The Ontology of Group Agency

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Abstract. We present an ontological analysis of the notion of group agency developed by Christian List and Philip Pettit. We focus on this notion as it allows us to neatly distinguish groups, organizations, corporations – to which we may ascribe agency – from mere aggregates of individuals. We develop a module for group agency within a foundational ontology and we apply it to organizations.

Keywords. Group agency, judgment aggregation, organization, social ontology.

1. Introduction

The problem of ascribing agency to groups of individuals, corporations, organizations and more generally to those entities that are made of collectivities of individuals is a fundamental issue in social ontology and has important consequences on our conceptual understanding of collective responsibility. In this paper, we shall deploy the philosophical investigation due to Philip Pettit and Christian List [14] on the concept of *group agency* that provides a rich theory of several types of groups and allows for developing a theory of responsibility of collective agents. Our aim is to provide an ontologically aware analysis of group agency by integrating List and Pettit's theory within the framework of a foundational ontology.

List and Pettit's contribution is placed within a wider approach to the justification of public choices and is one of the important perspectives in contemporary political philosophy. In a nutshell, in order to ascribe responsibility to collectivities of individuals, we need to be able to ascribe *agency* to the group itself [19]. In turn, in order to ascribe agency, the group needs to exhibit at least a modicum of rationality that expresses a form of cohesion of the group behavior and coherence of the group decision. The point is to distinguish collective agents from "mere collections" of individuals [14] and to ascribe agency only to the former. For example, we want to distinguish between a parliament that is supposed to make possibly consistent and responsible decisions and a number of randomly picked individuals whose behavior as a group is totally idiosyncratic. List and Pettit's approach is valuable because it provides the means for understanding both conceptually and mathematically what group rationality is. For our purposes, this is the main motivation for focusing on this approach to collective agents and omit, at least in this paper, a comparison with the literature on joint action and collective intentionality; we simply mention that a number of recent contributions compare the two approaches, see for example [5, 24, 14].

We can informally rephrase the condition for agency discussed in [14] by means of the following two constraints, that remind the belief-desire-intention model BDI used in multiagent systems. We ascribe agency to something whenever: 1) It has representational and motivational states, i.e. states that represent its information structure at a given moment and states that represent the environment and the goals that it has to achieve. 2) It has the capacity of processing its representational and motivational states and to interact with the environment in a possibly rational manner.

In order to model the first condition, List and Pettit build on the rich tradition of logical modeling of propositional attitudes: "The agent's representations and motivations can be modeled as attitudes held towards certain propositions" ([14], p. 42). In order to apply condition 1) to groups, we need to define what are the propositional attitudes that can be ascribed to collectivities. For this purpose, List and Pettit develop the notion of *collective propositional attitude*, by using the methodology of social choice theory (SCT) [10] that allows for mathematically grasping the relationship between the attitudes of a number of individuals and a single attitude that aggregates them. SCT is a branch of welfare economics that studies the procedures to aggregate individual preferences into a single social preference, so to respect as much as possible the individual stances. One paradigmatic example of the application of SCT is voting theory, namely the study of the formal properties of voting procedures such as the majority rule. In recent years, SCT has been applied to multiagent systems and AI [4] to model knowledge representation for collectives of agents.

Condition 2) is approached by tackling the narrower problem of consistency of collective attitudes. Consistency or non-contradiction is a crucial feature for agency since it allows for distinguishing the behavior of a single agent, who is supposed to exhibit at least a minimal form of coherence by not maintaining A and $\neg A$ at the same time, from the behavior of a number of agents, for which contradictory positions are simply expressions of possible disagreement. However, as we shall see, famous impossibility theorems state that it is not always possible to aggregate individual attitudes into a consistent collective attitude. A crucial example is the following. Take a committee composed by three members, who have to decide whether to implement a policy B: "we should increase workers' salaries" on the grounds of A: "low salaries cause crisis" and the material implication $A \to B$: "if low salaries cause crisis, then we should increase workers' salaries". The information at issue is here represented by means of propositional logic and every agent is supposed to be rational. Now suppose members hold different opinions, as follows.

	A	$A \to B$	B
1	yes	yes	yes
2	no	yes	no
3	yes	no	no

Agent 1 accepts the three propositions, 2 does not accept A but accepts B for different reasons, and 3 agrees on the premise A but thinks it is not sufficient to conclude B. If individuals vote by majority, then the collective accepts A, which is voted by 1 and 3, it accepts $A \to B$, voted by 1 and 2, but it does reject B. If we assume that rejecting a proposition is equivalent to accepting its negation, then, even if each individual opinion is logically coherent, the collective set $\{A, A \to B, \neg B\}$ is inconsistent. This toy example of collective inconsistency instantiates a famous case known as *discursive dilemma* that has received increasing attention in the past decade and has provided the seminal results in the formal theory of *judgment aggregation* [13, 15]. Judgment Aggregation is a branch of SCT that focuses on the study of the aggregation of logically interconnected propositions. Discursive dilemmas show that the problem of ascribing agency to groups requires a careful examination of which procedures that aggregate individual attitudes ensure consistency. Moreover, it is important to stress that discursive dilemmas, far from being envisaged as thought experiments, actually happened in the legal practice of collegial courts and have been perceived by legal scholars as jeopardizing the legitimacy of collegial decisions [12].

