Actions, Institutions, Powers. Preliminary Notes

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Abstract. In this paper we analyse some logical notions relevant for representing the dynamics of institutionalised organisations. In particular, some well-known action concepts introduced in the Kanger-Lindahl-Pörn logical theory of agency are discussed and integrated. Secondly, moving from the work of Jones and Sergot, a logical characterisation is provided of the ideas of institutional links, "counts-as" connections, and institutional facts . This approach is then enriched by a new modal operator *proc*, intended to account for the autonomous and decentralised creation of new institutional facts and normative positions within institutions.

1 Introduction

In recent work on agents and on their societies, a specific normative line of research has been emerging. This research assumes that as in human societies, also in artificial societies normative concepts may play a decisive role, allowing for the flexible co-ordination of intelligent autonomous agents (see the previous proceeding of the workshops of Norms and Agents [9]).

We also believe that the adoption of a normative perspective, would allow a substantial progress in the creation of agent societies, a progress that would be even more important for societies where humans and agents interact (see [16]).

However, one necessary precondition for the development of norm-governed societies consists in a precise logical account of normative notions (think about, e.g., software agents applications). Moreover, logical precision should not impede such an account from being practical, that is able of easily capturing the most significant normative structures (duties, powers, responsibilities, contracts, and so on).

Some significant steps in this direction have been accomplished in recent years (we mention the proceeding of the DEON conferences, which show how normative logic has been moving into the direction above indicated). In particular we will refer here to the tradition of research which starts with the work of Scandinavian logicians and legal theorists, such as Kanger, Lindhal, and Pörn (see for a review [12], and continues with the work of Carmo, Jones, Sergot, and their colleagues ([29, 18]).

In this paper we will move from the latter tradition, and after commenting on previous work on action, "counts-as" connections, and institutionalised power, and identifying some issues, we will attempt at providing some new solutions. In this spirit, we will provide some refinements to the action framework, a fresh account of the idea of "counts-as" connections, a general type of normative speech act (proclamation), a specific type of institutional power (declarative power) and an analysis of hierarchies over agents.

2 Actions and Obligations

Let us first outline the logic adopted here to deal with the concepts of action and obligation.

Our approach falls within the well-known Kanger-Lindahl-Pörn logical theory designed to account for agency and organised interaction (see [12]). More precisely, our aim is to extend and take advantage of what developed by F. Santos, A. Jones and J. Carmo in [28, 29] (in the following SJC). Such an approach is well-suited for our purposes because actions are viewed at a very abstract level and are simply taken to be relationships between agents and states of affairs. In addition, it is permitted to easily combine action concepts with other modalities (for a critical discussion, see [12, 33]). Let us recall the set of action concepts discussed there. In short, SJC use three kinds of action operators: E, G and H. The first is the well-known operator expressing direct and successful actions: a formula like E_iA means that the agent i brings it about that A. The second one corresponds to indirect and successful actions so that the reading of G_iA is that i ensures that A. Finally, the intended meaning of H is such that H_iA means that i attempts to make it the case that A. The idea is that H is not necessarily successful. Following their approach, the logic for such operators is provided by the following axiom schemas and rules.

For E:

$$E_iA \to A \tag{1}$$

$$(E_iA \land E_iB) \to E_i(A \land B) \tag{2}$$

$$\neg E_i\top \tag{3}$$

$$\frac{\vdash A \equiv B}{\vdash E_iA \equiv E_iB} \tag{4}$$

Notice that SJC also accept the following schema:

$$E_iE_jA \to \neg E_iA \tag{5}$$

for which E_iA expresses the idea that the agent i brings it about that A directly and personally. In general, we think that this is a correct reading of the operator E. However, for our purposes we feel that the axiom (5) sometimes turns out to be too strong. Suppose that i brings it about that John is greeted and that i brings it about that another agent j brings it about that John is greeted. Why is this situation contradictory? Actually, in counterexamples like this, the adoption of (5) has the same consequences as saying that the an action cannot be performed by more than one agent:

$$E_i A \to \neg E_j A, \quad \text{where } i \neq j \tag{6}$$

This assumption may be viewed as a principle of rationality for institutional organisations: It is counterintuitive that the same agent brings it about that A and brings it about that somebody else achieves A. However, the above example shows that this criterion does not apply to all cases. Consequently, we prefer not to validate the schema (5).

To differentiate the operator E from G we will assume only that the latter is characterised by the following axiom:

$$G_i G_j A \to G_i A \tag{7}$$

On the other hand, similar principles as (1), (2), (3) and (4) apply also to G.

A counterpart of (7) holds for H, which also shares with the previous operators similar principles such as those expressed by (2) and (4) for E.

