \ , \ \Box_k(O(C|\Box_j B))}{\Box_k(O(C|\Box_i A))} \quad \text{and} \quad i < j$$

$$\frac{Only(\Box_i A \Rrightarrow \Box_j B) \ , \ \Box_j(O(B|\Box_k C))}{\Box_i(O(A|\Box_k C))} \quad \text{and} \quad i < j$$

We concretize a norm with respect to its condition when, by means of a supervenience link, we can obtain the same normative consequence from a more concrete fact. Respectively we concretize a norm with respect to its content when, again by means of a supervenience link we can obtain from the same condition a normative consequence with a more concrete content. A norm is concrete when there is no supervenience conditional enabling any concretization of either the condition or the content of the norm.

The first inference above is formally treated in the following way. Given defaults $d_1 := \Box_i A \rightsquigarrow \Box_j B$ and $d_2 := \Box_j B \rightsquigarrow \Box_k O(C)$, we obtain the following default proof[8]:

$$\begin{array}{ll} \text{Ass.} & \Box_i A \\ \text{by } d_1 & \Box_j B \\ \text{by } d_2 & \Box_k O(C) \end{array}$$

Note that this proof exhibits exactly the kind of weak transitivity we observed in Section 3 but chaining a supervenience conditional and a norm.

Let us consider an example taken again from [22].

> Only authorized hospitals have the permission to carry out organ donations from living donors. Hospitals accomplishing quality criteria stated in Art. 11 count as authorized hospitals. Consequently, if an hospital accomplishes those criteria, then it is permitted to carry out organ donations from living donors.

This case would be represented as follows. Given defaults

$$\Box_j \ authorized\_ \ hospital) \rightsquigarrow \Box_k P \ donation \tag{7}$$

$$\Box_i \ hospital\_ \ accomplish\_ \ art.11 \rightsquigarrow \Box_j \ authorized\_ \ hospital \tag{8}$$

and given that $i < j$, it follows that:

$$\begin{array}{rl} Ass. & \Box_i \ hospital\_ \ accomplish\_ \ art.11 \\ by(8) & \Box_j \ authorized\_ \ hospital \\ by(7) & \Box_k \ P \ donation \end{array}$$

What precisely happens in such cases is that, through a supervenience link, we can apply the norm at a more concrete level obtaining the same normative consequence from a more concrete condition.

The second relation described at the beginning of this section cannot yet be handled in our framework. For doing this we need to provide a characterization of the *Only* operator used in this inference [9].

---

[8] Notice that we are using normal defaults, for which a definition of the notion of proof is possible (see [12]).

[9] Notice that this behavior closely resembles Clark's closure used to complete logic programs ([8]).

6 Institutions defined formally

In the previous sections we introduced a conceptual framework connecting all the components that we claim to constitute an institution (Sections 2 to 3), and a comprehensive formal analysis of them (Section 4). We are now in a position to give a formal definition of the concept of institution in terms of these components.

We claimed institutions to be normative systems representable as theories of deontic and supervenience conditionals (see Section 2.2 and Defintion 1). In this section we show how to understand institutions as normal prioritized default theories.

Before getting to the exact definition we are looking for, another problem should be considered, that is: how to relate institutions and levels of abstractness. Basically this problem might be restated as follows: at what level of abstractness does the institution end? If one includes only the levels explicitly specified for the institution, then the norms possibly coming from more abstract levels would not come to belong to the institutional theory. I.e. if $i < j$ and j is a level that does not belong to the institution then the norms operating on level j also are not "inherited" by the institution.

On the other hand, incorporating all levels of abstractness connected to the levels explicitly defined within the institution through the ordering between levels would include the complete institutional context the institution is merged in.

We therefore choose to propose two definitions, one corresponding to an "explicit" view on institutional theories and one corresponding to the "implicit" one.

Let L_I be the set of levels of abstractness institution I operates on. Let then Abs_{L_I} be the sub-ordering of Abs on L_I (see Section 3.1)

Definition 7. (Explicit Institutional Theories)
An explicit institutional theory I^{expl} is defined as a triple $(N_I, C_I, \prec)$ where:

$$N_I \equiv \bigcup_{i,j \in L_I} N_{(i,j)}$$

being $N_{i,j} \equiv \{d/d = \Box_i A \rightsquigarrow \Box_j O\ B\}$. And where

$$C_I \equiv \bigcup_{i,j \in L_I} C_{(i,j)}$$

being $C_{i,j} \equiv \{d/d = \Box_i A \rightsquigarrow \Box_j B\}$ The third element of the triple consists in the prioritization ordering $\prec$ on defaults in N_I and C_I.

