Subsumption and count as relation in arguments ontologies

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Abstract

The paper proposes a representation of the subsumption relation and of count as conditional in the context of argument ontologies. Starting from the weaker notion of classification represented by the subsumption relation towards the stronger notion of count as, we show how to reason whether an argument is accepted in ontologies involving these two notions. We adopt the methodology of meta-argumentation in order to model the design decisions. Argumentation, being able to handle contradictory information, is proposed as technique to reason about count as for ontology interoperability.

Introduction

The notion of count as comes from constitutive norms, where "*X counts as Y in the context of C*" is a standard representation in legal ontologies. Count as relations may hold between brute and institutional facts, but also between actions or processes and propositions, and so on. Constitutive norms, introduced by (Searle 1969; 1995), define that something *counts as* something else for a given institution. Searle claims about this kind of norms: "The activity of playing chess is constituted by action in accordance with these rules. The institutions of marriage, money, and promising are like the institutions of baseball and chess in that they are systems of such constitutive rules or conventions". In the context of constitutive norms, different interpretations of the notion of count as have been provided in the literature. On the one hand, count as is seen as a form of classification, in which the concept X is a subconcept of Y (Sartor 2006). On the other hand, count as is seen as a more complex notion in which the context C plays an important role since the classification would not hold without the normative system stating it (Grossi, Meyer, and Dignum 2008). In this paper, we refer to the first kind of count as as classification or subsumption relation and to the second one as count as relation.

The combining of the research areas of argumentation theory and the semantic web has produced significant contributions in the last years towards the progress of theoretical and pragmatical aspects concerning reasoning about ontologies (Dix et al. 2009). For example, the ontology mapping, identifying how terms of one ontology are related to terms in another ontology is an important issue. In legal ontologies, since normative systems change over time, it becomes necessary to handle the evolution of the ontologies. Argumentation theory provides a flexible way to compute inferences, stating explicitly the reasons behind these inferences (Dix et al. 2009).

In this paper, we address the following research question:

- How to reason about subsumption and count as conditional in argument ontologies?

We reason about subsumption and count as such that the acceptance of one argument is a reason to accept another argument. Note that this is the opposite of Dung's theory (Dung 1995), where the attack relation represents a negative relation and the acceptance of one argument is a reason to *reject* another argument. In (Boella et al. 2009), the methodology of meta-argumentation to model argument ontologies is proposed. The methodology of meta-argumentation instantiates Dung's abstract argumentation theory with an extended argumentation theory. We apply Dung's theory of abstract argumentation to itself by instantiating Dung's abstract arguments with meta-arguments. Arguments are seen as abstract entities as in classical (Dung 1995) and we identify them with the concepts of the ontology. Moreover, we reason about the consequences of a second-order attack on the count as relation itself. The count as relation is attacked by meta-arguments meaning that in another normative system, the count as relation does not hold. In meta-argumentation every additional structure is represented in terms of the two basic notions of arguments and attack relations, then we detect what arguments are acceptable and what inferences are no more actual.

The paper is organized as follows. Section 2 introduces the methodology of meta-argumentation. In section 3, the subsumption relation and count as conditional are modeled using meta-argumentation. Related work and conclusions end the paper.

Meta-Argumentation Methodology

Argumentation is the process by which arguments are constructed and handled. Thus argumentation means that arguments are compared, evaluated in some respect and judged in order to establish whether any of them are warranted (Besnard and Hunter 2009). There are, at the higher level, two ways to formalize a set of arguments and their relationships, abstract argumentation and logical argumentation. Abstract argumentation has been introduced by (Dung 1995) and it names the arguments without describing them and represents that an argument is attacked by another one. Logical argumentation (Prakken, Reed, and Walton 2003) is a framework in which more details about the arguments are considered. In this paper, we adopt the methodology of meta-argumentation as modeling technique for abstract argumentation.

When Dung's theory of abstract argumentation cannot be applied directly, there are two alternative methodologies to model argumentation: instantiating abstract arguments or extending Dung's framework. (Boella et al. 2009) argue that the dilemma of choosing among these two alternatives can be resolved using the meta-argumentation methodology, because it is a merger between the methodology of instantiating abstract arguments on the one hand, and extending argumentation frameworks on the other hand. We can instantiate Dung's theory with meta-arguments, *such that we use Dung's theory to reason about itself.*

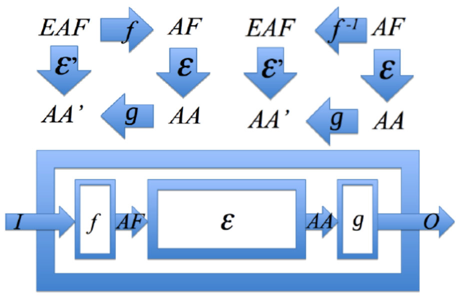

Figure 1: The meta-argumentation methodology.