Let us see now some interaction axioms from [29]:

$$E_i A \to G_i A \tag{8}$$

$$G_i E_j A \to G_i G_j A \tag{9}$$

$$E_i E_j A \to E_i G_j A \tag{10}$$

$$G_i A \to G_i E_i A \tag{11}$$

In addition, SJC also accept:

$$G_i A \to H_i A \tag{12}$$

$$E_i G_j A \to E_i H_j A \tag{13}$$

$$G_i G_j A \to G_i H_j A \tag{14}$$

$$H_i E_j A \to H_i G_j A \tag{15}$$

$$H_i G_j A \to H_i H_j A \tag{16}$$

Let us focus now on the operator H. In general, one of the main reasons why H is useful in a normative domain is that it is not necessarily successful, and therefore it may be used to model the idea of normative influence, that is the influence which is exercised by imposing obligations over an agent. Such an influence is not necessarily successful for the reason that $OG_j A$ does not imply that A: an obligation does entail its fulfilment.

First of all, let us define a suitable logic for obligations. Besides the well-known drawbacks connected with the treatment of logical structures such as contrary-to-duty obligations[1], it is clear that Standard Deontic Logic (SDL) is not adequate for combining deontic and action operators. For example, in SDL OE_iA implies that OA, which we feel unacceptable. For similar reasons, $OE_iE_jA \rightarrow OE_jA$ is a theorem of SDL. However, this cannot be accepted because the personal obligation on i should not imply a personal obligation on j [27].

To avoid this problem, we assume that the logic for O contains only the following axioms

$$(OA \wedge OB) \rightarrow O(A \wedge B) \tag{17}$$

$$OA \rightarrow \neg O \neg A \tag{18}$$

and is closed under classical logical equivalence (see [16]).

Given the above premise, we can represent normative influence by way of expressions like E_iOG_jA. In this regard SJC, accept the following axiom:

$$E_iOG_jA \rightarrow H_iG_jA \tag{19}$$

We believe that this principle (19) is quite reasonable insofar as, as we said, normative influence is a special kind of not necessarily successful influence over agents. On the other hand, we have some doubts concerning a further principle advanced in [29]. SJC propose the following axiom (though relativised to the counts-as operator $\Rightarrow_s$, which we discuss in the following section):

$$(G_iOG_jA \wedge G_jA) \rightarrow G_iA \tag{20}$$

Actually, they point out that (20) is not a logical principle but it can be adopted or not depending on the nature of the institution considered[2]. Even in this case, we believe that such a principle is too strong. In fact, even within an institution, $\neg G_iA$ should be consistent with both G_iOG_jA and G_jA since it is possible that j pays no attention to the obligation that i has imposed upon him, (and even that he does not know of his obligation). For example, suppose that a military commander orders his soldiers to kill their prisoners. Assume that the order does not reach one soldier (who is fighting in a far away place), but that this soldier still kills a prisoner, according to his autonomous decision. We do not believe that in any reasonable institution, in such a case one may say that the commander ensured that the prisoner was killed, and consider him responsible for that.

[1] By the way, we feel this is an important issue for a future development of convincing logical frameworks in which action operators and obligations are combined. In fact, since contrary-to-duty obligations may be conceived of as reparational obligations of violated norms, a full analysis of the concept of "violability" could shed a new light on notions like those of responsibility and delegation. See [7], where these concepts are analysed to cover situations where an agent has the power (or is obliged) to perform a given task but is also obliged to make reparation if she fails in such a task.

[2] In other words, (20) is changed into $(G_iOG_jA \wedge G_jA) \Rightarrow_s G_iA$. According to the same intuition, notice that they also adopt another axiom schema, that is $(OG_jA \wedge A) \Rightarrow_s G_jA$.

Other problems arise with (20). In fact, it may be the case that two (or more) different agents i and k ascribe to j the same obligation to realise A. If we have that $G_j A$, what conclusion have we to get? Actually, such a problem is acknowledged in [28] but the solution advanced there is once again that of confining the conclusion of $G_i A$ and $G_k A$ to an institution[3]. It has been noted in [7] that a principle like (20) usually holds in norm-governed organisations. We agree that something similar may be given in some kind of institutions. Anyway, we feel that in (20) something is missing.

Notice also that, in the analysis developed in [7], G is defined in a slightly different way as in [28, 29]:

$$G_i A =_{def} E_i A \vee (\exists j_1 \ldots \exists j_k (E_i O G_{j_1} A \wedge \cdots \wedge E_{j_{k-1}} O G_{j_k} A \wedge E_{j_k A})) \qquad (21)$$

$G_i A$ means that i ensures that A, namely that either i brings it about that A or that there is a deontic channel between i and a final agent j_k such that j_k brings it about that A. First of all, it is worth noting that (21) implies (20) but on this principle we have already put forth some doubts. More generally, we believe that G does not actually express a true relation of deontic influence between agents. The fact that j_k brings it about that A can be just a contingent action of j_k with respect to each of the intermediate obligations stated by the other agents in the deontic channel. As far as we can understand the matter, an influence channel via obligations is expressed by the nesting and the simple iteration of obligations and action operators.