Intuitively, an institution is described as the set of all normative and supervenience defaults defined between the levels explicitly belonging to that institution.

Definition 8. (Implicit Institutional Theories)
An implicit institutional theory I^{impl} is defined as a triple $(N*_I, C*_I, \prec)$ where:

$$N*_I \equiv N_I \cup \{N_{(k,l)}\}$$

for each couple (k, l) with $k, l \in L$ s.t. $\exists j \in L_I, j < k$. And where

$$C*_I \equiv C_I \cup \{C_{(k,l)}\}$$

for each couple (k, l) with $k, l \in L$ s.t. $\exists j \in L_I, j < k$. The third element of the triple consists in the prioritization ordering $\prec$ on defaults in N_I and C_I.

Intuitively, an implicit theory of an institution I is nothing but a sort of closure of the explicit theory I^{expl} of I along the abstractness ordering $<$, leading the explicit theory to incorporate every deontic and supervenience conditional operating between more abstract levels than the levels explicitly belonging to I.

Let's consider a simple example. In order to extract an organ from a living donor each hospital in Spain ought to ascertain the legal age of the donor. The state of affairs $legal\_age$ is not a concrete one; let the level of abstractness it holds on to be S_3. The institution "hospital in Spain" I_S inherits a rule from Spanish general law according to which $legal\_age$ supervenes on $being\_eighteen\_years\_old$. Neither this last state of affairs can be properly seen as concrete; let its level be S_2. Then the institution "Valencia hospital" I_V contains another rule according to which $being\_eighteen\_years\_old$ supervenes on $ID\_testifies\_legal\_age$. This can be deemed as concrete; let its level be S_1. We then have three ordered levels and two institutions constituted by rules operating on those levels. One institution is general, namely I_S, and it operates between levels S_1, S_2 and S_3, the other, namely I_V, is more particular and it operates between S_1 and S_2.

Theory I_S^{expl} would be a triple $(N_S, C_S, \prec)$ such that:

$$\Box_{S_1} extract \leadsto \Box_{S_2} O\ (being\_eighteen\_years\_old) \in N_S,$$
$$\Box_{S_2} being\_eighteen\_years\_old \leadsto \Box_{S_3} legal\_age \in C_S$$

Theory I_S^{expl} would instead be a triple $(N_V, C_V, \prec)$ such that, basically:

$$\Box_{S_1}\ (ID\_testifies\_legal\_age) \leadsto \Box_{S_2}(being\_eighteen\_years\_old) \in C_V.$$

To understand the sense of this rule in the context of I_V it is necessary to consider the explicit account I_V^{impl} of this institution: $(N{*}_V, C{*}_V, \prec)$. We then obtain what follows:

$$\Box_{S_1} extract \leadsto \Box_{S_2} O\ (being\_eighteen\_years\_old) \in N{*}_V,$$
$$\Box_{S_2} being\_eighteen\_years\_old \leadsto \Box_{S_3} legal\_age \in C{*}_V$$

This means that I_V^{impl} and I_S^{expl} share something: in this case $N *_V \cap N_S \neq \emptyset$ and $C *_V \cap C_S \neq \emptyset$. This exactly shows how I_V inherits rules from I_S, and more noticeably how I_V concretizes, with respect to the abstract condition problem (see Section 5), norms belonging to I_S by means of supervenience conditionals.

7 Reasoning with Institutions

In this section we show how our formal approach to institutions, that led to Definitions 7 and 8, can be straightforwardly merged in formal argumentation frameworks specifically developed to account for legal reasoning, such as [30, 26, 28]. This will show some guidelines on how to enable articulate reasoning patterns within our approach.

Logical systems for argumentation formalize "a particular group of patterns of inferences, namely those where arguments for and against a certain claim are produced and evaluated, to test the tenability of the claim" ([29]).