Following similar proposals in the recent literature as (Modgil 2009), we use X and Y meta-arguments to model second and higher order attacks. Table 1 summarizes the notation of meta-argumentation used in this paper. Our meta-argumentation approach is a particular way to define mappings from argumentation frameworks to extended argumentation frameworks: the arguments are interpreted as meta-arguments, of which some are mapped to "argument a is acceptable" where a is an abstract argument from the extended argumentation framework EAF. The meta-argumentation methodology is visualized in Figure 1. The function f assigns to each argument a in the EAF, an argument "argument a is acceptable" in the basic argumentation framework. We use Dung's acceptance functions $\mathcal{E}$ to find functions $\mathcal{E}'$ between extended argumentation frameworks EAF and acceptable arguments AA'. This transformation function consists of two parts: a function f^{-1} transforms an argumentation framework AF to an EAF, and a function g transforms the accepted arguments of the basic argumentation framework into acceptable arguments of the EAFs. Summarizing $\mathcal{E}' = \{(f^{-1}(a), g(b)) \mid (a, b) \in \mathcal{E}\}$.

The first step of our approach is to define the set of extended argumentation frameworks. The second step consists in defining flattening algorithms as a function from this set of EAFs to the set of all basic argumentation frameworks:

NOTATION	MEANING
U	universe of all generated arguments
$A \subset U$	a finite set of arguments
$a, b, c, \ldots \in A$	elements of A
$\rightarrow$	binary relation on A representing attack
MU	universe of all meta-arguments
$accept(a)$	"argument a is acceptable"
MA	a set of meta-arguments
$\longmapsto$	a relation on MA
EAF	an extended AF
$\mathcal{EAF}$	a set of possible EAF
f	function from EAF to AF
AF	a pair of A and $\rightarrow$
$\mathcal{AF}$	a set of possible AF
$\mathcal{E}$	mapping from $\langle A, \rightarrow \rangle$ to sets of subsets of A
g	function from accepted MA to accepted A
$\Rightarrow$	binary relation on A representing counts-as
X, Y	meta-arguments for attack

Table 1: Notation used in the paper.

$f : \mathcal{EAF} \rightarrow \mathcal{AF}$. The flattening defines the attack in the basic argumentation framework as the intersection of the attack and the preference relation of the extended argumentation framework. Definition 1 provides an example of how turning a second-order argumentation framework, which is an extended argumentation framework where attacks of attacks are allowed, into a meta-argumentation framework. The universe of meta-arguments is $MU = \{accept(a) \mid a \in U\} \cup \{X_{a,b}, Y_{a,b} \mid a, b \in U\}$, and the flattening function f is given by $f(EAF) = \langle MA, \longmapsto \rangle$. Given an acceptance function $\mathcal{E}$ for basic argumentation, the extensions of accepted arguments of an extended argumentation framework are given by $\mathcal{E}'(EAF) = g(\mathcal{E}(f(EAF)))$.

Definition 1 *Given an extended argumentation framework $EAF = \langle A, \rightarrow, \rightarrow^2 \rangle$ where $A \subseteq U$ is a set of arguments, $\rightarrow \subseteq A \times A$ is a binary relation, and $\rightarrow^2$ is a binary relation on $(A \cup \rightarrow) \times \rightarrow$, the set of meta-arguments is $MA \subseteq MU$ is*

$$\{accept(a) \mid a \in A\} \cup \{X_{a,b}, Y_{a,b} \mid a, b \in A\}$$

and $\longmapsto \subseteq MA \times MA$ is a binary relation on MA such that

$$accept(a) \longmapsto X_{a,b}, X_{a,b} \longmapsto Y_{a,b}, Y_{a,b} \longmapsto accept(b)$$
$$if\ and\ only\ if\ a \rightarrow b,$$
$$accept(a) \longmapsto X_{a,Y_{b,c}}, X_{a,Y_{b,c}} \longmapsto Y_{a,Y_{b,c}},$$
$$Y_{a,Y_{b,c}} \longmapsto Y_{b,c}\ if\ and\ only\ if\ a \rightarrow^2 (b \rightarrow c),$$
$$Y_{a,b} \longmapsto Y_{c,d}\ if\ and\ only\ if\ (a \rightarrow b) \rightarrow^2 (c \rightarrow d)$$

.