In this perspective, we believe that it could be useful to introduce a new action operator EI to express that an agent attempts to make it the case that A by creating, directly of indirectly a channel of deontic influence terminating with A.

The operator EI could be defined by means of an induction axiom as follows:

$$EI_i A \equiv G_i O G_j A \vee \bigvee_{j \in Ag_{\leq}}^{j \leq i} G_i O EI_j A \qquad (22)$$

Obviously, the logic for EI should be characterised at least by the following axiom:

$$EI_i A \rightarrow H_i A \qquad (23)$$

In this perspective, it is worth noting that a hierarchy between agents can play an important role in characterising EI. Suppose $\prec$ stands for a such a relation of hierarchy[4]. Thus, since we want a hierarchy of agents being rational, the following formula holds

$$(E_i O G_j A \wedge E_j O G_i A \wedge i \prec j) \rightarrow \bot \qquad (24)$$

We should also have that

[3] Notice also that this conclusion is in contrast with the idea expressed in (5) and (6).
[4] See Section 4.2 for its formal definition.

$$(EI_i A \wedge E_j OG_i A \wedge i \prec j) \rightarrow \bot \tag{25}$$

In other words, both explicit and implicit "circular" chains of deontic control are not permitted.

Technically speaking, the semantic characterisation of EI is quite simple. Let us just suggest very briefly some intuitions about how to do it. Consider the following neighborhood model structure:

$$\langle W, R^O, R^E, R^G, R^H, Ag_{\leq}, V \rangle$$

where W is the set of worlds; R^O is a function with signature $2^W \mapsto 2^W$; R^E, R^G and R^H are functions with signature $Ag_{\leq} \times 2^W \mapsto 2^W$; $Ag_{\leq}$ is the ordered set of agents; V is the usual valuation function. Accordingly, the truth in a world w of the expression $E_i A$ is defined as follows:

$$\mathcal{M}, w \models E_i A \text{ iff } w \in R^E(i, \|A\|)$$

where $\|A\| = \{w : \mathcal{M}, w \models A\}$. Similar truth-conditions apply to the operators G and H[5].

If we assume, as we do, that $Ag_{\leq}$ is finite, then EI is not a primitive operator but corresponds, for some agents $j \in Ag_{\leq}$, to one or more iterations of modalities of the kind $G_i(OG_{j_n})^n$, where $n \geq 1$. Accordingly, the semantics for EI is quite simple. Since (22) generates iterated sequences of $G_i(OG_{j_n})$ it is not hard to see that EI has a neighborhood interpretation in structures where a supposed R^{EI} is nothing but the iterative composition of the union of the function $R_i^G \circ R^O$. Accordingly, if R^* is the transitive closure of such a composition, then $\mathcal{M}, w \models EI_i A$ iff $w \in R^*(\|A\|)$.

Notice that, where $Ag_{\leq}$ is infinite, EI must be introduced as a primitive operator. In fact, its definition in (22) would not be well-founded since it produces an infinite regression. How to deal with this case would require some extra technicalities and will not be discussed here. This is an interesting issue that will be a matter of future work.

3 The 'Counts as' Link

3.1 Jones and Sergot's Analysis

A. Jones and M. Sergot [18] (abbreviated as JS in the following) have developed a formal approach to the notion of institutionalised power by introducing a new conditional connective '$\Rightarrow_s$'. Such a connective is intended to express the 'counts as' connection holding in the context of an institution s as described, notably,

[5] The model presented here is slightly different with respect to that usually adopted for all these operators. See [29] for the definition of the constraints on $\mathcal{M}$ to validate the axioms schemas recalled above. Such constraints can be easily reformulated for the model structure we have proposed.

by Searle [30]. In other words, when applied to action description, a conditional $A \Rightarrow_s B$ says that action A counts as (or generates, cf. [15]) action B. Notice that this is frequently used in the law: when there is a set of rules which link a certain legal effects to action (or situation) B, and the law wants the same effects to be linked also to a different action (or situation) A, then the law says that A counts as B (for the purpose of the achievement of those effects).

