From Collective Intentionality to Intentional Collectives: An Ontological Perspective

Emanuele Bottazzi, Carola Catenacci, Aldo Gangemi, and Jos Lehmann

Our Laboratory

The Laboratory for Applied Ontology
(LOA)

is part of

The Institute for Cognitive Sciences and Technologies
(ISTC-CNR)

Applied Ontology

- Applied Ontology is a 'joint venture' of Philosophy and Artificial Intelligence, which provides:

  - general theories of the types of entities and relations that make up given domains of human activity and inquiry;
  - formal accounts of such entities and relations for use in software applications.

- Applied Ontology is needed for a better management of:

  - Semantic Interoperability (web services, e-commerce, database integration in medical, legal, etc. domains)
  - Information Retrieval (query answering over document sets, natural language processing, etc.)

What is an ontology - socio-cognitive cut

- An ontology is (<u>extended</u> from Gruber 1993, Guarino 1998):
  - A
  - Formal,   *Logic*
  - Partial Specification of the   *Representation*
  - Conceptualization of a world   *Meaning*
  - Conceived by some   *Cognition*
  - Rational agent for some (good or bad)   *Embodiment*
  - Reason, and made in order to   *Motivation*
  - Negotiate that conceptualization with   *Agreement*
  - Someone else, or to   *Society*
  - Reuse it.   *Culture*

- It is not:
  - *a prescriptive specification of the inner structure of 'true reality'*

I. Examples we live by

1. A group of people running to a common shelter because it has suddenly started to rain (Searle 1990).

2. An outdoor ballet where the choreography calls for the entire corps de ballet to converge on a common shelter (Searle 1990).

3. Businessmen having the same goal (i.e. pursuing their own selfish interests) as well as mutual beliefs about their respective intentions, but not cooperating or acting together (Searle 1990).

4. A football team trying to execute a pass play (Searle 1990).

II. Other examples

1. Nazi Germans as possessed by a self-distructive desire (according to a subsequent psycho-historical reconstruction).
2. CIA agents executing orders into a setting about which they are informed "on a strictly need-to-know basis".
3. The actors of an organization (e.g. an oil company) which, in addition to its "constitutive" plan, plays a role in further plans (e.g. fuelling civil wars in oil areas like African countries).
4. Fans in a stadium performing the so-called "ola" (wave).
5. The human agent seen as a collection of temporal parts of herself, or as a collection of co-existing self systems (sub-agentive collectives).
6. The employees/workers in a SAP workflow, or a "Ford-style" production line.

Approach

- ## MAIN OBJECTIVE

  - To give an upside-down view of the problem of collective intentionality by providing a treatment of the notion of intentional collective.
  - To present a general formal framework for an ontology of social reality

- ## FOCUS

  - Collections and collectives as social entities

- ## RESEARCH CONTEXT

  - The reported work is part of LOA's research program dedicated to social domains.
  - The ontologies used in this paper have been – or are being – developed by LOA within EU academic and industrial projects in the domain of knowledge-based systems.

Our theses (I)

- Collectives are considered as *collections of agents*
  - People watching a movie in a cinema
  - A pack of hunting wolves
- Collections are considered as *social objects*
- Collections are dependent (generically) on their members
  - A collection of books of a library is the same entity even if some books are lost and others acquired over time
- Collections are dependent (specifically) on member roles
  - Consider the constellation of Orion. Should the role "being a member of Orion" cease to exist, the Orion constellation would disappear as well.

Our theses (II)

- Collections are *covered* by at least one role
  - A collection of bones

- Collections can be *characterized* by roles
  - Different machines in a factory

- Collections are *unified* by the descriptions containing said roles

  - E.g., intentional collectives are unified by plans
    - The staff of a publishing house working at the production of a textbook

We will talk about:

- Social objects
- Descriptions
- Roles
- Figures
- Plans
- Collections
- Collectives

Social Objects

- ## Two senses of 'social object'
  - Immaterial product of a community of agents that, by means of some sort of *convention*, creates, makes use of, talks about and accepts it; e.g. *quark*, *triangle*
  - In addition, its nature intrinsically involves a network of *relations among agents* (collective intentionality, actions and deontic constraints, etc.); e.g. *money*

