Solving Normative Conflicts by Merging Roles

Laurence Cholvy Frédéric Cuppens
ONERA-CERT
2 Av. E. Belin
31055, Toulouse Cedex
France
email: {cholvy,cuppens}@tls-cs.cert.fr

Abstract

This paper addresses the problem of conflicting norms. The solution we describe is based on the concept of role: a role defines some permissions, obligations and prohibitions which are supposed free of conflicts. As soon as an individual plays a role, he inherits the set of norms associated with this role.

We show that conflicting norms arise because an individual may play different roles.

The central idea of our paper is to consider that it is possible to make a judgement of priority between the roles an individual plays, in order to decide which are the actual norms which apply in a given situation. This priority may be chosen by the individual or may be dependent on the structure which may exist between roles.

Our paper mainly describes the axiomatic part of a logic for reasoning about norms associated with primitive roles as well as with composite roles obtained by merging several roles.

Introduction

Deontic logic, also called the logic of norm, refers to a logical model of the obligation, permission and prohibition concepts. One of the major issues in the study of deontic logic is the problem of conflicting norms, in particular the so-called moral dilemmas. The problem, briefly stated, is that it is impossible to specify moral dilemmas using any normal system of deontic logic, for instance the standard deontic logic (SDL).

However, instead of designing a modal logic weaker than SDL, a common view is to consider that conflicting norms and moral dilemmas should be dealt with from a nonmonotonic perspective (see for instance [RL91, Hor91, McC92, Pra94, vdT94]).

In this paper, we propose a new approach to defeasible norms, based on the concept of role [Cup94]. Intuitively, each individual is associated with a set of roles which represents the behavior the individual is playing in a given situation. Each role defines the permissions, obligations and prohibitions laid upon the role-holder. It should be noted that we consider that a role can be defined separately from the individuals. More precisely, we do not consider that a norm directly applies to individuals but instead, with each role is associated a set of norms and an individual will "inherit" this set of norms when playing a given role.

In our approach, we also consider that there is no normative conflict within a given role. Therefore, a conflict can only exist when an individual is playing two different roles and a conflict exists between these two roles. In this case, we argue that the norms inherited from a given role are only *prima facie* obligations, permissions or prohibitions and the central idea is to consider that it is possible to make a judgment of priority between these two roles in order to evaluate the *actual* norm which applies to a given situation.

In many situations, especially moral dilemmas, the judgment of priority depends on the individual and may differ from one individual to another. In this case, the judgment of priority must be explicitly specified if one wants to evaluate the actual norm. However, in other situations, this judgment of priority can be also implicitly derived by structuring the set of roles by using the concepts of sub-role and sub-ideal role. We argue that this point of view enables to respectively deal with defeasible and contrary to duty norms.

The remainder of this paper is organized as follows. In section 1, we present our deontic logic which consid-

ers that every norm is designed to apply to a given role. Section 2 informally describes how we plan to use this deontic logic to deal with normative conflicts. Section 3 addresses the problem of the regulation completion. Section 4 defines the fusion of a set of roles with respect to a given order of priority. This allows us to define in section 5 which actual norms apply to an individual in a given situation. In section 6, we suggest to distinguish between three kinds of normative conflicts – Moral dilemmas, defeasible norms and contrary to duty norms – and show how our deontic logic applies to these different types of conflict. Finally, section 7 concludes this paper on future works that remain to be done and proposes a comparison with other related approaches. It is important to notice that, in this paper, we only present the axiomatic part of our logic. This is mainly due to space limitation and a complete semantics will be presented in a forthcoming paper.

1 Obligation and permission

1.1 Language and axiomatics

Our deontic logic is based on the concept of role. For this purpose, we consider a finite set $Role = \{R_1, R_2, ..., R_n\}$ of roles. With each role is associated a set of norms. Therefore, we consider, for each role R_i, deontic modalities having the form O_{R_i}, P_{R_i} and F_{R_i}. We also need to consider a set of real agents; for the sake of simplicity, we shall consider only one real agent, called "the individual" in the remainder of this paper. The language L we use is then defined as follows:

Let VAR be a set of propositional variables. Then,

- If p belongs to VAR then p is a formula of L.
- If p is a formula of L then $\neg p$ is a formula of L.
- If p and q are formulas of L then $p \wedge q$ is a formula of L.
- If p is a formula of L and if R_i is a role then $O_{R_i}p$, $P_{R_i}p$ and $F_{R_i}p$ are formulas of L
- Nothing else is a formula of L.