Following Chellas' terminology [5], the logic provided by JS for $\Rightarrow_s$ is a classical (but not normal) conditional logic[6]. In addition, it is characterised by the following axiom schemas:

$$((A \Rightarrow_s B) \wedge (A \Rightarrow_s C)) \rightarrow (A \Rightarrow_s (B \wedge C)) \tag{26}$$

$$((A \Rightarrow_s B) \wedge (C \Rightarrow_s B)) \rightarrow ((A \vee C) \Rightarrow_s B) \tag{27}$$

and, possibly, by

$$(A \Rightarrow_s B) \rightarrow ((B \Rightarrow_s C) \rightarrow (A \Rightarrow_s C)) \tag{28}$$

JS's analysis is then integrated by introducing the normal **KD** modality D_s. This is suggested to express all constraints on s among which the link 'counts as' is included. In other words, D_sA means that A is "recongnised by the institution s" [29]. Accordingly, it is adopted the following schema:

$$(A \Rightarrow_s B) \rightarrow D_s(A \rightarrow B) \tag{29}$$

Besides the general meaning of D_s, one of the main consequences of D_s is to make possible a restricted version of detachment of the consequent of $\Rightarrow_s$. In fact, by accepting

$$(A \Rightarrow_s B) \rightarrow (A \rightarrow D_sA) \tag{30}$$

it can be derived that

$$(A \Rightarrow_s B) \rightarrow (A \rightarrow D_sB) \tag{31}$$

In other words, if $A \Rightarrow_s B$ and A, then B should be the case in s, namely D_sB.

3.2 A New Proposal

In this section, we will provide a fresh characterisation of the counts-as connection that, though preserving most properties of the model of JS, adopts a different perspective.

Rather then introducing a separate logic for the counts-as connection, and then linking it with a D_s logic (relativised to the particular institution under consideration), we use one conditional operator $\Rrightarrow$ to express any normative connections or constants, in any institutions.

In addition, we will use the D_s operator as in [18] but we will apply it to the consequent of such conditional links, in order to relativise this consequent to the particular institution under consideration. We argue that any institution can

[6] In other words, the logic for $\Rightarrow_s$ contains the rules RCEA and RCEC but not RCM.

only state what normative situation holds for itself, given certain conditions, but according to a general type of conditionality. Actually, we can have different types of facts between which a conditional link may hold with regard to an institution s: (1) links between brute facts and s-facts (raising one's hand is making a bid), (2) links between s-facts and other s-facts (making a bid is a contractual offer) , (3) links between s'-facts and s-facts, where s' is an institution different from s (a catholic or muslim marriage counts as a civil marriage).

By applying the D_s modality to the antecedents or to the consequents of our conditionals we can easily express and clearly distinguish all those connections.

So let us first try to characterise a normative conditional $\Rrightarrow$? Actually, we have different options depending on the approach we want to adopt. For example, we can view $\Rrightarrow$ either as a monotonic or a nonmonotonic link. Let us focus in particular on the second alternative since it is widely acknowledged that normative reasoning is basically defeasible (cf. [23]; see, in general, [24])[7]. In this perspective, a number of diverse choices are available. One could be that of adopting a logical machinery for dealing with defeasible logic [22, 1, 25]. Otherwise, along the same line followed by JS, it is possible to define a conditional operator $\Rrightarrow$ within a framework of conditional logic. For example, it seems reasonable to view it at least as the conditional counterpart of the nonmonotonic preferential system (see [2, 19, 10]). In fact, such a system embodies the minimal properties without which it should not be considered a logical system, plus the rule Or (see here below, axiom 35). This last property, accepted in its deontic version, e.g., in the Hansson-Lewis account of conditional obligations [20, 26], is also needed to model the count-as link (cf. [18]; see also the previous section). In other words, the logic for $\Rrightarrow$ contains besides classical propositional logic, the following axioms

$$A \Rrightarrow A \tag{32}$$

$$(A \Rrightarrow B) \wedge (A \wedge B \Rrightarrow C) \rightarrow (A \Rrightarrow C) \tag{33}$$

$$(A \Rrightarrow B) \wedge (A \Rrightarrow C) \rightarrow (A \wedge B) \Rrightarrow C) \tag{34}$$

$$(A \Rrightarrow C) \wedge (B \Rrightarrow C) \rightarrow (A \vee B) \Rrightarrow C) \tag{35}$$

and is closed under the usual inference rules

$$\frac{A \equiv B}{(A \Rrightarrow C) \rightarrow (B \Rrightarrow C)} \tag{$RCEA$}$$

and

$$\frac{(A_1 \wedge \cdots \wedge A_n) \rightarrow B}{(C \Rrightarrow A_1 \wedge \cdots \wedge C \Rrightarrow A_n) \rightarrow (C \Rrightarrow B)} \tag{RCK}$$

This logic, which is nothing but Burgess [3] system $\mathcal{S}$, permits to derive as a theorem the following restricted version of transitivity [21]:

$$((A \wedge B) \Rrightarrow C) \rightarrow ((A \Rrightarrow B) \rightarrow (A \Rrightarrow C)) \tag{36}$$

[7] For some short remarks on this matter, see also the next section.

