From the Modern Transcendental of Knowing to the Post-Modern Transcendental of Language

Unit 13: An updated taxonomy of formal ontologies for our communication age and the role of formal philosophy

Course WI-FI-BASTI-ER 2017/18

By

GIANFRANCO BASTI

Full Professor of Philosophy of Nature and of Sciences
At the Faculty of Philosophy of the Pontifical Lateran University

E-mail: basti@pul.it
Address: Pontifical Lateran University – Piazza S. Giovanni Laterano, 4 – 00184 Rome
Phone: +39 06 69895656
Cell.: +39 339 5760314
Web: www.irafs.org

IRAFS website: www.irafs.org

Bibliography

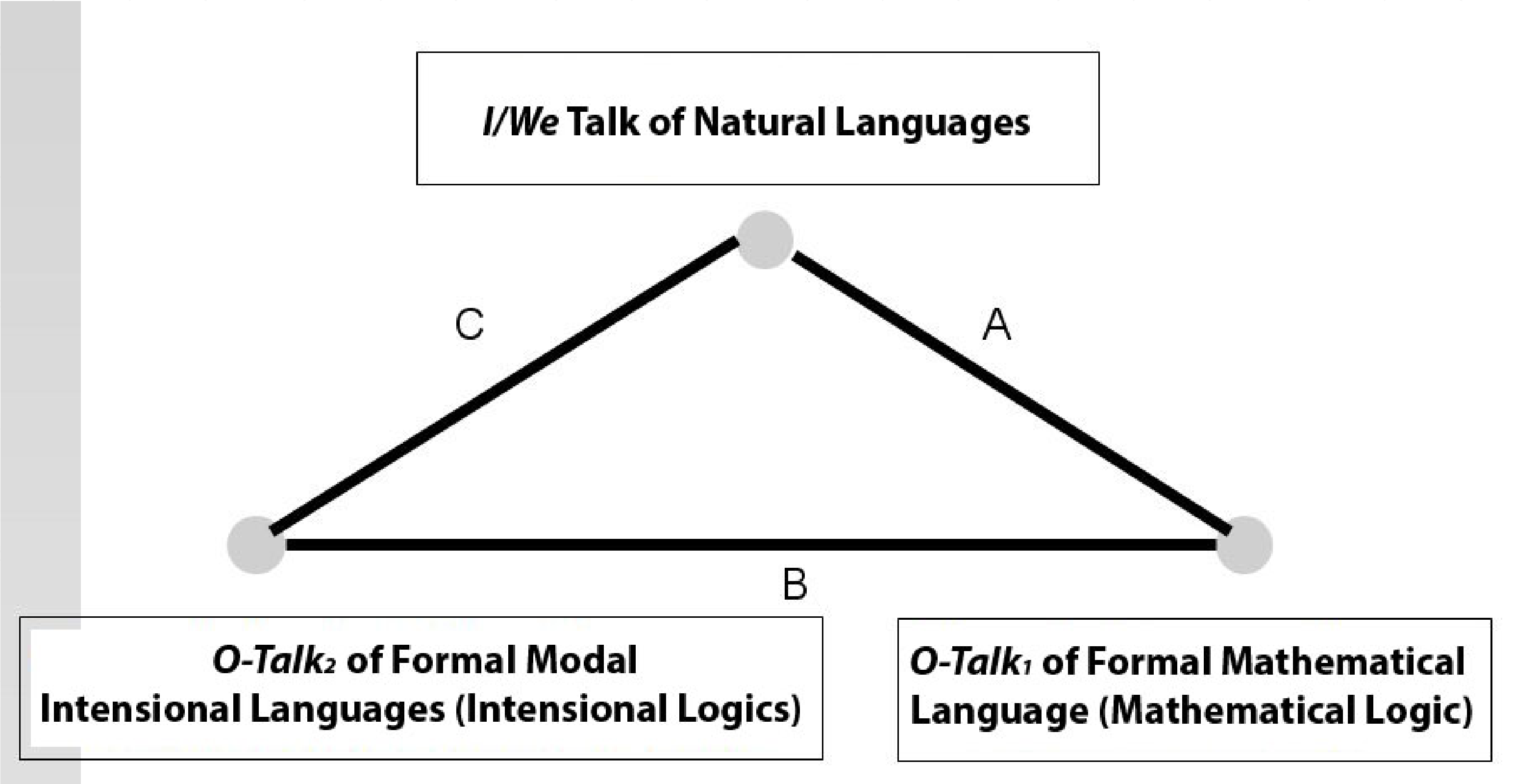
Reference

- The contents of this unit and the essential bibliography can be found in the Lecture Notes for this unit:
  - Basti G., *Lecture Notes on: “From formal logic to formal ontology”* [attached]

A Paradigm shift in philosophy

From the modern transcendental of knowledge to the post-modern transcendental of language

The necessity of formalizing ontologies in a global intercultural environment



From mathematical to philosophical logic: intensional logics as interpretations of modal logics

- Since the first publication of Whitehead & Russell *Principia* in 1912 the American philosopher **Carol I. Lewis,** prophetically**:**
  1. Warned against the misuse of **mathematical logic** for the analysis of philosophical & religious languages as it happened thereafter through the publication of L. Wittengstein's *Tractatus Logico-Philosophicus* by his mentor B. Russell (1917).
  2. Recognized that the power of **mathematical logic** is in its formalization → necessity of formalizing also the **philosophical logic,** so to understand clearly similarities and differences:
     - **Between science(s) and philosophy(ies)** and
     - **Among the different philosophies**, beyond the differences of ages, languages and cultures.

The **globalization of science** during XX cent. depends on its formalization, just as the marginalization of philosophy depends on its non-formalization → in the XXI cent. we have to restore the balance by **formalizing philosophy**.

Extensional (mathematical) *vs.* intensional (philosophical) logic

- → ML relational structures with all its intensional interpretations are what is today defined as **philosophical logic** (Burgess 2009), as far as it is distinguished from the mathematical logic, the logic based on the extensional calculus, and the extensional notions of meaning, truth, and identity.