The advantage in adopting the meta-argumentation methodology consists in the possibility to add new interactions between the arguments, as second-order attacks, the subsumption and the count as relations, without extending Dung's framework. This allows us to reuse all Dung's principles, properties and algorithms. For a further discussion about meta-argumentation, see (Boella, van der Torre, and Villata 2009; Boella et al. 2009).

Subsumption and count as conditional

Count as relation is a set of constraints within any institution according to which certain states of affairs of a given type count as, or are to be classified as, states of affairs of another given type (Jones and Sergot 1996). One of the simpler examples of count as conditional is "conveyances transporting people or goods count as vehicles in the context of normative system C". In this paper, we are interested in more *argument-based* examples which explicitly state the link with constitutive norms. Even when arguments are abstract, we may still assume that there is an ontology of arguments, for example when one argument is a sub-argument of a longer argument. Count as/subsumption relations among arguments are used to describe such an ontology, without describing the internal structure of the arguments which represent the notions of the ontology. For example:

- The argument that "agent A accepts argument b" is subsumed by an argument that "agent A knows argument b".
- The argument for "an insurer proposes a modification of an insurance contracts but the insuree does not answer" counts as "the insuree accepts such a modification" in the context of the Italian Civil Law but the same does not hold for the USA Civil Law (Sartor 2006).
- The argument "breaking the seal of a disk envelope" counts as the argument "accepting all the terms of the disk's license" (Sartor 2006).

In logical argumentation, the internal structure of the arguments is known, then such a count as/subsumption relation among arguments can be partly derived from this internal structure. For example, if an argument is represented by a propositional formula, then an argument a counts as/is subsumed by an argument b if the propositional sentence associated with argument a implies the propositional sentence associated with argument b. However, we do not consider such instantiations in this paper, and restrict our discussion to the abstract level.

Semantics (*without attacks on count as*)

We propose the following meaning for a count as relation among arguments: if argument a counts as an argument b, then argument a cannot be accepted without argument b being accepted too. In other words, if we have both that argument a counts as argument b, and argument a is accepted, then we are forced to accept argument b too. In our semantics, we have that argument a is seen as a sub-concept of argument b. For the examples above, our semantics gives the following interpretation to the count as/subsumption relation:

- If you accept the argument that "agent A accepts argument b" then you should also accept the argument that "agent A knows argument b".
- If you accept the argument for "no answer of the insuree about a modification of an insurance contract" then you should also accept the argument which stands for "acceptance of the insurance modification".
- If you accept the argument for "breaking the seal of a disk envelope" then you should also accept the argument for "accepting all the terms of the following license".

This semantics makes it explicit that "argument a counts as/is subsumed by argument b" is intuitively a stronger notion than "argument a supports argument b", because if argument a supports argument b and there is another argument c such that argument c attacks argument b, then we may have that argument a is accepted without argument b being accepted. In such a case, intuitively, argument a supports argument b, but the support was not strong enough for argument b to be accepted too (Amgoud et al. 2008). In the case of count as conditional, if argument a counts as argument b and argument a is accepted, then argument b will be accepted too, regardless of other attacks on argument b. The only way to have argument a accepted without accepting argument b is to attack the count as/subsumption relation between the two arguments, but that is an issue we defer to the next section.

There are some logical properties such count as relation has to obey. In particular, the following transitivity property: if a counts as b and b counts as c, then a counts as c. This follows from the semantics: if accepting b implies that c must be accepted, and accepting a implies that b must be accepted, then accepting a implies that c must be accepted. For example, if "secretary's signature" counts as "boss's signature" and "boss's signature" counts as "providing a valid claim for expenses" then also "secretary's signature" counts as "providing a valid claim for expenses". This logical consequence has been highlighted by (Jones and Sergot 1996) in the context of deontic and action logics.

There are two fundamental logical principles which follow from this semantics:

1. If a counts as b and b attacks c, then a attacks c. For example, if the argument "agent A knows argument b" attacks the argument that "agent A does not know anything", then "agent A accepts argument b" also attacks the argument that "agent A does not know anything". Likewise if "accepting all the terms of disks' license" attacks "pirate disks do not have license" then "breaking the seal of a disk envelope" attacks that "pirate disks do not have license" too.
2. If a counts as b and c attacks b, then c attacks a. For example, if the argument "agent A knows only arguments c and d" attacks the argument that "agent A knows argument b", then "agent A knows only arguments c and d" also attacks the argument that "agent A accepts argument b". Likewise if "not visualizing e-Bay Agreement and Privacy Policy in home page" attacks "accepting the e-Bay Agreement and Privacy Policy" then you should also accept that "not visualizing e-Bay Agreement and Privacy Policy in home page" attacks "using e-Bay website".