We think this is a good thing because, even in our approach, some form of transitivity for $\Rrightarrow_s$ is highly desirable. Although we are aware that this restricted version could not be fully satisfactory we have not been able to find examples where (36) is not adequate.

So far, so good. However, some problems are still open.

What about the detachment of the consequent? Instead of adopting (29)-(31), we propose the following rule for $\Rrightarrow$:

$$\frac{\Gamma \vdash A \qquad \Gamma \vdash A \Rrightarrow B}{\Gamma \vdash B} \tag{37}$$

where, for any formula A', if $\Gamma \vdash A' \rightarrow A$, then $\Gamma \nvdash A' \Rrightarrow \neg B$.

This is a restricted version of Modus Ponens for the conditional $\Rrightarrow$. It expresses the idea, well-know in nonmonotonic reasoning, that the detachment of the consequent is blocked when a more specific conditional permits to infer a conflicting conclusion. In fact, we want a set of formulas Γ be consistent when, e.g., $\Gamma = \{A \Rrightarrow B, A \wedge C \Rrightarrow_s \neg B\}$. In this case, however, the truth of A does not imply B whereas this is possible when $A \wedge C$ holds.

Let us give now a suitable characterisation of the "institutional modality" D_s. We believe that the logic for such an operator should be closed under logical equivalence and contain the following axiom schemas:

$$D_s A \rightarrow \neg D_s \neg A \tag{38}$$

$$(D_s A \wedge D_s B) \rightarrow D_s(A \wedge B) \tag{39}$$

Notice that we do not accept the necessitation rule. Since the intended meaning of this modality is to express the domain of the institutional facts holding in a given institution, the lack of necessitation is reasonable: it sounds strange that $\top$ is an institutional fact for any institution s.

Finally, on the basis of $\Rrightarrow$ we can define a relativised operator $\Rrightarrow_s$ operator, which behaves similarly to $\Rightarrow$ of JS. For this purpose we need to combine a link $A \Rrightarrow D_s B$ from a brute fact to an institutional fact, and a link $D_s A \Rrightarrow D_s B$ from an institutional fact to another institutional fact.

In this perspective, we state the following definition:

$$(A \Rrightarrow_s B) =_{def} (A \Rrightarrow D_s B) \wedge (D_s A \Rrightarrow D_s B) \tag{40}$$

3.3 A Comparison

Let us now compare the behavior of our logic to the original proposal of JS. Let us first focus on the communalities.

Basically, the main commonality between the two approaches is that both allow for the detachment of institutional consequents from brute facts and count-as conditionals: as in JS's approach $D_s(B)$ follows from A and $A \Rightarrow_s B$, according to (30, and 31), so in our approach $D_s(B)$ follows from A and $A \Rrightarrow_s B$, according to definition (40) (which implies $A \Rrightarrow D_s(B)$) and inference rule (37). In addition, we accepted for our definition of $\Rrightarrow_s$ a great part of the axiom schemas introduced by JS for $\Rightarrow_s$. In particular theorems corresponding to axioms 26 and 27 can be derived in our system, on the basis of definition 40.

Let us now consider the differences between the two systems.

One significant difference between our approach and JS's system is that our approach allows for non-monotonic reasoning. We believe that nonmonotonicity should be an essential property for the count-as link, but also in general for any normative conditional. This is the reason why we would like to treat it in a uniform way. Consider the following two examples.

In an auction if the agent i raises one hand, this may count as making a bid. However, this does not hold if i raises one hand *and* scratches his own head. However, we still want to have that "i's raising one hand 'counts as' i's making a bid" and the fact that i raised one hand imply that i made a bid.

As an example that does not deal with count-as connections, consider the classical fact that if one causes a damage, than one is liable, but this does not happens if one is acting in self defence.

It seems clear to us that the type of nonmonotonic reasoning involved the two example is exactly the same.

The main reason why JS's approach cannot appropriately deal with non-monotonicity is that it is joins two logical systems, the $\Rightarrow_s$ and the D_s logics, the second of which is monotonic. It is always possible to jump from the one into the other, by using the axiom (29). Since the second, monotonic system is used for the count-as detachment ((29)-(31), then this is necessarily monotonic. Even if $\Rightarrow_s$ logic were defeasible, defeated conclusions could be reinstated by moving into the D_s logic. In addition, note that JS's $\Rightarrow_s$ logic includes transitivity, by (28), which implies monotonicity (see [19]). As a matter of fact, as an alternative to (28), they also propose

$$(A \Rightarrow_s B) \rightarrow ((B \Rightarrow_s C) \rightarrow D_s(A \rightarrow C) \qquad (41)$$

which would solve the transitivity problem, but still would not overcome the above critique.