In [30] an argumentation framework is presented, which is based on normal default logic and which accounts for reasoning with both what we called, in Section 2, regulative and classificatory components of normative systems (respectively norms and rules in their terminology). In this work no attention is given to the issue of abstractness and concreteness of norms, and consequently the logic on which default theories are built upon is just a SDL. Defaults are therefore rules of this type: $A \leadsto B$ and $A \leadsto O\ B$. Within this setting, the central concept on which the argumentation system is established is the concept of *deontic context*.

Definition 9. (Deontic Context)
A deontic context $\mathcal{T} = (F, N, C, \prec)$ consists of a set F of propositional sentences; a set N of normal defaults of the type $A \leadsto O\ B$; a set C of normal defaults of the type $A \leadsto B$; and a prioratization ordering $\prec$ over defaults.

Once assumed the multi-modal system exposed in Section 4 as the logic on which to apply normal defaults, and recalling Definitions 7 and 8, Definition 9 can be adapted to our approach and modified as follows.

Definition 10. (Deontic Institutional Contexts)
A deontic explicit institutional context $\mathcal{I}^{expl} = (F, I^{expl})$ *consists of a set* F *of propositional sentences, and an explicit institutional theory* I^{expl}*. A deontic implicit institutional context* $\mathcal{I}^{impl} = (F, I^{impl})$ *consists of a set* F *of propositional sentences, and an implicit institutional theory* I^{impl}*.*

By means of these notions of deontic institutional contexts, scenarios in which an institution I is make operative on the set of facts F can be formalized: through I normative consequences at different levels of abstractness can be defeasibly established from F. In order to get a fully working argumentation system further conceptual machinery should be added, namely definitions of: the notion of *argument*, the notion of *conflict* and *defeating* between arguments, the notion of *defeasibility chain*, and the notions of *justified*, *defensible* and *overruled* arguments[10]. For this issue we refer to the aforementioned [30].

Analogous observations can be carried out in relation with the argumentation framework for legal reasoning presented in [26, 28], which is also based on normal default logic and therefore, in principle, perfectly suitable to handle our notion of institutional theory.

8 Conclusions

In this paper we have presented a first comprehensive formal approach to institutions that caters for both abstract and concrete norms. What is most important is that a formal account for the link between abstract and concrete norms has been proposed, such that it becomes possible to verify, given a certain institution, whether the concrete norms are actually in accordance with the abstract ones, and whether those abstract norms meet an effective translation in concrete terms.

However, although we have specified a link between the abstract and the concrete levels, we have not defined any restrictions on this type of link. We showed the possibility to constrain this link to be intuitively necessary: now, within our approach, it would be possible to define the killing of a donor as a way of getting his/her consent, which would sound ominously odd. This issue is, however, of an ontological nature rather than of a logical one: logically speaking nothing prevents from stating a rule of the just mentioned kind. The restriction seems rather to lie on the objects themselves, which are involved in the rule. A line we deem worth pursuing in future works consists in using formal ontological descriptions to define the concepts occurring on the different levels. On this basis, supervenience conditionals would be used as a kind of specialization relation which respects relevant ontological constraints: killing the donor cannot be a way of obtaining his/her consent because the concept of "consenting" never implies the death of the consenter.

For future work, this aspect will be the first to expand, together with the attempt to solve the *abstract content problem* (see Section 5).

References

1. C. E. Alchourrón, E. Bulygin *Normative Systems*. Springer Verlag, Wien, 1971.
2. G. Antoniou. *Nonmonotonic Reasoning*. MIT Press, Cambridge, 1997.
3. T. Bench-Capon, G. Robinson, T. Routen, M. Sergot *Logic Programming for Large Scale Application in Law*. In Proc. of the 1st Int. Conference on AI and Law, Boston, 1997, pp. 190-198.
4. P. Bouquet, L. Serafini *Two Formalizations of Context: a Comparison*. In Akman V., Bouquet P., Thomason R., Young R. *Modeling and Using Contexts*. LNAI 2116, Springer, Berlin 2001.
5. P. Bouquet, E. Giunchiglia, F. Giunchiglia *Contexts, Locality and Generality*. Mathware and Soft Computing 3, 1992.
6. S. Buvač, V. Buvač, I. A. Mason. *The Semantics of propositional Contexts*. In *Proceedings of the eight ISMIS*. LNAI-869, Springer, 1994, pp. 468-477.
7. S. Buvač, I. A. Mason. *Propositional Logic of Context*. In *Proceedings AAAI'93*. MIT Press, Washinghton DC, 1993, pp. 412-419.
8. K. Clark *Negation as Failure*. In Gallaire H., Minker J. (eds.) *Logic and Databases*. Plenum Press, New York, 1978, pp. 293-322.