The following principles are *not* valid:

3. If c attacks a and a counts as b, then c attacks b. For example, if "breaking the seal of a disk envelope" counts as "accepting all the terms of the disk license" and "unsticking the seal of a disk envelope" attacks "breaking the seal of a disk envelope", then you should also accept that "unsticking the seal of a disk envelope" attacks "accepting all

the terms of the disk license" but this principle does not hold.

4. If a counts as b and a attacks c, then b attacks c. For example, if "using e-Bay website" counts as "accepting the e-Bay Agreement and Privacy Policy" and "using e-Bay website" attacks "e-Bay website is not protected against hackers" then you should also accept that "accepting the e-Bay Agreement and Privacy Policy" attacks "e-Bay website is not protected against hackers" but this principle does not hold.

This list of valid and invalid properties raises two questions. First, is there another reason, besides the intuition for these examples, why these principles are valid or invalid? Second, even more ambitiously, what is the set of all the valid principles? To answer these questions, we turn to the logic of argumentation (Boella, Hulstijn, and van der Torre 2006). We can represent that "a attacks b" by "accept(a) implies not accept(b)" and "a counts as/is subsumed by b" by "accept(a) implies accept(b)", but the question is which kind of implication is used here. For count as/subsumption relation we can use the material implication $\supset$ from classical logic, following the example of (Jones and Sergot 1996) where $\rightarrow$ represents the material conditional of "if A then B", $A \rightarrow B$. Concerning the attack relation, we cannot use material implication, because, from the property of contraposition, it would follow from a attacks b that b attacks a: $(accept(a) \supset \neg accept(b)) \supset (accept(b) \supset \neg accept(a))$. Thus we use a weaker kind of implication $>$ here for representing the attack relation. So we have the transitivity relation: $(accept(a) \supset accept(b)) \wedge (accept(b) \supset accept(c)) \supset (accept(a) \supset accept(c))$ and the fundamental properties that a counts as/is subsumed by b and b attacks c, then a attacks c: $(accept(a) \supset accept(b)) \wedge accept(b) > \neg accept(c)) \supset (accept(a) > \neg accept(c))$ and if a counts as/is subsumed by b and c attacks b, then c attacks a: $(accept(a) \supset accept(b)) \wedge (accept(c) > \neg accept(b)) \supset (accept(c) > \neg accept(a))$ Likewise, the logic of argumentation shows why the other principles are invalid, such as if c attacks a and a counts as/is subsumed by b, then c attacks b: $(accept(c) > \neg accept(a)) \wedge (accept(a) \supset accept(b)) \supset (accept(c) > \neg accept(b))$ and if a counts as/is subsumed by b and a attacks c, then b attacks c: $(accept(a) > \neg accept(c)) \wedge (accept(a) \supset accept(b)) \supset (accept(b) > \neg accept(c))$.

In this first part of the paper we have introduced the weaker form of count as conditional which is similar to subsumption relation. This weaker notion of count as has been introduced by (Sartor 2006). (Grossi, Meyer, and Dignum 2008) provide a formal analysis about the many faces of count as, highlighting that count as statements are classifications which hold with respect to a context but which does not hold with respect to all situations. Let us consider again the example about conveyance vehicles. Since *bike* is a subconcept of the concept *conveyance vehicle transporting people or goods*, then we have that in the context of normative system C, *bikes count as vehicles*. From now on, we refer to classificatory count as with the term subsumption and to the count as with a context with the term count as. We restrict the conditional to a set of arguments. The logical principles hold only if they refer to arguments in the same context. For example, the argument "an insurer proposes a modification of an insurance contracts but the insuree does not answer" counts as "the insuree accepts the insurance modification" in the context C, Italian Civil Law, but the same count as does not hold in context D, USA Civil Law (Sartor 2006).

Given an argumentation framework together with a set of count as conditionals, we can extend the argumentation framework using the logical principles above. We define an extended argumentation framework $EAF = \langle A, \rightarrow, \Rightarrow_C \rangle$ where $\Rightarrow_C$ designates the notion of count as relation we seek to capture. The attack relations in meta-argumentation are defined as in Definition 1. The flattening function f is given by $f(EAF) = \langle MA, \longmapsto \rangle$ and the extensions of accepted arguments of this extended argumentation framework are given by $\mathcal{E}'(EAF) = g(\mathcal{E}(f(EAF)))$.