A second significant difference between the two approaches concerns weakening of the consequent. As JS pointed out, this property should not hold for the count-as link: it is quite odd that, in an auction, 'raising one hand counts as making a bid' implies the sentence 'raising one hand counts as making a bid or drinking some water'. However, the combination of the count-as and the D_s logics, which is a normal modality **KD** leads to the weakening of institutional consequences: A and $A \Rightarrow_s B$ imply $D_s(B)$, which implies $D_s(B \vee C)$. For example, in JS's system

$$(raising\_one\_hand) \Rightarrow_s (making\_a\_bid)$$

implies

$$D_s((raising\_one\_hand) \rightarrow ((making\_a\_bid) \vee (drinking\_some\_water)))$$

In our system weakening of institutional consequences does not hold, since we define D_s in terms a non-normal **D** modality without necessitation and axiom **K**, thus avoiding that D_s is closed under logical consequence[8].

In fact, the **K** schema was needed in JS's approach to guarantee detachment of institutional consequents through material implications modalised by D_s.

Obviously, because of the new characterisation of D_s and of our definition of the count-as link, the adoption RCK for $\Rrightarrow$ is not problematic since it determines the closure of $\Rrightarrow$ under logical consequence only when the consequent is not modalised by D_s.

4 Proclamation and Declarative Power

On the basis of the notions introduced in the previous section, we will now analyse a phenomenon which has a major importance in legal and similar institutions: this is the decentralised intentional creation of new normative positions. We will first describe the actions (i.e., proclamations) which maybe used to create those positions, and then we will consider the institutional rules making those actions effective, and finally we will analysis the power which these rules attribute (declarative power).

4.1 The Notion of Proclaiming

The idea of proclaiming is used to cover all those speech acts by which a subject makes a statement expressing a certain proposition, and this statement has the function (purpose, point or objective) of making this proposition true. So, we say that one subject i proclaims that A when i makes a statement which expresses A, and has the function of realising A.

The type of speech act we have so defined has some interesting peculiarities.

First, note that it is neutral in regard to intention-based [14] and non intention-based theories of speech acts [17]. By saying that the proclamation that A has the function to achieve A we do not specify how the notion of function is to be characterized: it may be determined by the intention of the speaker, by the intention attributed to the speaker by its interlocutor, by a shared convention, by a communication protocol, etc. What is sufficient, for our purpose, is that the act has a word to world direction of fit [31], that is that has the function to change the normative world to make it fit the content of the act.

Secondly, note that a proclamation is not necessarily effective (it does not necessarily produce A). When the notion of function is interpreted with reference to the intention of the speaker it necessarily involves an attempt to achieve A, but this attempt may not be successful. Whether it is successful or not, within a certain institutional context, depends on whether that institution makes it

[8] The reader who feels this choice unsatisfactory has a different option. It is enough to give up the necessitation rule for D_s. In this way, axiom **K** can be retained, thus obtaining a quasi-normal system [32, ch. 3]. However, this option will not be considered here.

effective. It is up to the institutional rules to establish whether i's proclamation that A, in the conditions in which it is made, produces A or not.

Thirdly, the idea of proclaiming is neutral in regard to what is proclaimed. So a proclamation can play the role usually attributed to many different speech acts. A proclamation of i can be an attempted commissive, as when its content is OE_iA, an attempted command, when refers to OE_jA, with j different from i, an attempt to free oneself from an obligation, as where its argument is $\neg OE_iA$.

The notion of proclaiming is formalised by the operator *proc*. Such an operator will be indexed by agents. In this way, $proc_iA$ means that i proclaims that A. As said, *proc* is not necessarily successful and so we do not accept:

$$proc_iA \to A \tag{42}$$

On the other hand, it is reasonable that the logic for this operator is closed under logical equivalence and is characterised at least by the following axiom:

$$(proc_iA \wedge proc_iB) \equiv proc_i(A \wedge B) \tag{43}$$

Of course, we have also to accept the following axiom schema:

$$proc_iA \to H_iA \tag{44}$$

A matter we think deserves special attention is about the intended effects of *proc*. A discussion of this question concerns how to represent the notion of institutional power. For our purposes, it is worth distinguishing in particular two kinds of power: the power to ascribe obligations and the power of conferring powers to ascribe obligations.