In this paper, we provide an ontological foundation to the notion of group agent. We shall place the theory of group agency within the framework of the foundational ontology DOLCE [17, 2]. Moreover, endorsing List and Pettit's non-reductionist view of group agents, we shall argue in favor of a multiplicative view of group agents, namely the group agents and the aggregates of individuals are distinct objects of the ontology. Although group agents are not reduced to aggregates of individuals, we shall analyze the dependence of group agents on their substrata by means of the concept of grounding [9, 6]. By placing the theory of group agency in the wider context of a detailed foundational ontology, we can relate group agency with other modules of DOLCE, in particular with the social module [18] and with organizations [3]. Hence, we can apply the concept of group agent to describe which types of organization, corporation, and general collective entities may be viewed as agents. This provides a conceptual justification to the ascription of responsibility to organizations.

The remainder of this paper is organized as follows. Section 2 presents the formal approach of Judgment Aggregation (JA). JA provides a general theory of the aggregation of propositional attitudes [7], thus it provides the mathematical grounding of our formalization and shall be used as a basic layer to develop our ontological analysis. Section 3 presents our ontological modeling of the notion of group agency by placing our analysis within the framework of DOLCE[17, 2]. Section 4 instantiates our analysis to organizations. Section 5 concludes.

2. Judgment aggregation

The content of this section is based on the standard presentation of JA in [15], rephrased in [8]. Let P be a set of propositional variables. The language L_P is the set of propositional formulas built from P by using the usual logical connectives $\neg$, $\wedge$, $\vee$, $\rightarrow$, $\leftrightarrow$. If A is a propositional formula, define $\sim A$, the *complement* of A, as $\neg A$ if A is not negated, and as B if $A = \neg B$. We define an **agenda** of propositions as a finite nonempty set $\Phi \subseteq L_P$ that is closed under complements: if $A \in \Phi$ then $\sim A \in \Phi$. An agenda represents the matter of discussion in a given situation. Agents may approve or reject a given matter and the rejection of A is modeled by the acceptance of $\sim A$. A **judgment set** J on an agenda Φ is simply a subset of the agenda $J \subseteq \Phi$. We call a judgment set J **complete** if $A \in J$ or $\sim A \in J$ for all $A \in \Phi$, **complement-free** if for all $A \in \Phi$ it is not the case that both A and $\sim A$ are in J, and **consistent** if there exists an assignment that makes all formulas in J true.

These constraints model a notion of rationality of individuals, i.e. they respect the rules of (classical) logic.[1] The property of complement-freeness is called *weak con-*

[1] These requirements are to be understood in a normative way, e.g. we expect that a member of the parliament does not vote for a proposal A and a proposal $\neg A$ at the same time.

sistency in standard JA literature and its formulation here is due to [8]. Note that complement-freeness is weaker than logical consistency: it prevents contradictory sets only of the form of $\{A, \neg A\}$, whereas it permits inconsistent sets such as $\{A, A \to B, \neg B\}$, the one we have encountered in the discursive dilemma. The motivation for distinguishing consistency and complement-freeness shall be clear at the end of this section.

Denote by $J(\Phi)$ the set of all complete and consistent subsets of the agenda Φ, i.e. the set of all possible rational judgment sets on Φ . Given a set $N = \{1, \ldots, n\}$ of *individuals*, denote by $\mathbf{J} = (J_1, \ldots, J_n)$ a *profile* of judgment sets, one for each individual. A profile lists all the individual judgments involved in the decision at issue. We can now introduce the concept of aggregation procedure: An **aggregation procedure** for an agenda Φ and a set of individuals N is a function $F : J(\Phi)^n \to \mathscr{P}(\Phi)$.

An aggregation procedure maps any profile of individual judgments to a single collective set (an element of the powerset $\mathscr{P}(\Phi)$). Given the definition of the domain of the aggregation procedure, the framework presupposes *individual rationality*: all individual judgment sets are complete and consistent. Note that we did not yet put any constraint on the collective judgment set, i.e. the result of aggregation, so that at this point the procedure may return an inconsistent set of judgments. For example, in the discursive dilemmas of the previous section, the majority rule maps the profile of individual judgments into an inconsistent set $\{A, A \to B, \neg B\}$.

The rationality of the output of the aggregation is defined by the following property. An aggregation procedure F, defined on an agenda Φ, is said to be **collectively rational** iff F is **complete**: $F(\mathbf{J})$ is complete for every $\mathbf{J} \in J(\Phi)^n$ and **consistent**: $F(\mathbf{J})$ is consistent for every $\mathbf{J} \in J(\Phi)^n$.