Definition 2 *Let $EAF = \langle A, \rightarrow, \Rightarrow_C \rangle$ be an extended argumentation framework where A is the set of arguments, $\rightarrow \subseteq A \times A$ is a binary attack relation and $\Rightarrow_C \subseteq A \times A$ is a binary subsumption relation. This EAF is a meta-argumentation framework $\langle MA, \longmapsto \rangle$ where:*

- *$MA \subseteq MU$ is a finite set of meta-arguments such that*

$$\{accept(a) \mid a \in A\} \cup \{X_{a,b}, Y_{a,b} \mid a, b \in A\};$$

- *$\longmapsto \subseteq MA \times MA$ is relation on meta-arguments such that if $(a \Rightarrow_C b) \in \Rightarrow_C$, then:*
  - *if $(c \rightarrow b) \in \longmapsto$ then $(c \rightarrow a) \in \longmapsto$*
  - *if $(b \rightarrow c) \in \longmapsto$ then $(a \rightarrow c) \in \longmapsto$*
  - *if $(c \rightarrow a) \in \longmapsto$ then $(c \rightarrow b) \notin \longmapsto$*
  - *if $(a \rightarrow c) \in \longmapsto$ then $(b \rightarrow c) \notin \longmapsto$*

Definition 2 represents an extended argumentation framework in which it is introduced the count as relation. The definition explains what attacks arise from a count as relation like $a \Rightarrow_C b$ and what attacks cannot be added due to the count as relation. Let us consider the issue of ontology change. Suppose one agent has an ontology of arguments, then it adds a new argument to the ontology. The result is that all count as relations and their consequent attack relations have to be reconsidered again to see which attacks must be added or deleted now. Let us consider again the example about e-Bay Privacy Policy. We have that "using e-Bay website" (argument a) counts as "accepting the e-Bay Agreement and Privacy Policy" (argument b) in context Italian Law and "not visualizing e-Bay Agreement and Privacy Policy in home page" (argument c) attacks "accepting the e-Bay Agreement and Privacy Policy" (b) and "using e-Bay website" (a) attacks "e-Bay website is not protected against hackers" (argument d). Then, according to principle 2 and principle 4, we have that $c \rightarrow a$ but only $a \rightarrow d$. If we add a new argument e, attacking argument c, not only argument b is supported by this new argument but argument a is supported by e, too.

Now we present how to model these examples with the meta-argumentation modeling. In Figure 2, we have a count as/subsumption relation between two arguments and first-

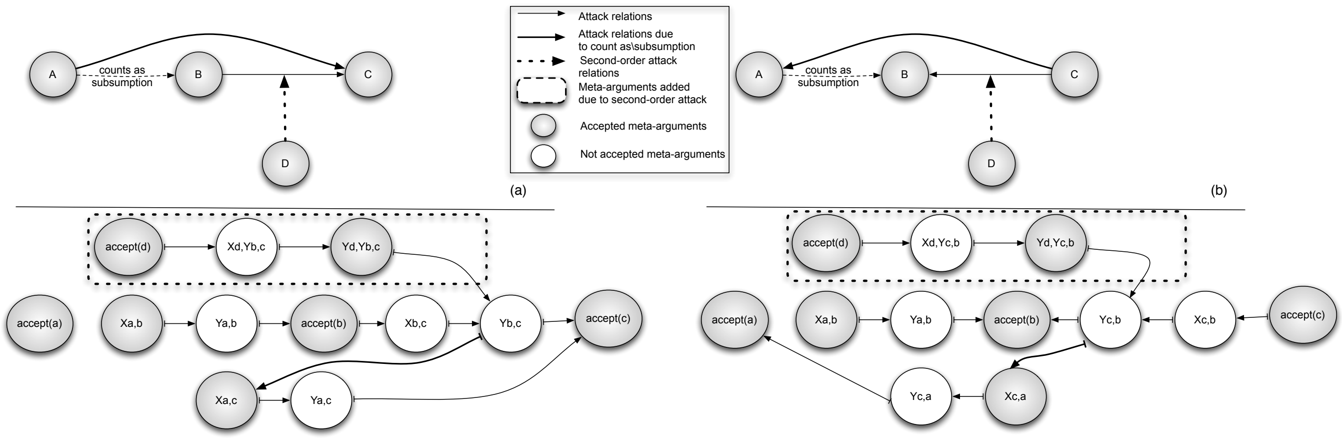

Figure 2: Example of ontology evolution with a subsumption relation.

and second-order attacks among other arguments. Definition 2 can be specified by Definition 3 which explains what meta-arguments have to be related to each other in order to represent the count as/subsumption relation.