Well, let us consider when a proclamation is effective. Unfortunately, there is not much that we may say in general. We may just say that a proclamation is effective if the concerned institution provides for its effectiveness, i.e. the institution recognises that, by proclaiming A, one produces the normative state A. This means that, if the concerned institution has (or possibly implies) a rule: $proc_iA \Rrightarrow_s E_iA$[9], then, for the institution it holds that, by proclaiming that A, i produces A. In other words, for the institution i's proclamation that A counts as (or generates) i's production of A. Note that according to the action logic above presented, E_iA implies A. Therefore when a $proc_iA$ is effective A should follow. When an institution provides for the effectiveness of a proclamation to the effect that A, we say that the subject of the proclamation has a declarative power with respect to A:

$$DeclPow_iA =_{df} proc_iA \Rrightarrow_s E_iA \tag{45}$$

According to (45), if an agent i has the power over j to ascribe the obligation to achieve A, the following formula holds:

$$proc_iOG_jA \Rrightarrow_s E_iOG_jA \tag{46}$$

[9] Where, as we argued, $proc_iA \Rrightarrow_s E_iA$ is an abbreviation of $(proc_iA \Rrightarrow D_sE_iA) \wedge (D_sproc_iA \Rrightarrow D_sE_iA)$.

More generally, i's power to ascribe an obligation also concern the creation of a deontic channel according to a specific hierarchy. This means that i is empowered to oblige other agents:

$$(proc_i OEI_j A \Rrightarrow_s E_i OEI_j A) \tag{47}$$

It is immediate to see that the following formula can be proved from (47:

$$(proc_i OG_j A \Rrightarrow_s EI_i A) \tag{48}$$

On the other hand, i has the power to delegate the power to make it the case that A if we have that

$$(proc_i(proc_j A \Rrightarrow_s E_j A)) \Rrightarrow_s E_i(proc_j A \Rrightarrow_s E_j A) \tag{49}$$

Thus we are ready to define the notion of power to delegate powers of ascribing obligations. Following (49), this can be trivially done as follows:

$$(proc_i(proc_j OG_k A \Rrightarrow_s E_j OG_k A)) \Rrightarrow_s E_i(proc_j OG_k A \Rrightarrow_s E_j OG_k A) \tag{50}$$

or, more generally,

$$(proc_i(proc_j OEI_k A \Rrightarrow_s E_j OEI_k A)) \Rrightarrow_s E_i(proc_j OEI_k A \Rrightarrow_s E_j OEI_k A) \tag{51}$$

We may also have a kind of power, which includes both the power of conferring a power creating a normative position (an obligation or its negation) and also the power of transferring to others a similar power. We define this type as a sort of recursive power *RecDeclPow*. It can be formalised following a similar idea as that expressed in (22) for EI. In other words,

$$\begin{aligned} &RecDeclPow_i(OG_k A) \equiv \\ &DeclPow_i(OG_k A) \wedge (\bigwedge_{j \in Ag_{\leq}}^{k \leq j \leq i} DeclPow_i(RecDeclPow_j(OG_k A))) \end{aligned} \tag{52}$$

The above formula means that the holder i of the recursive declarative power is enabled to exercise his power in two ways. The first capacity $DeclPow_i(OG_k A)$, enables i to make so that k is obliged to realize A. The second capacity $DeclPow_i(RecDeclPow_j(OG_k A))$ enables i to transfer to another agent j the same recursive declarative power which i possesses. This latter notion is useful in those cases in which an organization is extended over multiple levels, and the top level wants to delegate not only the performance of the action, but also the command to perform it.

4.2 Hierarchy among Agents

As we have alluded to in the previous sections, to deal with the notion of power we need to introduce an explicit relation of hierarchy $\prec$ among agents. How to characterise $\prec$? In [11], for instance, it is suggested that the power relation should correspond to a partial ordering on the class of agents.

This characterisation is too weak for our purposes. What about a total ordering? It is clearly too strong: usually, an institution does not require that, for each pair of agents, one is superior to the other. A reasonable condition is then that $\prec$ corresponds to a total ordering with clusters. In other words, we have that, for every two agents i and j such that

- $i \in Ag_m$ and $j \in Ag_n$;
- $Ag_m \subseteq Ag$ and $Ag_n \subseteq Ag$;
- $Ag_m \cap Ag_n = \emptyset$;

either $i \prec j$ or $j \prec i$.

It is worth noting that this ordering is also dependent on the operator *proc* and the connective $\Rrightarrow_s$. In particular, it seems to be intuitive to reformulate the declarative power of an agent i to ascribe obligations $DeclPower_i OG_j A$ by stipulating that $\neg j \prec i$.