JA studies the desirable properties of aggregation procedures. For sake of example, we informally discuss three properties Anonymity (A), Neutrality (N), and Independence (I). Anonymity states all individuals should be treated equally by the aggregation procedure. Neutrality is a symmetry requirement for propositions, meaning that all the issues in the agenda have the same weight. Independence says that if a proposition is accepted by the same subgroup under two distinct profiles, then that proposition should be accepted either under both or under none. List and Pettit [13] proved a famous impossibility theorem that is at the origin of JA literature: it states that there are agendas.[2] Φ such that there is no aggregation procedure $F : J(\Phi)^n \to \mathscr{P}(\Phi)$ that satisfies (A), (N), (I) and collective rationality.

In particular, for any aggregation procedure that satisfies (A), (N), and (I), there is a profile of judgment sets that returns an inconsistent outcome. The majority rule satisfies (A), (N), and (I), accordingly, there are cases of inconsistent aggregation exemplified by discursive dilemmas.

JA can treat many voting procedures and characterize whether they may return inconsistencies. Since the notion of aggregation procedure is very abstract, one can in principle model more complex procedures or norms, such as those that define decision making in organizations (a simple example being a dictatorial aggregation that always returns the judgment set of a designated individual j, the chief of the corporation).

We have seen that group agency requires at least a minimal form of rationality. In a slight departure from List and Pettit's view, we shall use the condition of *complement-freeness* in order to model minimal rationality. Our motivation is that we do not want to

[2] For a characterization of which agendas may lead to inconsistency, see [15] and [8].

rule out group agents that use the majority rule as an aggregation procedure. Although the majority rule does not satisfy collective rationality, still it ensures complement-freeness [8, 20]. The minimal consistency that we are assuming is enough to rule out immediately detectable contradictions and provide a minimal cohesion of the group decisions.

General propositional attitudes (beliefs, desires, preferences, etc) can be taken into account in the framework of JA [7]. It is enough to extend the logical language that models individual attitudes. For example, if we want to deal with beliefs, we extend the agenda Φ by adding individual belief operators in epistemic modal logic B_iA, standing for "The agent i believes that A". In the general case, it is possible to define judgment sets that are rational with respect to a number of logical systems [20] and extend the definition of aggregation procedure accordingly.

3. Ontological foundation of group agency

JA provides the mathematical means to view the group as a *single agent* and to ascribe propositional attitudes to the group itself by means of an aggregation procedure. We develop an ontological foundation of group agency by integrating the JA analysis within DOLCE. Our main conceptual contribution is to present an explicit construction of group agency as a *social concept* that classifies aggregates of individuals. Then, we present our non-reductionist approach to group agents by viewing the classification of an aggregate of individuals as a group agent as the constitutive act that grounds the existence of a new object. That is, aggregates of individuals and group agents are distinct objects in our ontology.

Firstly, we shall present the construction of *groups* as social concepts, then we turn to define concepts of group agency. The main idea is that an aggregate of individuals counts as a group agent only if the individuals acknowledge an aggregation procedure that unifies their heterogeneous attitudes into a single attitude. Individuals' acknowledgement of an aggregation procedure means that they delegate their agency to the group agent.

3.1. The construction of group agency as social concept

For a synopsis of the categories that we use and for the main features of DOLCE [2], we refer to Table 1 at the end of the paper. As usual, we shall assume that same level categories are disjoint. AOI is the category of aggregates of individuals, which is a subcategory of the category of arbitrary (mereological) sums AS in DOLCE. AOI contains mere collectivities of individuals of type IND, that is the class of persons as physical objects. We represent the membership of an individual i in an aggregate x by means of the relation $\mathsf{IN}(i,x,t)$ that holds between individuals, aggregates of individuals, and times.[3]

a1 $\mathsf{IN}(i,x,t) \rightarrow \mathsf{IND}(i) \wedge \mathsf{AOI}(x) \wedge \mathsf{TL}(t)$

Next, we define a number of subcategories of instances of norms N [1].[4] MNORM denotes the class of norms that define the membership of a specific particular group. Examples of group membership are the norms that define the membership of a specific parlia-

[3]The membership relation can be modeled in mereology by means of the atomic parthood. We have introduced IN for an easier reading.

[4]For lack of space, we omit the typing axioms, they can be easily retrieved from Table 1.

ment, a corporation, a private club, a social network etc. We do not provide any further condition of membership, not to commit to any specific view of groups and to leave a specialization of such concept to domain specific analysis. AGG represents aggregation procedures, in the sense of Section 2, e.g. the majority rule. Aggregation procedures are functions, so in order to stay first-order, AGG contains a finite number of elements that are names for aggregation procedures. Moreover, cfAGG is the class of complement-free aggregation procedures.[5]

Since group agency is constructed as a type of social concept, we recall some elements of the analysis of social concepts in DOLCE. Firstly, *concepts* (C) classify entities at a given time by means of the classification relation $\mathsf{CF}(x,y,t)$ between objects (O), concepts, and time locations (TL)[6]. A social concept is characterized by *anti-rigidity* $\mathsf{AR}(x)$ and *foundational dependence* $\mathsf{FD}(x)$ on another concept [18]. Anti-rigidity means that for any time an entity x is classified under a social concept, there exists a time at which the entity x is present (denoted by $\mathsf{PRE}(x,t)$) but not classified under the concept. *Foundational dependence* means that the definition of x involves at least another concept y that is distinguished from x. This analysis captures social roles, e.g. the president of a company, a member of the parliament, etc. For example, the concept of being member of a parliament is a role (a specific kind of social concept), since the individual who is classified as such *becomes* a representative at a certain time (anti-rigidity) and the definition involves at least another extensionally distinguished concept (e.g. being an individual agent). Roles are defined in [18] as those concepts that satisfy: $\mathsf{RL}(x) \leftrightarrow \mathsf{AR}(x) \wedge \mathsf{FD}(x)$.