- ## Social Concepts and Social Individuals
  - Concepts: *catalyst*, *quark*, *bank*, *money*, *company*, *president*, *etc.*
  - Individuals: *The Bank of Italy*, *the FIAT company*, *etc.*

Background ontologies: DOLCE

A Descriptive Ontology for Linguistic and Cognitive Engineering

Main classes:

- Endurant:
    - Physical Object (*a hammer, a house, a stone*)
    - Non Physical Object
        - Social (*a law, an organization, a collective*)
        - Mental (*a belief, a desire, an intention*)
- Perdurant
    - Event (*a departure, a death, a conference, an ascent*)
    - Stative (*sitting, being open, running, writing*)

Background ontologies: DOLCE

- Quality
  - Temporal Quality (*the duration of World War I, the starting time of the 2004 Olympics*)
  - Physical Quality (*the weight of a pen, the color of an apple*)
- Abstract
  - Set
  - Region
    - Temporal Region (the time axis, 22 june 2002, one second)
    - Physical Region (the physical space, an area in the color spectrum, 80Kg)

Background ontologies: D&S

Descriptions and Situation Ontology

Main classes:

- Description
  - Italian Constitution
- Concept
  - Role
    - Italian President
  - Course
    - An Election task
- Figure
  - Italian State
- Situation
  - The circumstances of 2004 European election in Italy

- An ontology of descriptions
  Plans, norms, theories, etc.

  - and also coded, communicable, hence social counterparts of mental states (e.g., *beliefs* and *desires*)

- Reification

  Individual concepts and theories are in the same domain of quantification as the entities from the ground ontology

- "Naturalization"

  Descriptions and concepts as embodied in cognitive agents, e.g. roles as entities in space/time

D&S General Strategy

- Reify social **concepts** to be able to predicate on them

  Social concepts and roles as *first-class-citizens* in the ontology

- Reify contexts or concept definitions, called here **descriptions**

  Deal with the social, relational, and contextual nature of social concepts

- Introduce a **temporalized classification** relation to link concepts to the entities they classify

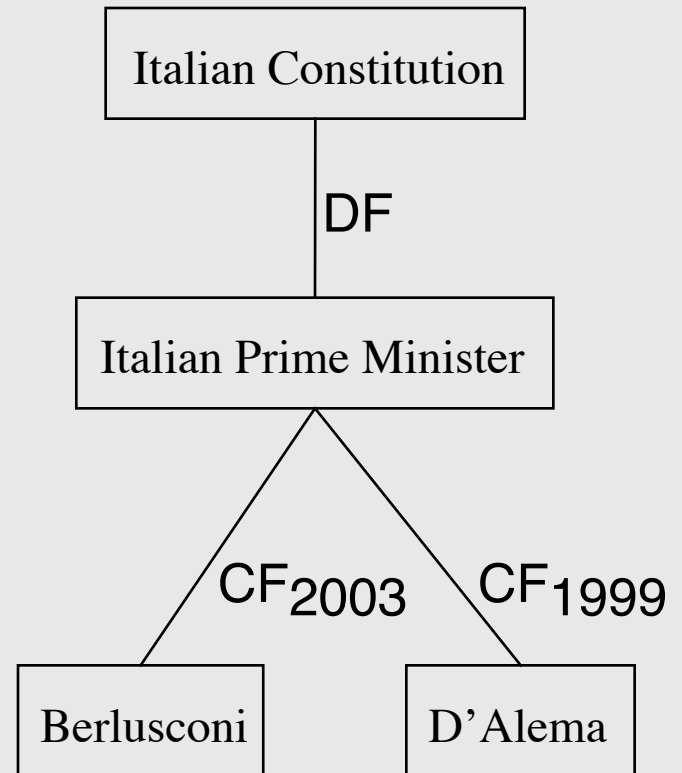 Account for the *dynamic behavior* of social concepts

Underlying assumptions

- Descriptions:

  - are created by intentional agents at the time of their first encoding in an expression of a 'public' language
  - cease to exist when their last physical support ceases to exist
  - have a unique semantic content (different, but semantically equivalent, expressions can be associated to the same description)
  - have an internal structure intimately related to the logical structure of their semantic contents

- Concepts:

  - are statically linked to descriptions: they cannot change their definitions
  - inherit the temporal extension of their definitions
  - are used to "classify" entities from a given *ground* ontology