Intuitively, $O_{R_i}p$, $P_{R_i}p$ and $F_{R_i}p$ are respectively to be read: "Within the role R_i, p is obligatory, permitted or forbidden". The axiomatics of the logic is defined as follows:

- (A0) All tautologies of propositional logic
- (A1) $O_{R_i}p \wedge O_{R_i}(p \rightarrow q) \rightarrow O_{R_i}q$
- (A2) $P_{R_i}(p \wedge q) \rightarrow P_{R_i}p \wedge P_{R_i}q$
- (A3) $O_{R_i}p \rightarrow P_{R_i}p$
- (A4) $O_{R_i}p \rightarrow \neg P_{R_i}\neg p$
- (A5) $F_{R_i}p \leftrightarrow O_{R_i}\neg p$

The inference rules of the logic are the following:

- (I1) Modus ponens
- (I2) $\frac{\vdash p}{\vdash O_{R_i}p}$
- (I3) $\frac{\vdash p}{\vdash P_{R_i}p}$

1.2 Comments

The axiomatics for each modality O_{R_i} is a KD logic [Che88]. In particular, notice that from axioms (A3) and (A4) we can derive the axiom D for O_{R_i}: $O_{R_i}p \rightarrow \neg O_{R_i}\neg p$. This is fully compatible with SDL.

On the other hand, we break with the tradition in deontic logic which generally views obligation as dual of permission, i.e. $\vdash O_{R_i}p \leftrightarrow \neg P_{R_i}\neg p$. We only accept the implication form the left to the right (A4) but not the converse. This is because we consider that the set of norms associated with a role generally does not represent a complete regulation of the world, i.e. within a role, there may be sentences which are neither permitted nor obligatory.

This assumption is important when we shall merge the regulations associated with two different roles R_i and R_j. As a matter of fact, by merging the two roles, we want to consider that the roles are in some sense complementary and this is not possible if each role R_i and R_j represents two different *but complete* regulations of the world.

On the other hand, axioms (A3) and (A4) are required because, as we pointed out in the introduction, we consider that there is no normative conflict within a given role, i.e. it is not possible that p is obligatory without p being permitted (A3) and with the negation of p being not permitted (A4).

Finally, axiom (A5) says that "it is prohibited that p" is defined as "it is obligatory that $\neg p$".

2 Examples of conflict

Under the assumption of the previous section, conflicting norms may only exist between two different roles. From a logical point of view, we may distinguish several types of conflicting norms:

- (C1) $O_{R_i}p \wedge O_{R_j}\neg p$

- (C2) $O_{R_i}p \wedge F_{R_j}p$
- (C3) $O_{R_i}p \wedge P_{R_j}\neg p$

In our logic, we can derive from axiom (A5) that (C1) and (C2) are actually equivalent and by using axiom (A3) we can derive that (C3) is a weaker conflict than (C1) in the sense that (C1) implies (C3).

As an example of normative conflict, let us consider the two following norms:

- (N1) A Christian ought not kill his neighbour.
- (N2) If a Soldier is ordered to kill an enemy, then he ought kill him.

To represent these norms in our logic, we shall actually consider that the first norm only applies within a first role, namely $R_1 = Christian$ and the second norm applies to another role, namely $R_2 = Ordered\_Soldier$. In our logic, this leads to the following specification:

- $O_{R_1}\neg Kill \wedge O_{R_2}Kill$

This corresponds to the case (C1) of normative conflict. Notice that this does not necessarily correspond to a case of moral dilemma. To obtain such a dilemma, the individual must be playing both roles of *Christian* and *Ordered_Soldier*. In this case, the individual is obliged to kill and obliged not to kill. However, as was suggested by David Ross [Ros30], these are only *prima facie* obligations, not actual obligations; *Prima facie* obligations can conflict while actual obligation cannot (see also [Mor94]).

So, if an individual is playing both the roles of *Christian* and *Ordered_Soldier*, how will he proceed to transform his conflicting *prima facie* obligations to kill and not to kill into actual obligations? We suggest that he will decide that one of his obligation takes precedence. This will be formalized in our logic by a judgment of priority between the two conflicting roles. Notice that, in the case of moral dilemmas, this judgment of priority clearly depends on a choice performed by the individual faced to the dilemma. Some individuals may indeed decide that in this situation the role of *Ordered_Soldier* takes precedence; in this case the obligation to kill is the actual obligation. While other individuals will decide that the role of *Christian* has higher priority; in this case the obligation not to kill becomes the actual obligation.