Our claim is: *Group agency is a social concept (a role) that classifies aggregates of individuals*. We shall firstly define roles that classify aggregates of individuals. Thus, we extend the domain of the classification relation CF in [18], in order to apply it also to aggregates of individuals (a2). We define two classes of concepts, let CGRP be the class of group concepts (e.g. facebook users) and CGA the class of concepts of group agents (e.g. the US Supreme Court). We assume that concepts in CGRP and CGA are roles:[7]

a2 $\mathsf{CF}(x,y,t) \to (\mathsf{O}(x) \vee \mathsf{AOI}(x)) \wedge \mathsf{C}(y) \wedge \mathsf{TL}(t)$

a3 $\mathsf{CGRP}(x) \to \mathsf{RL}(x)$

a4 $\mathsf{CGA}(x) \to \mathsf{RL}(x)$

Concepts of groups and group agents impose a certain form of cohesion that distinguishes the aggregate classified by them from mere aggregates of individuals. Specific concepts of group and group agent strictly depend on a single membership norm at any time t. The membership specifies the condition under which an individual is a member of the group. We define the relation $\mathsf{M}(y,m,t)$ that connects each concept of group with its membership norm:[8]

a5 $\mathsf{M}(y,t,m) \to (\mathsf{CGRP}(y) \vee \mathsf{CGA}(y)) \wedge \mathsf{MNORM}(m) \wedge \mathsf{TL}(t)$

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[5] Our treatment easily generalizes to account for a number of types of aggregation procedures for different types of attitudes, e.g. judgments, preferences, beliefs...

[6] DOLCE distinguishes different modes of predication: concepts, properties, and individual qualities, [2]. Concepts have an intensional nature.

[7] Note that the definitions are not second-order, concepts are viewed as individuals. This is the *reification* strategy of DOLCE.

[8] The precondition $\mathsf{PRE}(y,t)$ in (a6) and (a7) allows concepts of group and group agent to be created at a certain time.

a6 $\mathsf{CGRP}(y) \to \forall t(\mathsf{PRE}(y,t) \to \exists! m\, \mathsf{M}(y,t,m))$

a7 $\mathsf{CGA}(y) \to \forall t(\mathsf{PRE}(y,t) \to \exists! m\, \mathsf{M}(y,t,m))$

a8 $\mathsf{ACK}(i,n,t) \to \mathsf{IND}(i) \wedge \mathsf{N}(n) \wedge \mathsf{TL}(t)$.

The cohesion of the individuals in the group is modeled by means of the *acknowledgment* relation $\mathsf{ACK}(i,n,t)$ in (a8). This relation is intentionally very abstract so to capture a variety of modes of constitution of groups. For example, members of an organization subscribe the enrollment in that specific organization, employees sign the employment contract, and so on. The acceptance of the norm may be explicit or not, may or not demand an explicit consensus at any given time, so acknowledgment is not an act that is performed at time t, it is a state of the individual that depends on the type of group we are classifying and lasts accordingly. For example, one may enroll in a private club by paying a fee (we say, by acknowledging the membership) and she/he is a member of that club until a given deadline or until she/he explicitly revokes the membership. This treatment correctly allows the same aggregate of individuals to constitute two different groups at a time, by acknowledging two different membership norms (e.g. the group of users of two social networks).[9]

Next, we define a necessary condition for the classification of an aggregate of individuals as a group and as a group agent. We denote by m^t_y the unique membership norm m of the concept y at t: m^t_y exists because of (a6) and (a7), and because of the fact that if $\mathsf{CF}(x,y,t)$ holds, then both x and y are present at time t [18].[10]

a9 $\mathsf{CF}(x,y,t) \wedge \mathsf{CGRP}(y) \to \mathsf{AOI}(x) \wedge \forall i(\mathsf{IN}(i,x,t) \to \mathsf{ACK}(i,m^t_y,t))$

a10 $\mathsf{CF}(x,y,t) \wedge \mathsf{CGA}(y) \to \mathsf{AOI}(x) \wedge \forall i(\mathsf{IN}(i,x,t) \to \mathsf{ACK}(i,m^t_y,t))$

The aggregate x counts as a group or a group agent y at t iff every individual who is extensionally member of x acknowledges the membership norm m^t_y. For example, the set of individuals who are enrolled in a social network can be classified as a group.[11]

We cannot yet ascribe agency to mere groups: groups may lack any minimal form of rationality that is presupposed for agency. Moreover, without an aggregation procedure, we do not have any means to ascribe propositional attitudes to a group.[12] We shall now present the construction of the concepts of group agency as social concepts, by adding a further necessary condition. The peculiarity of concepts of group agency is that they require an aggregation procedure. We assume that, at any given time, the aggregation procedure is unique, cf. (a12). This is motivated by the fact that two different aggregation procedures may lead to inconsistent outcome, violating our assumption of rationality of group agents. We define the relation $\mathsf{A}(y,t,f)$ that specifies for any time the (complement-free) aggregation procedure of the concept of group agent (a11). We de-

[9] We are assuming that membership norms can change through time, so the same concept of group may survive changes in its norm. The time-dependent unicity is required to single out a group.