Definition 3 *We say that argument a counts as argument b, $a \Rightarrow_C b$, and that argument c attacks argument b (c is attacked by argument b) with $a, b \in A$ if for all arguments $c \in A$, we have $Y_{b,c}$ attacks $X_{a,c}$ ($Y_{c,b}$ attacks $X_{c,a}$).*

Algorithm 1 describes how to build the meta-argumentation network in these cases. Example 1 introduces the meta-argumentation modeling for the subsumption relation and the ontology change in case of additional attacks.

Example 1 *Figure 2.a presents the changes in the argument ontology due to an attack from argument b, subsuming argument a, to argument c. This attack brings to the addition of another attack from argument a to argument c, as stated before. What happens if another argument d attacks the attack between b and c? Intuitively, the ontology changes are that the attack of argument d attacks also the attack from argument a to argument c, due to the subsumption relation.*

The subsumption relation is represented by means of an attack from meta-argument $X_{a,b}$ to meta-argument $Y_{a,b}$ and another attack from meta-argument $Y_{a,b}$ to meta argument "b is acceptable". The advantage brought by meta-argumentation consists in representing every extended argumentation framework by means of a classical Dung's framework composed only by arguments and attack relations. The attack from b to c "activates" the attack from a to c due to the subsumption relation. Meta-argument $Y_{b,c}$ attacks meta-argument $X_{a,c}$ in order to "activate" the attack from a to c constrained to the activation of the attack from b to c (meta-argument $Y_{b,c}$ has to be accepted in order to make accepted also meta-argument $Y_{a,c}$). The set of acceptable arguments is $\{a, b\}$. If d attacks the attack between b and c, then the attack from a to c has to be deleted too. This is modeled by an attack from meta-argument d to meta-argument $Y_{d,Y_{b,c}}$ and this attack involves also the attack from a to c, which is now made out. The set of acceptable arguments is $\{a, b, c, d\}$.

Let us consider now the example of Figure 2.b described in Example 2.

Example 2 *Figure 2.b presents the ontology change due to an attack from an argument c to argument b given that argument a is subsumed by b. This means that argument c attacks also argument a. This attack, then, should be deleted if another attack from argument d to the attack $c \rightarrow b$ is raised, due to the subsumption relation. In the meta-argumentation modeling, the attack from c to b is characterized by meta-argument $Y_{c,b}$. This meta-argument attacks meta-argument $X_{c,a}$, in order to "activate" the attack from argument c to argument a as a consequence of the activation of the attack from c to b. The set of acceptable arguments is $\{c\}$. If argument d attacks the attack from argument c to argument b then also the attack from argument c to argument a has to be attacked. This is modeled in the following way: meta-argument $Y_{d,Y_{c,b}}$ attacks meta-argument $Y_{c,b}$, making it not acceptable. The changes occurring in the arguments ontology thanks to this "deactivation" are that also meta-argument $Y_{c,a}$ is made not accepted, deleting in this way the attack from argument c to argument a. The set of acceptable arguments is $\{a, b, c, d\}$.*

Semantics (*with attacks on count as*)

Thus far, we analyzed the cases in which the arguments involved in a count as/subsumption relation are attacked or attacks other arguments. The difference between the classificatory count as (here called subsumption) and the count as relation related to constitutive norms has to be underlined when you consider an attack on the count as relation itself. The attack on the count as relation is strictly related to the notion of context. Given that argument a counts as argument b in normative system Γ then what happens if in the same legal argument ontology are added notions from normative system Θ in which the count as relation between a and b does not exist? We represent the normative system Θ by means of a meta-argument attacking the count as relation. This attack leads to a change in the ontology as we discuss in the following examples.