3 Completion of a regulation

The problem of completion of a regulation consists in adopting a position, in deontic terms, towards the sentences which are not explicitly ruled by the regulation.

For instance, let us consider a language with two propositions: *Finger* (eating with fingers) and *Napkin* (putting napkin on lap). Assume that a regulation associated with the role *Eater* only expresses that it is obligatory to put napkin on lap, i.e $O_{Eater}Napkin$. The problem is that the regulation takes no position about eating with fingers. Does this mean that it is permitted to eat with fingers because the regulation does not explicitly prohibit it? Does it mean that it is forbidden, because the regulation does not explicitly permit it?

When addressing the problem of merging regulations associated with different roles, the problem of completion must be attacked.

For instance, consider two roles. The first one R_1 expresses that eating with fingers is permitted. The second one expresses that putting napkin on lap is obligatory. We could consider that R_1 permits not to put napkin because it does not explicitly forbid it. In this case, there is a conflict of type (C3) between R_1 and R_2: the first one allows people not to put napkin while the second one obliges them to put napkin. On the opposite, we could consider that R_2 forbids to eat with fingers because it does not explicitly permit it. In such a case too, there is also a conflict of type (C3) between R_1 and R_2 because one allows people to eat with fingers, while the other forbids it. In both case, merging the two regulations implies solving these problems of conflicting norms.

The solution we adopt for completing a regulation consists in considering that a literal l[1] is not obligatory if the regulation does not explicitly obligates it and a literal is not permitted if the regulation does not explicitly permits it and does not explicitly obligates it.

It is important to notice that we restrict the application of this approach to regulations defined in terms of sets of permitted or obligated literals. This approach would indeed lead to inconsistency if we had apply it to any kind of regulation, especially those including disjunctive norms.

Therefore, let us consider that the regulation associated with a role R is represented by a finite set $\mathcal{R} = \{O_R l_1, ..., O_R l_i, P_R l'_1, ..., P_R l'_j\}$ where each $l_1, ..., l_i, l'_1, ..., l'_j$ is a literal. For completing this regulation, let us consider the formula:

$$\psi_R = \bigwedge_{O_R l \in \mathcal{R}} O_R l \ \wedge \bigwedge_{(P_R l \in \mathcal{R}) or (O_R l \in \mathcal{R})} P_R l \ \wedge \bigwedge_{O_R l \notin \mathcal{R}} \neg O_R l \ \wedge \bigwedge_{(P_R l \notin \mathcal{R}) and (O_R l \notin \mathcal{R})} \neg P_R l$$

where l is any literal of the underlying propositional

[1] A literal is a positive or negative atomic formula

language.

Proposition 1 Assume that the logic for reasoning with modalities O_R and P_R is the one presented in section 1.1. Let $\mathcal{R}$ be a regulation associated with the role R and let l be a literal of the underlying propositional language, then:

$$((\vdash \psi_R \rightarrow O_R l) \text{ xor } (\vdash \psi_R \rightarrow \neg O_R l))$$
$$\text{and } ((\vdash \psi_R \rightarrow P_R l) \text{ xor } (\vdash \psi_R \rightarrow \neg P_R l))$$

where xor stands for the exclusive or.

Proof of proposition 1 is immediate.

This ensures that considering ψ_R provides a means to complete the regulation $\mathcal{R}$ associated with R.

For instance, let us consider our previous roles R_1 and R_2. In this case, we have: $\mathcal{R}_1 = \{P_{R_1} Finger\}$ and $\mathcal{R}_2 = \{O_{R_2} Napkin\}$. Therefore, applying the completion to these regulations leads to the following formulas:

$$\begin{aligned}
\psi_{R_1} = {} & P_{R_1} Finger \wedge \neg O_{R_1} Finger \wedge \\
& \neg O_{R_1} Napkin \wedge \neg P_{R_1} Napkin \wedge \\
& \neg O_{R_1} \neg Finger \wedge \neg P_{R_1} \neg Finger \wedge \\
& \neg O_{R_1} \neg Napkin \wedge \neg P_{R_1} \neg Napkin \\
\psi_{R_2} = {} & O_{R_2} Napkin \wedge P_{R_2} Napkin \wedge \\
& \neg O_{R_2} Finger \wedge \neg P_{R_2} Finger \wedge \\
& \neg O_{R_2} \neg Finger \wedge \neg P_{R_2} \neg Finger \wedge \\
& \neg O_{R_2} \neg Napkin \wedge \neg P_{R_2} \neg Napkin
\end{aligned}$$