[10] That is, m^t_y can be defined by a definite description $\iota m.M(y,t,m)$.

[11] We are defining a very abstract notion of group. A comparison with the literature on the ontological status of groups is left for future work. Here, we assume groups are not mere sets, they do have some structure, provided by their membership norm m, cf. [22]. As we are specifying necessary conditions, we do not exclude that particular concepts of groups are not fully specified by the membership norms.

[12] For example, take the sentence: "Twitter users believe that tomorrow is Sunday". Do we mean that each of them believes it? Most of them? Just some of them? Without an aggregation procedure we do not have any means to define in a consistent way what counts as a propositional attitude that may be ascribed to the group.

note by f_y^t the unique (complement-free) aggregation procedure that is associated to the concept y at time t. Finally, (a13) introduces the required necessary condition for concepts of group agency, that is, every individual has to acknowledge the complement-free aggregation procedure f.

a11 $\mathsf{A}(y,f,t) \rightarrow \mathsf{CGA}(y) \wedge \mathsf{cfAGG}(f) \wedge \mathsf{TL}(t)$

a12 $\mathsf{CGA}(y) \rightarrow \forall t(\mathsf{PRE}(y,t) \rightarrow \exists! f \mathsf{A}(y,t,f))$

a13 $\mathsf{CF}(x,y,t) \wedge \mathsf{CGA}(y) \rightarrow \forall i(\mathsf{IN}(i,x,t) \rightarrow \mathsf{ACK}(i,f_y^t,t))$

For example, the set of members of a jury counts as a group agent wrt the majority rule. The acknowledgment of f, $\mathsf{ACK}(i,f,t)$, models the endorsement of the decision procedure that delegates individual agency to the group agent. Summing up, the social concept of group agent classifies aggregates of individuals who are unified by a membership norm and have consistent decisional or reasoning capability.[13]

3.2. Group agents as social objects

Our previous analysis allows for classifying aggregates of individuals as group agents. However, we cannot yet ascribe collective propositional attitudes to an aggregate of individuals. For this reason, we shall view the classification of an aggregate of individuals as group agent as baptizing a new type of social object, the group agent, who is the bearer of collective propositional attitudes. That is, we assume that the group agent is a distinct object wrt to the aggregate of individuals, by endorsing a multiplicative view of entities in our ontology. The motivation for this move is that we want to attribute to the group agent properties of a different kind with respect to those that we may attribute to the mere aggregate of individuals; one crucial example being that we shall ascribe propositional attitudes, therefore agency and responsibility to the group agent and not to the aggregate of individuals. Moreover, by viewing a group agent as a distinguished object, its identity criteria can be appropriately spelled out. We shall introduce the category of group agents GA as a subcategory of agentive social object ASO in DOLCE [18, 3]. The main idea is that a group agent a exists because of the classification of x by a concept of group agency. Moreover, we want to understand the relationship between group agents and aggregates of individuals. We maintain an existential dependency of the group agents on their substrata, by means of the notion of (time-dependent) *grounding*, discussed in particular in [9, 6] and [16]. We say that y is *grounded* (existentially depends on) x at time t and write $x \prec_t y$ to state that the existence of x at t is sufficient to make the existence of y possible. Grounding is assumed to be a strict partial order (i.e. transitive and asymmetric). The notion of grounding is related to the possibility of distinguishing different ontological levels, e.g. the statue and the amount of matter that constitutes it [16]. We define the relation of being at the same level $x \equiv y$ as an equivalence relation (i.e. reflexive, symmetric, and transitive). Moreover, the relations between grounding and ontological levels are specified by the following axioms. We list only the axioms that we use and we refer to [16] for an exhaustive treatment.

[13]We do not assume that every concept of group agency is a concept of group. For example, we want to distinguish the US Supreme Court as a group and the US Supreme Court as a group agent. Moreover, due to the intensional nature of concepts, groups and group agents are distinct, as they have quite different definitions. They are of course related, in the sense that if an aggregate of individuals x is classified by a concept of group agency y, then there exists a concept of group y' that classifies x.

a14 $x \prec_t y \rightarrow \mathsf{PRE}(x,t) \wedge \mathsf{PRE}(y,t)$

a15 $x \prec_t y \wedge x \prec_t z \rightarrow y \prec_t z \vee z \prec_t y \vee z = y$

a16 $y \prec_t x \wedge z \prec_t x \rightarrow y \prec_t z \vee z \prec_t y \vee z = y$

a17 $x \equiv y \rightarrow \neg \exists t (x \prec_t y)$

Axiom (a14) entails that if x grounds y at t, then both exist at time t. Axioms (a15) and (a16) impose downward and upward linearity of the grounding relation. Axiom (a17) states that same level entities cannot ground one another. General arguments for and against those axioms have been discussed in [16]. We shall see that they are appropriate for our analysis of group agents.