[10] For an exhaustive account of the role of these concepts in argumentation logics we refer to [29]

9. F. Dignum *Abstract Norms and Electronic Institutions*. RASTA workshop, Bologna, 2002.
10. F. Dignum *Agents, Markets, Institutions and Protocols*. In Dignum F., et.al. (eds.) *AMEC, The European Agent Link Perspective*, LNCS-91, Springer, pp. 98-114.
11. L. Farinas del Cerro, A. Herzig *Modal Deduction with Applications in Epistemic and Temporal Logics* In Gabbay D., et.al. (eds.) *Handbook of logic in AI and Logic Programming, VOL. 4*, Oxford University Press, Oxford, 1995, pp. 499-595.
12. H. Geffner *Default Reasoning: Causal and Conditional Theories*. MIT Press, Cambridge, 1990.
13. J. Gelati, G. Governatori, A. Rotolo, G. Sartor *Actions, Institutions, Powers. Preliminary Notes*. RASTA workshop, Bologna, 2002.
14. A. I. Goldman *A Theory of Human Action*. Princeton University Press, Princeton, 1976.
15. J. Hage, B. Verheij *The Law as a Dynamic Interconnected System of States of Affairs*. IJHCS: International Journal of Human-Computer Studies 51, Academic Press, 1999.
16. H. L. A. Hart *The Concept of Law*. Clarendon Press, Oxford, 1961.
17. A. J. I. Jones *Deontic Logic in Legal Knowledge Representation*. Ratio Juris 3, 1990.
18. A. J. I. Jones, M. Sergot *On the Characterization of Law and Computer Systems*. In J.-J. Ch. Meyer, R. J. Wieringa (eds.) *Deontic Logic in Computer Science*. Wiley, Chichester, 1993, pp. 275-307.
19. A. J. I. Jones, M. Sergot *A Formal Characterization of Institutionalized Power*. Journal od the IGPL 3, 1996.
20. A. J. I. Jones, M. Sergot *Deontic Logic in the Representation of Law: towards a Methodology*. Artificial Intelligence and Law 1, 1992.
21. O. R. Jones *Supervenience*. In Honderich T. (ed.) *The Oxford Companion to Philosophy*. Oxford University Press, 1995, p. 860.
22. Legislación Española sobre Extracción y Transplante de Órganos. *Real Decreto 2070/1999*. $http://www.juridicas.com/base\_datos/Admin/rd2070-1999.html$.
23. J.-J. Ch. Meyer, R. Wieringa (eds.) *Deontic Logic in Computer Science: Normative Systems Specification*. Wiley, Chichester, 1993.
24. D. C. North *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, Cambridge, 1990.
25. A. Peczenik *On Law and Reason*. Kluwer, Dordrecht, 1989.
26. H. Prakken *A logical framework for modeling legal argument*. Proceedings of the Fourth International Conference on Artificial Intelligence and Law, Amsterdam, ACM Press, 1993.
27. H. Prakken *Two Approaches to the Formalization of Defeasible Deontic Reasoning*. Studia Logica 57, 1996.
28. H. Prakken *Logical Tools for Modelling Legal Arguments*. Kluwer, Dordrecht, 1997.
29. H. Prakken, G. Vreeswijk *Logics for Defeasible Argumentation*. In D. Gabbay, F. Guenther (eds.) *Handbook of Philosophical Logic VOL 4*. Kluwer, Dordrecht, 2002, pp. 218-319.
30. L. Royakkers, F. Dignum *Defeasible Reasoning with Legal Rules*. In Nute D. (ed.) *Defeasible Deontic Logic*. Kluwer, Dordrecht, 1997, pp. 263-286.
31. J. Searle *The Construction of Social Reality*. Free Press, 1995.
32. H. H. Von Wright *A New System of Deontic Logic*. In Hilpinen R. (ed.) *Deontic Logic: Introductory and Systematical Readings*. Reidel, Dordrecht, 1971, pp. 105-115.