Notice that, when completing the regulation $\mathcal{R}_1$, we obtain in particular that $\neg P_{R_1} Napkin \wedge \neg P_{R_1} \neg Napkin$. This formula is satisfiable in our logic. It only means that both $Napkin$ and $\neg Napkin$ are not *positively* permitted. In our logic, this does not lead to $Napkin$ and $\neg Napkin$ being both prohibited. This would not be possible using SDL since in SDL the formula $Pp \vee P\neg p$ is sound for any formula p.

4 Merging roles

In this section, we present the axioms of the logic used for reasoning with composite roles, i.e. roles obtained by merging several roles. The problem, as described in section 2, is that roles may be conflicting. For instance, one obliges something and another one obliges the contrary. For solving this problem, we suggest to use an order for merging the roles. This order represents a priority between them. In this section, we will consider that this order is total. The extension to partial orders will be discussed in section 7.

Notice that our approach is similar to the one which was adopted in [Cho93] for merging several information sources. Indeed, when merging several information sources (databases, belief bases...) the problem of conflict between different sources also arises. We attacked this problem from a logical point of view, defining a multi-agent logic: each agent was either a primitive information source, or a new information base obtained by merging several information sources with an order of priority. In this case, the order represented the relative reliability of the sources. In [Cho93], we have presented two logics for reasoning with such information. The first one implements a suspicious attitude in which any information provided by a source which contradicts a more reliable source was ignored. The second one implements a trustful attitude in which we ignore only the smallest piece of information provided by a source which contradicts a more reliable source.

Here, for merging roles, we adopt the second kind of attitude.

Notations If the roles to be merged are noted $R_1, ..., R_k$, then the role obtained by merging them using the order $R_1 > ... > R_k$ will also be noted $R_1 > ... > R_k$.

If $o = R_1 > ... > R_k$ is a composite role obtained by merging k roles, we will note $o > R_{k+1}$ the composite role obtained by merging $R_1, ..., R_k, R_{k+1}$ with the order $R_1 > ... > R_k > R_{k+1}$.

4.1 Extending the logic of section 1

We extend the language L we propose in section 1 by considering the following modalities:

- O_o, P_o and F_o where o is any primitive role or composite role obtained by merging several roles.

Intuitively, $O_o p$, $P_o p$ and $F_o p$ will mean that, according to the primitive or composite role o, p is respectively obligatory, permitted or prohibited.

4.2 Axiomatics of the extended logic

We replace axioms (A0)-(A5) of section 1.1 by the following axioms. In these axioms, l represents a propositional literal, p and q represent propositional formulas, R_i represents a primitive role and o represents a primitive or composite role.

- (A0) All tautologies of propositional logic
- (A1) $O_o p \wedge O_o(p \rightarrow q) \rightarrow O_o q$
- (A2) $P_o(p \wedge q) \rightarrow P_o p \wedge P_o q$

- (A3) $O_o p \rightarrow P_o p$
- (A4) $O_o p \rightarrow \neg P_o \neg p$
- (A5) $F_o p \leftrightarrow O_o \neg p$
- (A6) $O_o l \rightarrow O_{o>R_i} l$
- (A7) $O_{R_i} l \wedge \neg P_o \neg l \rightarrow O_{o>R_i} l$
- (A8) $O_{o>R_i} l \rightarrow O_o l \vee O_{R_i} l$
- (A9) $P_o l \rightarrow P_{o>R_i} l$
- (A10) $P_{R_i} l \wedge \neg O_o \neg l \rightarrow P_{o>R_i} l$
- (A11) $P_{o>R_i} l \rightarrow P_o l \vee P_{R_i} l$

Axioms (A1)–(A5) are the axioms defined in section 1.1, extended to any primitive or composite role. Notice that the extension of these axioms to non primitive roles means that the way of reasoning with obligations and permissions in composite roles is the same as the way of reasoning in primitive roles.

Axiom (A6) expresses that if l is obligatory in role o, then it is also obligatory according to the composite role $o > R_i$.

Axiom (A7) expresses that if l is obligatory in a primitive role R_i and if $\neg l$ is not permitted in role o, then l is obligatory according to the role $o > R_i$.