- What generally characterizes intensional logic(s) as to the extensional one(s) is that:
  1. neither the **extensionality axiom** between classes: $\mathbf{A \leftrightarrow B \Rightarrow A = B}$**;**
  2. nor the **existential generalization axiom:** $Pa \Rightarrow \exists x\, Px$
  of the extensional predicate calculus hold in intensional logic(s).
- Consequently, also the **Fegean notion of extensional truth** based on the truth tables does not hold in the intensional predicate and propositional calculus.

Intensional logic and intentionality

- Anyway because of the axiomatization of modal and intensional logics starting from Lewis' pioneering work:
  - → There exists an **intensional logical calculus**, just like there exists an extensional one, and this explains why both mathematical and philosophical logic are today often quoted together within the realm of **computer science**.
  - This means that intensional semantics and even the intentional tasks **can be simulated artificially** («third person» simulation of «first person» tasks, like in human simulation of understanding, without conceptual «grasping»).
  - → The "thought experiment" of Searle's "Chinese Room" is becoming a reality, as it happens often in the history of science

Modal logic: from philosophy to computer science

- Following (Blackburn, de Rijke & Venema, 2002) we can distinguish three eras of **modal logic** (ML) recent history:

1. **Syntactic era (1918-1959):** C.I.Lewis…: second-order modal logic and intensional semantics
2. **Classic era (1959-1972):** S. Kripke's… relational semantics based on **frame theory (second-order «global» semantics)** and **Kripke models (first-order «local» semantics)** (Goranko & Otto, 2007)
3. **Actual era (1972…):** S. K. Thomason's algebraic interpretation of modal logic for reducing to it Turing-like second-order semantics → ML as a fundamental tool in theoretical computer science
    a. → **Correspondence principle:** equivalence between modal formulas interpreted on models and first order formulas in one free variable → Possiblity of using ML (decidable) for **individuating novel decidable fragments** of first-order logic (being first-order theories (models) not fully decidable)
    b. → **Duality theory** between ML relation semantics and algebraic semantics based on the fact that models in ML are given not by substituting free variables with constants like in logistic, but by **using binary evaluation letters** in relational structures (frames/models) like in algebraic semantics.