We specify the dependency of a group agent a on three entities: its aggregate of individuals, the membership norm m, and the decision procedure f. We write $x+m+f \prec_t a$, where $x+f+m$ is the (extensional) mereological sum of the aggregate of individuals, the membership norm, and the aggregation procedure.[14] We define the class AOIN, whose elements are sums of aggregates of individuals, membership norms, and aggregation procedures, i.e. those elements have exactly the form $x+m+f$, (a18). We assume that group agents, norms, aggregates of individuals, and sums of aggregates of individuals and norms are all distinct ontological levels, viz. axiom (a19) (for lack of space, we omit the full list of axioms). Moreover, we assume that every group agent is in the same level, (a20).

a18 $\mathsf{AOIN}(z) \leftrightarrow z = x+m+f \wedge \mathsf{AOI}(x) \wedge \mathsf{MNORM}(m) \wedge \mathsf{cfAGG}(f)$

a19 $\mathsf{AOIN}(x) \wedge \mathsf{GA}(y) \rightarrow \neg\, x \equiv y$

a20 $\mathsf{GA}(x) \wedge \mathsf{GA}(y) \rightarrow x \equiv y$

The construction of group agents in our ontology is specified by the following axioms. We use again the notation m^t_y, f^t_y to shorten the formulas.

a21 $\mathsf{GA}(a) \wedge \mathsf{PRE}(a,t) \rightarrow \exists z\, \mathsf{AOIN}(z) \wedge z \prec_t a$

a22 $\mathsf{CF}(x,y,t) \wedge \mathsf{GA}(y) \rightarrow \exists a\, (\mathsf{GA}(a) \wedge x + m^t_y + f^t_y \prec_t a)$

Axiom (a21) implies that every group agent is grounded on an aggregate $x+m+f$ at every time it exists. Axiom (a22) implies that the classification of an aggregate of individuals by a concept of group agency is sufficient for the existence of an object a of type GA. Note that the aggregate of individuals x and the group agent a are distinct objects, since we assume that AOI and GA are disjoint. By (a15), (a20), and (a17), we can infer from (a22) that the group agent so constructed is unique (t1). Moreover, by (a16), (a20) and (a17), we can infer that the grounding of a group agent is unique at each time (t2):

t1 $z \prec_t a \wedge z \prec_t b \rightarrow a = b$

t2 $z \prec_t a \wedge z' \prec_t a \rightarrow z = z'$

(t1) provides a necessary condition for identity of group agents. It entails that we cannot distinguish two group agents that have the same groundings at every time. However, we could identify more group agents; since our treatment does not specify any condition on

[14] This move is done for simplifying the presentation. Alternatively, we can avoid sums, use the notion of partial grounding, and write three different grounding statements: $x \prec_t a$, $m \prec_t a$, and $f \prec_t a$. Moreover, one could view group agents as multi-level objects, cf.[16].

diachronic identity, (t1) permits that the same group agent changes its members, reforms the membership norm, or reforms the decision procedure.)[15] The modalities of this dynamic identification may depend on the specific group agent (e.g. a constitutional reform of a state). The concept of grounding allows for many possible extensions and refinement of our treatment: e.g. by extending the classification relation to aggregates of group agents, we can model group agents that are grounded on aggregates of group agents.

3.3. Ascribing propositional attitudes to group agents

We can now present our view of collective attitudes as something that can be ascribed only to group agents. For lack of space, we only sketch the main points. We introduce a time dependent relation $\mathsf{ASC}(x,a,t)$ between propositional attitudes of a certain type, agents, and times. We need a category ATT for propositional attitude that is a subcategory of propositions PROP in DOLCE [17]. This amounts to interpreting propositional attitudes as publicly sharable contents in contrast with mental possibly private objects (e.g. my belief, my desire). We want to make an ontological distinction between individual attitudes and *collective attitudes*.[16] The reason being that, for something to count as a collective attitude, it needs to be ascribed to a group agent: We want to be able to distinguish proper collective attitudes, e.g. “The jury believes that the defendant is guilty”, from figurative ways of ascribing collective attitudes, e.g. “The market wants more austerity”. The point is that such ascription may be metaphorically effective, however it is not grounded in a definition of any agent who is entitled to carry the collective attitude. Namely, the market is not constructed as an agent. We define the category of CATT and put as a necessary condition the existence of a group agent who is the bearer of the collective attitude. Moreover, by imposing the existence of a group agent, (f1) excludes that a collective attitude may be defined by taking the beliefs of random individuals and aggregating them by majority.

f1 $\mathsf{CATT}(x) \wedge \mathsf{ASC}(x,y,t) \rightarrow \mathsf{GA}(y)$

An exhaustive analysis has to show that collective attitudes at a time depend on the aggregation procedure of the group agent at that time. Such a dependence on group agents and aggregation procedures makes collective attitudes social objects, this motivates the categorization of CATT in Table 1. We sketch the construction of collective attitudes, that is analogous to the construction of group agents. Aggregates of individual propositional attitudes can be classified by means of a concept of collective attitude (that depends on an aggregation procedure at a time). Then, we introduce the objects in CATT and we assume that they are grounded on aggregates of individual propositional attitudes, membership norms, and aggregation procedures.