Axiom (A8) expresses that if l is not obligatory in both roles o and R_i, then it is not obligatory in role $o > R_i$.

Axiom (A9) expresses that if l is permitted in role o, then it is also permitted in role $o > R_i$.

Axiom (A10) expresses that if l is permitted in a role R_i and if $\neg l$ is not obligatory in role o, then l is permitted in role $o > R_i$.

Axiom (A11) expresses that if l is not permitted in both roles o and R_i, then it is not permitted in role $o > R_i$.

The inference rules are extension of the ones presented in section 1.1 to any kind of role, primitive or composite:

- (I1) Modus ponens
- (I2) $\frac{\vdash p}{\vdash O_o p}$
- (I3) $\frac{\vdash p}{\vdash P_o p}$

Finally, notice that axioms (A6)–(A11) does not apply to any formulas, especially disjunctive formulas. For instance, let us consider two propositions a and b. Let us assume that according to a first role R_1 we have $O_{R_1}(a \vee b)$ and $\neg P_{R_1} a \wedge \neg P_{R_1} b$. Let us also assume that according to a second role R_2 we have $O_{R_2} \neg a \wedge O_{R_2} \neg b$. Now, by applying axiom (A6), we can derive that $O_{R_1 > R_2} a \vee b$ and, by apllying axiom (A7), we can also derive that $O_{R_1 > R_2} \neg a \wedge O_{R_1 > R_2} \neg b$ and therefore $O_{R_1 > R_2}(\neg a \wedge \neg b)$. However, according to axioms (A1)–(A5), the formula $O_o p \rightarrow \neg O_o \neg p$ is valid for any role, primitive or composite. Therefore, the above axiomatics would have fallen into inconsistency if we had considered that axioms (A6)–(A11) apply to any formulas. On the other hand, if these axioms are restricted to literals, then this axiomatics does not lead to inconsistency as it is now shown.

4.3 Property of the extended logic

As said in the introduction of this section, we assume that there are n roles to be merged. Each role R_i can be associated with a formula ψ_{R_i}, as defined in section 3, which represents the completion of the regulation associated with role R_i.

Let us define: $\psi = \psi_{R_1} \wedge ... \wedge \psi_{R_n}$.

This formula expresses what are the obligations and permissions in each primitive roles, and these ones only.

Proposition 2 Let o be a role obtained by merging k roles in n ($k \geq 1$). Let l be a propositional literal. Then:

$$((\vdash \psi \rightarrow O_o l) \text{ xor } (\vdash \psi \rightarrow \neg O_o l))$$
$$\text{and } ((\vdash \psi \rightarrow P_o l) \text{ xor } (\vdash \psi \rightarrow \neg P_o l))$$

The proof is by induction on the length of o i.e the number of roles which are merged in o. Notice that, if there is only one role, then we re-use the result of proposition 1 in section 3.

This proposition ensures us that the regulation corresponding to role o (primitive or composite) is complete with respect to literals.

5 Deriving actual norms

Merging several roles together allows us to derive the actual norms which apply to the individual in a given situation. For this purpose we first need a means to specify which roles the individual is playing in the situation we want to consider and which judgment of priority between these roles applies in this situation. Therefore, we add to the language of section 4 the following propositions:

- $All\_Roles(R_1, ..., R_k)$ for each subset $\{R_1, ..., R_k\}$ of the set of roles.

Intuitively, $All\_Roles(R_1, ..., R_k)$ is to be read "$R_1, ..., R_k$ are all and only all the roles played by the individual and these roles are ordered according to the judgment of priority $R_1 > ... > R_k$".

We can now define which actual norms apply to the individual in a given situation. For this purpose, we also add to the language of section 4 simple modalities O, P and F. Intuitively, Op, Pp and Fp are respectively to be read: "p is an actual obligation, permission or prohibition for the individual". The axioms defining O, P and F are the following:

- (A16)
  $All\_Roles(R_1, ..., R_k) \rightarrow (Op \leftrightarrow O_{R_1>...>R_k}p)$
- (A17)
  $All\_Roles(R_1, ..., R_k) \rightarrow (Pp \leftrightarrow P_{R_1>...>R_k}p)$
- (A18) $Fp \leftrightarrow O\neg p$

Axiom (A16) says that if $R_1, ..., R_k$ are all and only all the roles played by the individual and if $R_1 > ... > R_k$ represents the judgment of priority between these roles then the actual obligations of the individual are derived by merging all the roles according to this order of priority.