Main intensional logics: alethic logics

- **Alethic logics:** they are the descriptive logics of “being/not being” in which the modal operators have the basic meaning of “necessity/possibility” in two main senses:
- ***Logical necessity***: the necessity of lawfulness, like in deductive reasoning
- ***Ontic necessity***: the necessity of causality, that, on its turn, can be of two types:
  - ***Physical causality***: for statements which are true (i.e., which are referring to beings existing) only in some possible worlds.
  - ***Metaphysical causality***: for statements which are true of all beings in all possible worlds, because they refer to properties or features of all beings such beings.

Main intensional logics: deontic and epistemic logics

- **The deontic logics**: concerned with what “should be or not should be”, where the modal operators have the basic meaning of “obligation/permission” in two main senses: *moral* and *legal obligations*.
- **The epistemic logic**: concerned with what is “science or opinion”, where the modal operators have the basic meaning of “certainty/uncertainty”.

Main axioms of Lewis' ML syntax

- For our aims, it is sufficient here to recall that formal modal calculus is an extension of classical propositional, predicate and hence relation calculus with the inclusion of some further axioms:
- **N**: $<(\mathbf{X}\rightarrow\alpha) \Rightarrow (\Box\mathbf{X}\rightarrow\Box\alpha)>$, where **X** is a set of formulas (language), $\Box$ is the necessity operator, and α is a meta-variable of the propositional calculus, standing for whichever propositional variable *p* of the object-language. **N** is the fundamental *necessitation rule* supposed in any normal modal calculus

More…

- **D:** $<\Box\alpha \to \Diamond\alpha>$, where $\Diamond$ is the possibility operator defined as $\neg\Box\neg$ a. **D** is typical, for instance, of the *deontic* logics, where nobody can be obliged to what is impossible to do.
- **T:** $<\Box\alpha \to \alpha>$. This is typical, for instance, of all the *alethic* logics, to express either the *logic* necessity (determination by law) or the *ontic* necessity (determination by cause).
- **4:** $<\Box\alpha \to \Box\Box\alpha>$. This is typical, for instance, of all the “unification theories” in science where any “emergent law” supposes, as necessary condition, an even more fundamental law.
- **5:** $<\Diamond\alpha \to \Box\Diamond\alpha>$. This is typical, for instance, of the logic of metaphysics, where it is the “nature” of the object that determines necessarily what it can or cannot do.

Main Modal Systems (Galvan 1991; Creswell & Huges 1996)

- By combining in a consistent way several modal axioms, it is possible to obtain several **modal systems** which constitute as many **syntactical structures available for different intensional interpretations.**
- So, given that **K** is the fundamental modal systems, constituted by the ordinary propositional calculus **k** plus the necessitation axiom **N,** some interesting modal systems for our aims are:
  - **KT4** (**S4,** in early Lewis' notation), typical of the physical ontology;
  - **KT45 (S5,** in early Lewis' notation), typical of the metaphysical ontology;
  - **KD45** (**Secondary S5**)**,** with application in deontic logic, but also in epistemic logic, in ontology.

Alethic *vs.* deontic intensional interpretations

- Generally, in the **alethic** (either logical or ontological) interpretations of modal structures the necessity operator $\Box p$ is interpreted as "*p* is true in all possible world", while the possibility operator $\Diamond p$ is interpreted as "*p* is true in some possible world". In any case, the so called **reflexivity principle** for the necessity operator holds in terms of axiom **T**, i.e, $\Box p \rightarrow p$.
- This is not true in *deontic* contexts. In fact, "if it is obligatory that all the Italians pay taxes, does not follow that all Italians really pay taxes", i.e.,

$$\mathbf{O}p \not\rightarrow p$$

Reflexivity in deontic contexts

- In fact, the obligation operator **O***p* must be interpreted as "*p* is true in all *ideal* worlds" different from the actual one, otherwise **O**=□, i.e., we should be in the realm of **metaphysical determinism** where freedom is an illusion, and ethics too.
- The reflexivity principle in deontic contexts, able to make obligations **really effective** in the actual world, must be thus interpreted in terms of an *optimality operator* $\mathbf{O_t}$ for *intentional agents x*, given *a condition of acceptance,* c_a by *x* of the optimality or "goodness" of *p* for him, and given a *condition of non-impediment* for *x* in doing *p,* i.e,

$$(\mathbf{O}p \rightarrow p) \Leftrightarrow ((\mathbf{O_t}(x,p) \wedge c_a \wedge c_{ni}) \rightarrow p)$$