4. Agency, corporations and organizations

We have argued that it is not meaningful to ascribe agency to mere aggregates of individuals. Differently, in cases such as parliaments, representative assemblies, corporations,

[15] Note that concepts of group agency and group agents are not in one-to-one correspondence, e.g. there may be two equivalent concepts that constitute the same group agent.

[16] The choice of terminology is meant to refer to the specific concept of collective attitude in JA and in [14].

organizations, it can be meaningful, and sometimes even necessary, to ascribe attitudes to them. For instance when they are involved in bad happenings or in delicate circumstances, one would like to keep them under the scrutiny and control of the community. Take for example the BP oil disaster of 2010 in the Gulf of Mexico, when the company was sanctioned and forced to pay billions of dollars. This case shows that it is more than reasonable to hold an organization responsible for actions that are believed to be under its control, and therefore agentive. In a previous work [3], we left the issue of agentivity of organizations open:

> A case which is particularly tricky is that of organisations: they act via the action of some physical agent who acts on their behalf; is this to be considered a sort of agentivity (maybe indirect), or should we apply the Occam's razor and say that organisations' actions are to be reduced to agents' actions? We would not commit on this yet and we will leave the question open, focusing our attention on other features of social entities. [3]: p. 227.

In [11], the authors correctly pointed out that in our [3] we did not take a definite position on it, while there is a natural language surface evidence that would urge to consider them as agentive (an argument already developed in [23]). Now, in the light of what presented above, we would like to restate and address the question from an ontological perspective: can organizations be considered as genuine group agents? To briefly recap the previous sections: firstly, we have distinguished aggregates of individuals from groups, stating that when a membership norm is shared among all the individuals composing the aggregate, such an aggregate can be classified as a group. Then, we have distinguished "mere" groups from group agents, by establishing in the framework that when each member of a group acknowledges a decision procedure, that is to say when there exists a mechanism to unify the heterogeneous attitudes of the individuals into a single attitude, a group becomes a group agent. If we go back to the BP example, we can ask whether the organization as a whole displays all the necessary elements to be classified as a group agent. If it were to be classified this way, we should have that every single employee or secretary or workman in every oil-plant acknowledges the decision procedure holding in the organization. For the sake of the argument, let's suppose this is not the case: that would mean that BP as a whole is not a group agent. Should this mean that one cannot attribute any responsibility for the 2010 disaster? The answer is negative, if one can find, among BP's suborganizations, a genuine group agent. However, we can be fairly confident that BP has a group of decision makers who are normatively members of an organization, as the board of directors, and everyone of them has acknowledged a formal procedure to take decisions. So, even if we cannot consider the whole BP as a group agent, it appears that the board of directors of BP can be considered as such. As a consequence, we can claim that, strictly speaking, the organization BP *is not* a group agent, but *has* a group agent in it. We thus include such distinction in our framework, we will then have both *agentive* organizations (categorized in ASO) and *non-agentive* organizations (in NASO). Firstly, we define the concepts of organization CORG. We denote the extensional inclusion of aggregates of individuals by $x \sqsubseteq y$. We assume that the concepts of organization satisfy (a9) and (a6), that is, we assume that organizations, like groups, have membership norms.[17] Moreover, organizations have decisional capacity provided by the following necessary condition:

[17] One can of course separate membership norms of groups and organizations.

a23 $\mathsf{CF}(x,y,t) \wedge \mathsf{CORG}(y) \rightarrow \exists x', y'\ (x' \sqsubseteq x \wedge \mathsf{CGA}(y') \wedge \mathsf{CF}(x', y', t) \wedge m^t_y = m^t_{y'})$

Axiom (a23) means that an organization requires that some of its members may be classified by a concept of group agency. The concept of organization and the concept of group agency are related since they share the same membership norm. By (a22), (a23) entails that there exists a unique group agent a that is grounded on $x' + m_y + f$, thus organizations' decisional capacity is provided by the existence of the[18] group agent (e.g. the president of the organization, the board of directors, etc.) that is made up of *some* members of the organization. That the group agent a is part of the same organization and not another totally separated entity is modeled by assuming that both the group agent and the organization share the same membership norm, cf. condition $m^t_{y'} = m^t_y$. Alternatively, one could keep two distinct norms and relate them, by adding further specifications.