Axiom (A17) is a similar definition for the actual permissions. Axiom (A18) simply says that "p is an actual prohibition" if and only if "$\neg p$ is an actual obligation".

6 Application to examples

In section 2, we have shown that, from a logical point of view, we may distinguish several types of conflicting norms. From a philosophical point of view, we can also distinguish different types of normative conflicts – namely moral dilemmas, defeasible norms and contrary to duty norms. We now show through examples how our approach applies to each type of conflict.

6.1 Moral dilemmas

Let us first come back to the example of moral dilemma proposed in section 2:

- (N1) A Christian ought not kill his neighbour.
- (N2) If a Soldier is ordered to kill an enemy, then he ought kill him.

In our logic, we introduce two roles: $R_1 = Christian$ and $R_2 = Ordered\_Soldier$.

Then norms (N1) and (N2) are specified as follows:

- $O_{R_1}\neg Kill \wedge O_{R_2}Kill$

Let us assume that the individual is a Christian soldier who has received the order to kill. Since, the individual is playing the two roles R_1 and R_2, he is faced to a moral dilemma.

If he decides that the role R_2 takes precedence on the role R_1, (i.e he is first of all a soldier) then we shall consider: $All\_Roles(R_2, R_1)$. Therefore, using axioms (A6)-(A11) and (A16)-(A17), we can prove that the actual obligations and permissions are:

- $\neg O\neg Kill \wedge \neg P\neg Kill \wedge OKill \wedge PKill$

In other terms, the individual is obliged to kill.

On the opposite, if the individual considers that he is first of all a Christian, then we assume: $All\_Roles(R_1, R_2)$. In this case, we can derive:

- $O\neg Kill \wedge P\neg Kill \wedge \neg OKill \wedge \neg PKill$

i.e. the individual is obliged not to kill.

6.2 Defeasible norms

Let us consider the following example [Hor91]:

- (N3) You ought not eat with your fingers.
- (N4) If you are served asparagus, you may eat with your fingers[2].
- (N5) You ought put your napkin on your lap.

Here again , we suggest to use the concept of role. We introduce two roles: $R_3 = Eater$ and $R_4 = Asparagus\_Eater$ and we consider that rules (N3), (N5) and (N4) respectively apply to R_3 and R_4.

In our logic, this leads to the following specification:

- $O_{R_3}\neg Finger \wedge O_{R_3}Napkin \wedge P_{R_4}Finger$

Now, let us assume that the individual eats asparagus. In such a case, since he is playing both roles R_3 and R_4, the individual is faced to a conflict of type (C3): he is permitted to eat with fingers and he is obliged not to do so.

In the previous example, the individual was free to choose the precedence between the roles. On the opposite, in this example, we can consider that independently of the individual, R_4 is a **sub-role** of role R_3 in the

[2] Actually, in the original "asparagus eater" paradox, the second rule is rather: "If you are served asparagus, you *ought* eat with your fingers". We transform this obligation into a permission to show how our approach applies when merging obligation with permission.

sense that as soon as the individual plays the role R_4 he also plays the role R_3 and he inherits from R_3 as many norms as possible.

So it comes to consider that the individual plays a composite role $R_4 > R_3$ obtained by merging R_3 and R_4 in such a way that norms relative to role R_4 take precedence on the norms relative to role R_5. Therefore, we add the following formula: $All\_roles(R_4, R_3)$. Let us now show how to evaluate actual norms in this case. We have:

$$\begin{aligned}\psi_{R_3} = {} & O_{R_3}\neg Finger \wedge O_{R_3} Napkin \wedge \\ & P_{R_3}\neg Finger \wedge P_{R_3} Napkin \wedge \\ & \neg O_{R_3} Finger \wedge \neg O_{R_3}\neg Napkin \wedge \\ & \neg P_{R_3} Finger \wedge \neg P_{R_3}\neg Napkin \\ \psi_{R_4} = {} & \neg O_{R_4}\neg Finger \wedge \neg O_{R_4} Napkin \wedge \\ & \neg P_{R_4}\neg Finger \wedge \neg P_{R_4} Napkin \wedge \\ & \neg O_{R_4} Finger \wedge \neg O_{R_4}\neg Napkin \wedge \\ & P_{R_4} Finger \wedge \neg P_{R_4}\neg Napkin\end{aligned}$$

Then, by applying the axioms (A6)–(A11) and (A16)–(A17), we can show that:

- $ONapkin \wedge PFinger \wedge P\neg Finger$

In other terms, when an individual eats asparagus, i.e when he plays the two roles R_3 and R_4, since R_4 is a sub-role of R_3, the individual is obligated to put his napkin on his lap, he is permitted to eat with his fingers and he is also permitted not to eat with his fingers.