Reflexivity in epistemic context

- In similar terms, in **epistemic** contexts, where we are in the realm of representations of the real world.
- The interpretations of the **two modal epistemic operators** **B**(*x*,*p*), "*x* believes that *p*", and **K**(*x*,*p*), "*x* knows that *p*" are the following: **B**(*x*,*p*) is true iff *p* is true in the realm of representations believed by *x*. **K**(*x*,*p*) is true iff *p* is true for all the **sound** representations believed by *x*. Hence the relation between the two operators is the following:

$$\mathbf{K}(x,p) \Leftrightarrow \left(\mathbf{B}(x,p) \wedge \mathbf{F}\right)$$

Reflexivity in epistemic logic embedding a belief in reality

- While

$$\mathbf{B}(x,p) \nrightarrow p$$

- because of **F**

$$\mathbf{K}(x,p) \rightarrow p$$

- In a word, the difference between **believing** and **knowing,** or, in more classical terms, between **opinion or belief** and **science** depends entirely on the satisfaction of the **foundation condition F** making **sound, i.e., «true»,** some beliefs instead of other ones.
- Of course, this clause **F** is different for the different **epistemologies** and, more radically, for the different **ontologies.**

Finitistic, infinitistic, and finitary interpretations of the F foundation clause (second-order *vs.* first-order semantics)

- Different interpretations of the foundation clause **F** depend on the different **ontologies** that, if formalized in the proper modal logic, are as many **formal ontologies** (truth conditions of predication in logic and mathematics)

1. As far as we move within **a second-order logic** like Lewis' modal one (Creswell & Huges 1996), we move inside an **infinitistic** interpretation of **F,** consistent with a **logicist** (Plato, Descartes, Frege, Kutschera, Galvan…), **conceptualist** (Kant, Husserl, Stein, Cocchiarella,…), or **logical atomist** (Democritus, Newton, Wittengstein, Carnap, …) formal ontologies.

2. As far as we move within **a first-order logic (FOL)** like in all **constructive** approaches to logic and mathematics, we move inside a **finitistic** interpretation of **F** consistent with an **anti-platonic, nominalist** formal ontology (Buridan, Ockham, Bishop, Nelson,…).

3. However, **FOL** is consistent also with a **relational (coalgebraic) modal semantics,** based onto a "homomorphic duality" coalgebra-algebra in Category Theory, we move inside a **finitary** interpretation of **F,** consistent with an Aristotelian, **naturalist** formal ontology based on the distinction between **natural kinds** and **logical classes** (Aristotle, Aquinas, Poinsot, Peirce, Kripke, …) → notion of **local modal truth** in Kripke models:

$$\Box_{n|\forall n(n>m)}\left(\underbrace{horse \in mammmalian}_{\text{Algebra}(\Omega^*)}\ \underbrace{\overset{\rightleftarrows}{\longleftarrow}}_{\text{Bounded Morphism}}\ \underbrace{horse \ni mammalian}_{\text{Co-Algebra}(\Omega)}\right)$$

Ordinary languages as implicit ontologies

- As we know from the First Part of our book, from the pragmatic standpoint of semiotics, any ordinary language can be considered as an *implicit ontology* of the human community using it. Any ordinary language, indeed, makes able its users to communicate efficiently - and hence to interact effectively - among them, and with the particular sector of the natural, cultural and social reality, all of them share. This is the core of the *pragmatic stance* underlying semiotics.
- The philosophical ontologies of the different peoples and cultures expressed in the natural languages of ordinary, non-formalized philosophies are then only *a manifestation of the implicit ontologies hidden in their own ordinary languages*. This is also the *pragmatic core* of any formalized ontology in formal philosophy, as far as based on the *philosophical (modal and intensional) logic,* as distinguished from the *mathematical (extensional) logic.*