On the other hand, something stronger can be accepted. For instance, new hierarchical relations between agents can be made explicit:

$$DeclPower_i OG_j A \Rrightarrow_s i \prec j \tag{53}$$

We think that also (53) is quite reasonable. If an agent i has the power to ascribe obligations to another agent j, this mean, at least defeasibly, that i is superior to j. However, accepting (53) could raise some problems for a semantic treatment of $\prec$. In fact, since we have the detachment for $\Rrightarrow_s$, (53) permits to infer new hierarchical relations between agents. How to deal with question?

As usual, an action can be conceived as a transition between two states. Obviously, a speech act is a very special kind of action. In this perspective, we have to consider the dynamic corresponding to institutionalised speech acts, in particular *proc* whose argument is either an obligation (e.g., OA or $OE_j A$) or an attribution of power (e.g., $i \prec j$). Those actions transform the state actual at the time of utterance in a state where the content of the speech act holds. Semantically, we can analyse this kind of acts by means of two dimension hierarchical fibred models. Shortly and roughly a two dimensional hierarchical model is a possible world structure where the points of the outer logic are models of the inner logic and the points are related by a fibring function. For the application at hand we can adopt a revision function as the fibring function of the model. In other words, each time we can detach $i \prec j$ from $DeclPower_i OG_j A \Rrightarrow_s i \prec j$ it is possible to define via the fibring function another model where $i \prec j$ holds (see [13] for the technical details).

5 Conclusions and Future Work

In this paper we have analysed some concepts useful to model the concept of normative power. We have discussed some well-known action operators such as

E, G, H and their combination with deontic logic. In this perspective, we have thus introduced a new operator EI able to capture the idea of deontic influence of an agent over an ordered set of agents. We have also argued that a convincing account of the notion of power has to be integrated

1. by logically characterising the count-as link holding within institutions;
2. by introducing a new operator corresponding to the notion of proclaiming;
3. by making explicit a superiority (hierarchy) relation between agents.

As regards the first point, we started from the analysis of Jones and Sergot but developing a different logical characterisation. One of the aims of our approach was designing a unique nonmonotonic conditional able to model both the count-as link and other normative links. The resulting formalisation seems to enjoy good properties, thus avoiding some limitations of JS's system.

With regard to point 2 above, we have defined a new modal operator *proc* to represent the speech act of proclaiming. The concept of proclaiming has thus been combined with the count-as link in order to provide reasonable definitions of agents' power both to ascribe obligations and to transfer such a power to other agents.The importance of communication and speech acts in normative and institutional domains is widely acknowledged [34, 16, 11]. However, a common view in most approaches is that of providing as many operators as different speech acts are needed. Accordingly, there are operators to represent assertives, declarations, directives, commisives etc (see, e.g., [8]). We have argued for a different perspective according to which it is sufficient to devise only one "minimal" speech act operator. As a consequence, differentiating the speech acts depends on the specific nature of the argument in the scope of *proc*. For example, if an obligation occurs within the scope of *proc*, the resulting speech act is nothing but a directive. This approach strongly simplifies the logical machinery. However, it seems to be enough to model the basic notions needed to describe the dynamics of institutional systems.

Concerning point 3, we have introduced a binary connective $\prec$ to account for explicit hierarchical relations between agents. This fact permits to introduce some rational criteria within institutions, such as that of avoiding circular chains of deontic influence. In a similar perspective, we have shown how it is possible to derive superiority relations when a certain power (e.g., to ascribe obligations) holds in a given institution.

Finally, we suggest a couple of refinements that could enrich the logical framework presented in this paper.

For example, a realistic definition of the operator *proc* can be provided by labelling such an operator both by the speaker of the speech act of proclaiming (as we do here) and by its addressee. This fact could be useful, e.g., to model situations where *proc* is iterated. Moreover, *proc* may transformed so that its argument becomes a pair consisting of a statement s and a state of affairs A. In this way, an expression like $proc_j(A, s)$ would mean that the subject j proclaims that A through s. In other words, proclaiming that A through statement s, j produces A.

In addition, the binary operator $\prec$ could be also indexed by formulas. Accordingly, $i \prec_A j$ means that i is superior to j with respect to the achievement of A. This fact would make much more complicated the semantic interpretation of this operator. On the other hand, it seems to reasonable to limit the power of an agent over other agents only with reference to a specific pattern of actions and goals. In this perspective, notice that, in the presence of a rule like $A_1, \ldots, A_n \Rrightarrow A$ we could have trivially the following rule:

$$\frac{i \prec_A j \qquad A_1, \ldots, A_n \Rrightarrow A}{i \prec_{A_k} j} \qquad (1 \leq k \leq n) \tag{54}$$

Both the above refinements, plus a full characterisation (namely, by presenting a full semantics and metalogical results) of the operators here discussed are matter of future work.

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