Notice that considering that R_4 is a sub-role of R_3 is a way of representing defeasible norms. Indeed, rule (N4) may be viewed as an exception to the general rule (N3), when asparagus are served.

6.3 Contrary to duty norms

Let us now consider a third example, generally called "the gentle murder paradox":

- (N6) A Christian ought not kill his neighbour[3].
- (N7) If you kill someone, then you ought kill him gently.

This is an example of contrary to duty (CTD) structures, i.e. situations in which there is a primary obligation, namely the obligation stated by rule (N6), and a secondary obligation, namely the obligation stated by rule (N7), which comes into effect when the primary obligation is violated. It is a well-known problem in the study of deontic logic to investigate representations which provide consistent readings to CTD-structures.

Here, we want to show how to apply our approach to CTD-structures. The basic idea is quite similar to the two previous examples. We consider that rules (N6) and (N7) respectively apply to two different roles, namely $R_5 = Christian$ and $R_6 = Killer$. Then, we have:

- $O_{Christian}\neg Kill \wedge O_{Killer}(Kill \wedge Gently)$

First, notice that we cannot consider that *Killer* is a sub-role of *Christian* or that *Christian* is a sub-role of *Killer* as informally defined in the previous example. However, we can consider that *Killer* is a **sub-ideal role** of *Christian* in the sense that *Killer* is a role the individual plays when he has violated the obligation not to kill associated with *Christian*.

In this case, we can also consider that the norms associated with *Killer* take precedence on the norms associated with *Christian*.

By applying the axioms, we can derive that the obligation to kill gently (and therefore to kill) must be considered the actual obligation when the individual commits a murder.

This is a plausible view of CTD-structures.

7 Discussion and related work

In this paper, an approach based on the concept of roles was proposed to deal with normative conflicts. We guess that this approach provides a clear distinction between *prima facie* and *actual* norms. In our model, *prima facie* norms are inherited by the individual when this individual is playing a given role. *prima facie* norms may be defeated when a normative conflict between two different roles occurs. *Actual* norms are derived by merging all the roles the individual is playing in a given situation.

To make our work complete, we need a means to characterize conditions on which an individual is playing a role. For instance, there is a condition to be satisfied by an individual to be a killer, namely to have killed someone. These conditions may be viewed as the descriptive part of the regulation, besides the normative part. Notice that they implicitely define a structure on roles. For instance, the role *asparagus-eater* is a sub-role of the role *eater*, because its associated condition (eating asparagus) implies the condition associated to *eater* (eating). In another way, the role *killer* is a sub-ideal-role of *christian*, because its associated condition (to kave killed) violates the norm associated to *christian*

[3] Actually, in the original gentle murder paradox, the first rule is rather: "Everyone ought not kill his neighbour". We sightly change this rule to make a clearer difference with the asparagus-eater example.

(they ought not kill).

When an individual is playing several roles, these roles are merged after stating a judgment of priority between them. This judgment of priority generally depends on the individual, especially when the individual is faced to a moral dilemma. However, in some specific situations, this judgment of priority may be derived from the structure of the set of roles in term of sub-roles or sub-ideal-roles hierarchy. In these cases, we guess that our work is quite close to recent works whose purpose was to deal with conflicting norms by applying non-monotonic logics [RL91, Hor91, McC92, Pra94, vdT94]. It consists in viewing deontic rules as situation-dependent rules that may be denied or defeated if an exception occurs.

Recently, there has been also some attempts to represent contrary to duty norms by means of defeasible reasoning and therefore, to apply nonmonotonic logics. Prakken and Sergot [PS94] argued that these proposals are inadequate because they are unable to distinguish between defeasibility and violability of primary obligations. They propose an alternative approach based on an extension of SDL by adding, for every formula B, a modal operator O_B. If A is proposition, then $O_B A$ is to be read "there is a secondary obligation that A presupposing the sub-ideal context B". In our approach, the difference between defeasibility and violability relies upon the hierarchy of roles: the sub-role hierarchy is used to discharge an exception and the sub-ideal-role hierarchy is used to discharge a CTD norm.