Example

- The Italian Constitution is a description defining the current concepts of Italian President, Italian government, Italian Prime Minister…

- B. is classified under the concept of IPM during 2003
- D. is classified under the concept of IPM during 1999

- During 2000, B. did not have all the necessary characteristics to be IPM, therefore he is not classified under this concept

```
┌─────────────────────┐
│ Italian Constitution │
└─────────────────────┘
           │ DF
┌─────────────────────┐
│ Italian Prime Minister│
└─────────────────────┘
     CF_2003    CF_1999
┌───────────┐   ┌─────────┐
│ Berlusconi │   │ D'Alema │
└───────────┘   └─────────┘
```

CF_{2003} CF_{1999}

Figures

Figures, or **social individuals,** are other social objects defined by descriptions; differently from concepts, however, they do not classify particulars:

Figure(x) → SocialObject(x)

Figure(x) → ∃y. Description(y) ∧ DF(x,y)

Figure(x) → ¬∃y,t. CF(y,x,t)

Examples: organizations,
political-geographic objects,
sacred symbols, *personas*,
personal or shared façades, etc.

Agent

Descriptions (like all non-physical objects) are **generically dependent on** some agent, who is able to conceive them at some time:

Agent(x) =$_{df}$ AgentivePhysicalObject(x) ∨ AgentiveSocialObject(x)

Two levels of agentivity:

- as only implying *conception* (i.e., 'intentionality' in Brentano's terms)

  AgentivePhysicalObject(x) =$_{df}$ PhysicalObject(x) ∧ ∃y,t. Description(x) ∧ Conceives(x,y,t)

- as implying the conceiving of *plans*

  CognitiveAgentivePhysicalObject(x) =$_{df}$ AgentivePhysicalObject(x) ∧ ∃y,t. Plan(y) ∧ Conceives(x,y,t)

Ontology of plans

- Main classes:

  - Plan
  - Goal
  - Task

Plans

- A **plan** is a description that represents an *action schema*. A plan is conceived by a cognitive agent, it defines or uses at least one *task* and one role, and has at least one goal as a proper part:

$$Plan(x) \rightarrow Description(x)$$

$$Plan(x) \rightarrow \exists y,t.\ Conceives(y,x,t) \wedge CognitiveAgent(y)$$

$$Plan(x) \rightarrow \exists y.\ Task(y) \wedge Uses(x,y)$$

$$Plan(x) \rightarrow \exists c.\ (Role(c) \wedge \forall a.\ Classifies(c,a) \rightarrow Agent(a)) \wedge Uses(x,c)$$

$$Plan(x) \rightarrow \exists g.\ Goal(g) \wedge ProperPart(x,g)$$

E.g. how to *make some coffee*, *write a paper*, *build a house….*

Goals

- A *goal* is a *desire* (another type of description) that is conceived by a cognitive agent and that is part of a plan; usually, a goal is desired by the creator or beneficiary of a plan:

$$\text{Desire}(x) \rightarrow \text{Description}(x)$$

$$\text{Desire}(x) \rightarrow \exists y,t.\ \text{Conceives}(y,x,t) \land \text{CognitiveAgentivePhysicalObject}(y)$$

$$\text{Desire}(x) \rightarrow \exists y,z.\ (\text{Role}(y) \land \forall a,t.\ \text{Classifies}(y,a,t) \rightarrow \text{Agent}(a)) \land \text{Course}(z) \land$$
$$\text{Uses}(x,y) \land \text{Uses}(x,z) \land \text{DesireTowards}(y,z,t)$$

$$\text{Goal}(x) =_{df} \text{Desire}(x) \land \exists p.\ \text{Plan}(p) \land \text{ProperPart}(p,x)$$

E.G a desire to start a relationship can become goal to start a relationship if someone takes action - or let someone else take action on her behalf - with the purpose of starting the relationship

Tasks

- *Tasks* are courses used to sequence activities or other perdurants that can be under the control of a planner. They are defined by a plan, but can be used by other kinds of descriptions:

$$Task(x) =_{df} Course(x) \wedge \exists y,z. \; Plan(y) \wedge Defines(y,x) \wedge (Role(z) \wedge$$
$$\forall a,t. \; Classifies(z,a,t) \rightarrow Agent(a)) \wedge Uses(y,z) \wedge$$
$$DesireTowards(z,x,t)$$