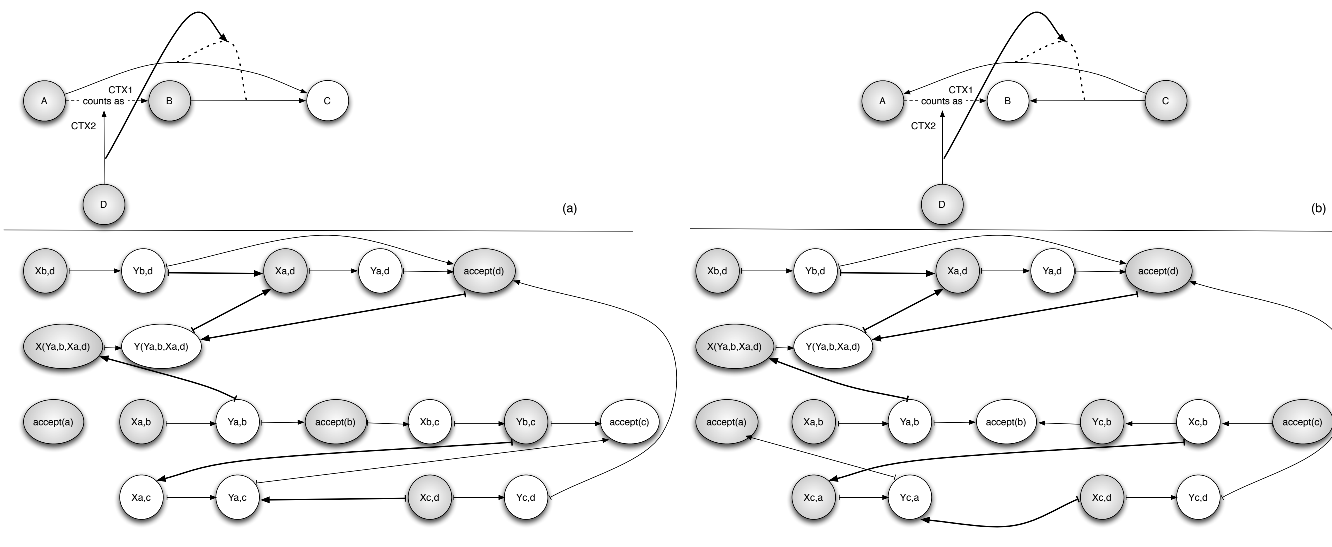

Figure 3: Example of attack from an argument to a count as relation.

We say that argument a counts as argument b in context CTX_1 and argument d of context CTX_2 attacks the count as relation. The ontology changes are propagated to all the arguments involved in the count as relation. Algorithm 1 provides the procedural way to change the ontology due to an attack on the count as relation.

Example 3 illustrates the evolution of the arguments ontology due to an attack on the count as relation.

Example 3 *Figure 3 (where not all the attack relations use meta-arguments for clarity of the figure) introduces the changes occurring in the ontology when an attack on a count as relation is fired. If argument a counts as argument b and argument c attacks argument b and argument d attacks the count as relation, the link between the attack relations* $c \rightarrow b$ *and* $c \rightarrow a$ *should be deleted. If argument a counts as argument b and argument b attacks argument c and argument d attacks the count as relation, the connection between the attack relations* $b \rightarrow c$ *and* $a \rightarrow c$ *should be deleted.*

In the meta-argumentation modeling of Figure 3.a, meta-argument $Y_{a,c}$ *which represents the attack from a to c is attacked by meta-argument* $X_{c,d}$*, representing the new argument d. Algorithm 1 provides only this situation and not the following one in which c attacks b, depicted anyway in Figure 3, due to space constraints. The set of acceptable arguments is* $\{a, b, d\}$*. Conversely, in Figure 3.b, argument d attacks the count as relation, thus the connection between the attack from c to b and the attack from c to a does not hold anymore. Meta-argument* $X_{c,d}$ *attacks meta-argument* $Y_{c,a}$ *which represents the attack from argument c to argument a. This allows argument a to be in the extension of this argumentation framework where the set of acceptable arguments is* $\{a, c, d\}$*.*

It remains the open question: *Can a count as/subsumption relation attack an argument?* From our point of view, it would be possible. This additional kind of attack will change all the cases considered above. For example, if argu-