Moreover, axiom (a23) entails that whenever the individuals who are member of the organization coincide with the individuals who ground the group agent, the whole organization grounds a group agent. That is, in that case, the organization as a whole can be viewed as agentive. Otherwise, the full organization is non-agentive and what is entitled to have agency is just the group agent that is part of the organization, e.g. the board of directors. Our analysis allows us to introduce a category for non-agentive organizations NAORG (cf. Table 1) whose elements are those organizations that do not coincide with their group agent, i.e. they only have a vicarious agency. We do not introduce a specific category for agentive organizations because, at this level of abstraction, they are simply elements in the category of group agents GA. It is of course possible to introduce further distinctions, but we leave this for domain specific applications. One simple way of doing it is to define a class of membership norms that are specific to organizations.

Summing up, not all organizations are agentive, but every organization must at least include an agentive entity – being it either a group agent or an individual agent – that plays the role of decision maker. By exploiting our methodology, we can view a non-agentive organization as containing an agentive organization as suborganization, namely the group agent. The remaining individuals in the organization (i.e. the complement of the set of those who ground the group agent), constitute strictly speaking a group, and not a sub-organization, since by definition they do not have any decisional agent within. To conclude, on the one hand, our extension solves the issue we left open in [3] and, on the other hand, it allows modelers to choose how to classify the organizations in their domain and to ground their choice in the axioms that we have introduced.

5. Conclusion

We have presented a detailed analysis of the concept of group agency. Firstly, we have introduced the methodology of JA in order to grasp mathematically the relationship between individual and collective attitudes. Then, we have presented our ontological treatment of group agency. In particular, we have defined the social concepts of group agency that classifies aggregates of individuals, then we have defined a new type of objects, the group agents, to present a non-reductionist view of group agency. We have applied our

[18] Unicity is justified since two independent possibly conflicting group agents may violate the minimal consistency requirement for agency. Our formulation allows more complex constructions of agency in organizations, e.g. organizations that organize themselves in organizations, confederations of industries, see [3].

treatment to understand how to ascribe agency to organizations and we have presented a consistent way to distinguish groups, non-agentive organizations and agentive organizations or group agents. The level of our analysis is abstract, so to be as general as possible and to develop a module for group agency in a foundational ontology. Future work shall be dedicated to interface the abstract module of group agency with domain specific descriptions of types of organizations. For example, we have used the methodology of JA and social choice theory to model the complex entanglement of information in socio-technical systems [21]. Our modeling of agency of collective entities can be extended to socio-technical systems, where human and artificial agents interact, in order to define a framework for investigating the problem of the ascriptions of agency and responsibility at individual and systemic level.

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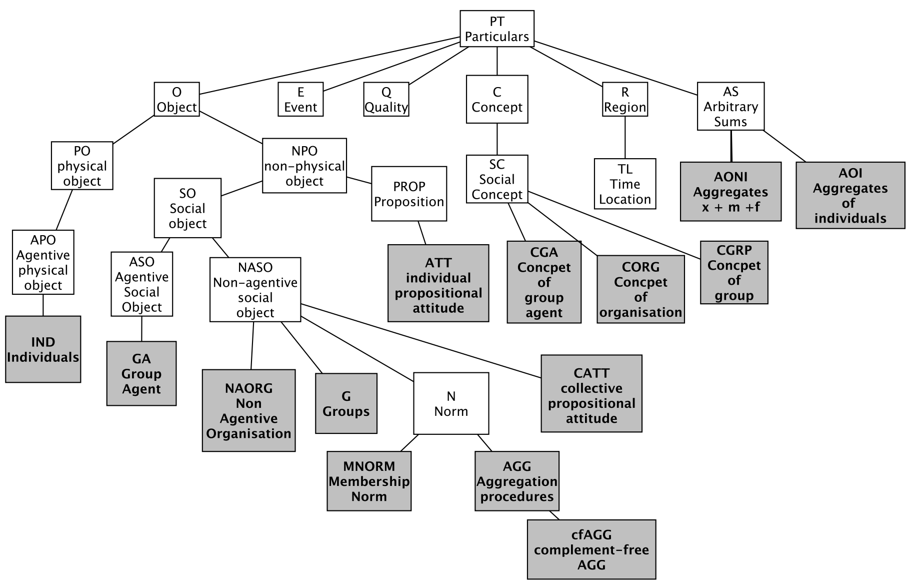

$\mathsf{A}(y,t,f)$: f is the aggregation procedure of y at t
$\mathsf{ACK}(i,n,t)$: agent i acknowledges norm n at t
$\mathsf{AR}(y)$: concept y is anti-rigid
$\mathsf{CATT}(y)$: y is a collective attitude
$\mathsf{CF}(x,y,t)$: x is classified by y at t
$\mathsf{CGA}(y)$: y is a concept of group agency
$\mathsf{CGRP}(y)$: y is a concept of group
$\mathsf{CORG}(y)$: y is a concept of organization
$FD(y)$: concept y is founded
$\mathsf{GA}(y)$: y is a group agent
$\mathsf{M}(y,t,m)$: m is the membership norm of y at t
$\mathsf{PRE}(x,t)$: x is present at t
$\mathsf{RL}(y)$: concept y is a role
$x \prec_t y$: x grounds y at t,
$x \equiv y$: x and y are on the same level

Table 1. Ontology of group agency. Boldface categories are new wrt DOLCE.

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