The proposal

Collections: basic idea

- A collection is constituted by entities that, while retaining their identity, unity, and physical separation, are 'kept together' in order to form a new entity

- Endurants constituting a collection are either mereotopologically disconnected (e.g. statues in a statuary) or weakly connected (e.g. a pile of plates)

  Examples: a collection of musical instruments, a collection of bones, a collection of books

Collections: assumptions and definition

Constructivist position: a collection depends on one or more social objects that provide a unity criterion for it

Definition: a collection is a social object, the members of which are all classified by the same role, and which has at least two endurants as actual members:

$Collection(x) =_{df} SocialObject(x) \land \exists r. Role(r) \land \forall w,t. ConstituentOf(w,x,t) \rightarrow Classifies(r,w,t) \land \exists y,z,t1. Endurant(y) \land Endurant(z) \land y \neq z \land ConstituentOf(y,x,t1) \land ConstituentOf(z,x,t1) \land Classifies(r,y,t1) \land Classifies(r,z,t1)$

Membership: a collection is constituted by its members;
the membership relation defined on collections is a constitution relation:

$Membership(e,c,t) =_{df} ConstituentOf(e,c,t) \land Endurant(e) \land Collection(c) \land \exists r. Role(r) \land Classifies(r,e,t)$

Collectives

A *collective* is a collection of agents:

Collective(c) $=_{df}$ Collection(c) $\wedge$ $\forall$x,t. Membership(x,c,t) $\rightarrow$ Agent(x)

Collectives are covered or characterized by roles and eventually unified by some description (in particular, by some plan).
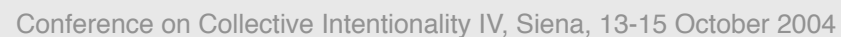
Intentional collective

An *Intentional Collective* is an agentive social object. It is unified by a plan and characterized by a role used by this plan

IntentionalCollective(x) =$_{df}$ Collective(x) ∧ AgentiveSocialObject(x) ∧ ∃y,r. Plan(y) ∧ Unifies(y,x) ∧ Role(r) ∧ Uses(y,r) ∧ Characterizes(r,x)

Huey, Dewey and Louie decide to play Pirates

A class of (possible) intentional collectives unified by a plan that defines three roles and one task.

Our (preliminary) Typology of Collectives

COLLECTIVE

    Simple (covered by roles, and not unified by plans with *characterizing* roles)

        <u>Type-based</u>

            Genetic | Taxonomic | Epidemiological

        <u>Simple-planned</u>

    Organized

        <u>Intentional</u> (unified by plans with *characterizing* roles)

            Stable vs. Unstable (based on negotiated vs. conflicting plans)

            Devised vs. Emerging (based on s.o. bringing about the collective)

               [Emerging]: Casual vs. Spontaneous (based on time of plan conception)

            Maximal agency collective (based on figure)

            Governed vs. Ungoverned (based on control)

            Transparent, Opaque, Obscure

            (based on degree of plan sharing across members)

            By modes of plan sharing

             (of goal)

             (of conception)

             (of adoption)

             (of trust)

            By internal structure of plans and/or related descriptions

        <u>Temporary</u> (scheduled)

Some classified examples

Intentional Collective	T	agreement	devisal	transparency	control	structure
Common shelter ballet	I	stable	devised	trans(g,c,a,t)	governed	structured
Selfish businessmen	I	unstable	emerging (casually)	trans(g)	ungoverned	unstructured
Football team	I	stable	devised	trans(g,c,a)	governed	structured
Self-destructive Nazis	I	unstable	emerging (spont.)	obsc(g,a)	ungoverned	unstructured
CIA agents	I	stable	devised	obsc(g,c,a)	governed	structured
Partly cognizant maximal agency	I	stable	devised	opaq(g,c,a)	governed	structured
Fans in a stadium (ola)	I	stable	emerging (spont.)	trans(g,c,a,t)	ungoverned	unstructured
Maximal agency of selves	I	unstable	emerging	opaq(g,c,a,t)	(un)governed	structured
SAP workers max. agency	I	stable	devised	obsc(c,a)	governed	structured

A preliminary formal typology of collectives