Input: $\langle A, \rightarrow, \Rightarrow_C \rangle$
Output: $\langle MA, \longmapsto \rangle$
forall $a \times b \in \Rightarrow_C$ **do**
  add($X_{a,b}, Y_{a,b}$);
  newAttack($X_{a,b}, Y_{a,b}$);
  newAttack($Y_{a,b}, accept(b)$);
end
forall $c \times b \in \rightarrow$ *with* $c \in A, a \times b \in \Rightarrow_C$ **do**
  add($X_{c,b}, Y_{c,b}, X_{c,a}, Y_{c,a}$); newAttack($accept(c), X_{c,b}$);
  newAttack($X_{c,b}, Y_{c,b}$); newAttack($Y_{c,b}, accept(b)$);
  newAttack($X_{c,a}, Y_{c,a}$); newAttack($Y_{c,a}, accept(a)$);
  newAttack($Y_{c,b}, X_{c,a}$);
end
forall $b \times c \in \rightarrow$ *with* $c \in A, a \times b \in \Rightarrow_C$ **do**
  add($X_{b,c}, Y_{b,c}, X_{a,c}, Y_{a,c}$); newAttack($accept(b), X_{b,c}$);
  newAttack($X_{b,c}, Y_{b,c}$); newAttack($Y_{b,c}, accept(c)$);
  newAttack($X_{a,c}, Y_{a,c}$); newAttack($Y_{a,c}, accept(c)$);
  newAttack($Y_{b,c}, X_{a,c}$);
end
forall $d \times (a \times b) \in \rightarrow, b \times c \in \rightarrow$ *with* $d, c \in A, a \times b \in \Rightarrow_C$ **do**
  add($X_{a,d}, Y_{a,d}, X_{b,d}, Y_{b,d}, X_{c,d}, Y_{c,d}, X_{Y_{a,b},X_{a,d}}, Y_{Y_{a,b},X_{a,d}}$);
  newAttack($X_{a,d}, Y_{a,d}$); newAttack($Y_{a,d}, accept(d)$);
  newAttack($X_{b,d}, Y_{b,d}$); newAttack($Y_{b,d}, accept(d)$);
  newAttack($X_{c,d}, Y_{c,d}$); newAttack($Y_{c,d}, accept(d)$);
  newAttack($X_{c,d}, Y_{a,c}$); newAttack($Y_{b,d}, X_{a,d}$);
  newAttack($Y_{a,b}, X_{Y_{a,b},X_{a,d}}$);
  newAttack($X_{Y_{a,b},X_{a,d}}, Y_{Y_{a,b},X_{a,d}}$);
  newAttack($Y_{Y_{a,b},X_{a,d}}, X_{a,d}$);
  newAttack($accept(d), Y_{Y_{a,b},X_{a,d}}$)
end

Algorithm 1: COUNTAS_ATTACK

Figure 4: Algorithm for count as in meta-argumentation.

ment a counts as/is subsumed by argument b and the count as/subsumption relation is attacked by argument d, the attack from the count as/subsumption relation to argument c does not hold thus the extension would be $\{a, b, c, d\}$. The analysis and representation of this kind of attack in meta-argumentation is left for future research.

Related work

A logical analysis of constitutive rules and counts-as connections is provided by (Jones and Sergot 1996) where the authors introduce a conditional connective intended to capture the consequence relation implicit in statements of the form: according to the constraints of institution a, the performance of some action x by agent i counts as a means of creating the state of affairs y. This new connective facilitates the analysis of a number of notions crucial to the understanding of organised interaction in institutions, such as authorization and delegation. (Jones and Sergot 1996)'s characterization of count as has been criticized by (Gelati et al. 2002) where, rather then introducing a separate logic for the counts-as connection relativised to the particular institution under consideration, the authors use one conditional operator to express any normative connections or constants, in any institutions. (Grossi, Meyer, and Dignum 2008) define three notions of count as conditional. The first kind of count as is called classificatory count as and it is treated in a way similar to the subsumption relation we analyze in this paper. The second and the third kind of count as relation are called proper contextual classification and constitutive count as, respectively. In this paper, we do no distinguish among these two kinds of count as, considering only a kind of count as relation with the introduction of the context CTX. A different perspective is provided by (Sartor 2006) who presents, among a set of other legal concepts, the notion of count as conditional as all such conditionals which determine the constitution of certain non-natural entities such as states of affairs, events and so on. The count as relation may be viewed, according to (Sartor 2006) as subsuming only the notions of non-deontic state and event emergence, according to our definition of subsumption relation. In (Amgoud et al. 2008), Dung's argumentation framework is extended with a new kind of binary relation representing support. At the meta level, they have arguments in favor of other arguments, i.e., the support relation, and also arguments against other arguments, i.e., the defeat relation.

Conclusions

We introduce the notions of count as and subsumption in the context of legal argument ontologies looking not only at the representation of these new relations among arguments but analyzing also the consequences of attacks to a count as relation by an argument representing the fact that the count as relation does not hold in another normative system. Given that argument a counts as argument b, we highlight how to model the fact that another argument c attacks b or b attacks c. The ontology changes due to these kinds of attacks are described. The advantage in using argumentation theory for legal ontologies dynamics consists in having a flexible and compact way to compute inferences which does not hide the reasons behind these inferences. Moreover, we represent subsumption and count as without providing an extended argumentation framework as done by (Amgoud et al. 2008) for support but using the methodology of meta-argumentation which enables us to represent also these notions under the form of a Dung's framework.

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