There are several other issues to this work. As already noted in the introduction, we have to present the semantics of the logic we propose in this paper. This will be done in a forthcoming paper. We can briefly say here that the semantics associated with composite roles obtained by merging several roles is an adaptation of possible models approach defined in the theory of revision [KM88].

In this paper, we assumed that the judgment of priority is a total order between roles. In which situation is it actually interesting to consider a partial order? For instance, let us consider two roles R_1 and R_2. If there is no conflict between these two roles then it is not necessary to state a judgment of priority between them. However, this extension is straightforward because the composite role obtained by merging R_1 and R_2 inherits in this case of both norms associated with R_1 and R_2. Another case is when there is a conflict between R_1 and R_2 but it is actually impossible for the individual to simultaneously play the roles R_1 and R_2. In this case too, it is not necessary to state a judgment of priority between R_1 and R_2. The third and final case is when there is a conflict between R_1 and R_2 and it is possible for the individual to simultaneously play R_1 and R_2. We claim that it is then necessary to state a judgment of priority between R_1 and R_2 in order to transform the conflicting *prima facie* norms into non conflicting *actual* norms. Therefore, in this case we need a total order.

Another issue is that we consider that, when a judgment of priority between R_1 and R_2 is stated, let us say for instance $R_1 > R_2$, then any norm associated with R_1 takes precedence on the norms of R_2. However, we guess that it would be also interesting to express various priority levels of the norms associated with a same role (see [CD94] for a similar idea). For instance, we guess that a Catholic should prefer to violate his obligation to go to the church on Sunday rather than his obligation not to kill. This represents another subject of future investigation.

Acknowledgement

This work was supported by the DRET. We would also like to thank Paul McNamara and Michael Morreau for their helpful comments on the concepts of role and *prima facie* obligation.

References

[CD94] L. Cholvy and R. Demolombe. Reasoning with information sources ordered by topics. In *Proceedings of Artificial Intelligence: Methodologies, Systems and Applications (AIMSA)*, 1994.

[Che88] B. F. Chellas. *Modal Logic: An Introduction.* Cambridge University Press, 1988.

[Cho93] L. Cholvy. Proving theorems in a multi-sources environment. In *Proceedings of IJCAI*, pages 66–71, 1993.

[Cup94] F. Cuppens. Roles and Deontic Logic. In A. J. I. Jones and M. Sergot, editors, *Second International Workshop on Deontic Logic in Computer Science*, Oslo, Norway, 1994.

[Hor91] J. Horty. Moral Dilemmas and Nonmonotonic Logic. In *Proc. of the First International Workshop on Deontic Logic in Computer Science*, Amsterdam, The Netherlands, 1991.

[KM88] H. Katsuno and A. Mendelzon. Propositional knowledge base revision and minimal change. *Artificial Intelligence*, 52, 1988.

[McC92] L. T. McCarty. Defeasible deontic reasoning. In *Proceedings of the Fourth International Workshop on Nonmonotonic Reasoning*, Plymouth, Vt, 1992.

[Mor94] M. Morreau. Prima Facie and Seeming Duties. In A. J. I. Jones and M. Sergot, editors, *Second International Workshop on Deontic Logic in Computer Science*, Oslo, Norway, 1994.

[Pra94] H. Prakken. Two Approaches to Defeasible Reasoning. In A. J. I. Jones and M. Sergot, editors, *Second International Workshop on Deontic Logic in Computer Science*, Oslo, Norway, 1994.

[PS94] H. Prakken and M. Sergot. Contrary-to-Duty Imperatives, Defeasibility and Violability. In A. J. I. Jones and M. Sergot, editors, *Second International Workshop on Deontic Logic in Computer Science*, Oslo, Norway, 1994.

[RL91] Y. Ryu and R. Lee. Defeasible Deontic Reasoning: A Logic Programming Model. In *Proc. of the First International Workshop on Deontic Logic in Computer Science*, Amsterdam, The Netherlands, 1991.

[Ros30] D. Ross. *The Right and the Good.* Oxford University Press, 1930.

[vdT94] L. W. N. van der Torre. Violated Obligations in a Defeasible Deontic Logic. In *Proceedings of the 11th European Conference on Artificial Intelligence*, Amsterdam, The Netherlands, 1994.