Ontology as theory of the ante-predicative foundation of the predicate logic

- When we consider the issue of the foundations of the *ontological notion of local truths*, as far as distinguished from the *logical notion of absolute truth,* we are effectively dealing with the *ante-predicative* background of any *language* and of any logic, given that in logic any relation is a *predicate*, that is a relation with a *definite domain-codomain (support).*

- As we know, in first order logic, the predicates are defined on a definite domain of (names of) individuals (e.g., when we say “the blood is red”). In second order logic, the predicates are defined on a definite domain of first order predicates, i.e., we are speaking about “predicates of predicates” (e.g, when we say “the red is a color”), evidently supposing, in the ordinary language usage, some form of “nominalization” of first order predicates (in our example, the predicate “being red”).

Formal ontology and formal logic

- In this framework, when we deal with *the ante-predicative foundations of logic,* we are in the proper context of *formal ontology*, either in its phenomenological interpretation, i.e., as far as considering logic and language as to a *knower,* or in its semiotic interpretation, i.e., as far as considering logic and language as to a *communication agent.* That is Peirce’s “interpretant”, either human or animal, either natural or artificial.
- In this way, the main ontologies of whichever philosophy and culture can be formalized like as many *theories of predication — nominalism, conceptualism, realism* —, and/or like as many *theories of universals.* By “universal” — as distinguished from “class” or “set” in logic and mathematics — we intend “what can be predicated of a name”, according to Aristotle’s classical definition (*De Interpretatione,* 17a39).

Nominalist ontologies and first order predicate logics

- Therefore, from the standpoint of the predicate logic, it is evident that all the *nominalist* ontologies suppose only a *first order* predicate logic, since in such ontologies it is forbidden quantifying over predicate symbols – that is, speaking about “predicates of predicates”. The predicates, indeed, in nominalism, cannot denote anything, i.e., “cannot be nominalized”: the “universals” do not exist at all in such ontologies. There exist only individuals: universals are only linguistic conventions.
- Therefore, they cannot be proper arguments of any higher order predicate symbols. If in some cases nominalism admits higher order predicate symbols, this is only in a *substitutional* sense —, i.e., in the sense of a linguistic, conventional, shortened second order formula instead of many first order true propositions —, without any proper extra-linguistic referential meaning. In this sense, nominalist ontologies are very similar to empirical sciences, because both share some form of exclusiveness to the only first order predicate calculus.

Nominalism and empiricism

- Effectively, indeed, the absolutization of the empirical sciences, i.e., the *empiricism,* is a sort of nominalism.
- On the contrary, the other types of possible ontologies admit higher order predicates, that is quantifying over predicate symbols, because they admit, even though in different senses, the existence of the *universals*, so to make possible the quantification on predicate variables.
- To sum up, following Cocchiarella (Cocchiarella, 2007), and other my papers on the same argument (Basti, *Ontologia formale: per una metafisica post-moderna*; Basti, *Ontologia formale. Tommaso d'Aquino ed Edith Stein*), we can distinguish among at least *three types of ontology*, with the last one subdivided into two others:

A taxonomy of the different ontologies

1. *Nominalism*: the predicable universals are reduced to the predicative expressions of a given language that, *by its conventional rules,* determines the truth conditions of the ontological propositions (Sophists, Quine, …).
2. *Conceptualism:* the predicable universals are expressions of *mental concepts,* so that the laws of thought determine the truth conditions of the ontological propositions (Kant, Husserl, Stein…).
3. *Realism:* the predicable universals are expressions of *properties and relations* existing independently of the linguistic and/or mental capacities in:
   - *The logical realm,* we have then the ontologies of the so-called *logical realism*, where the *logical relations* determine the truth conditions of the ontological propositions (Plato, Frege, …);
   - *The physical realm,* we have then the ontologies of the so-called *natural realism,* or “naturalism”. On its turn, naturalism can be of two types:
     - *Atomistic:* without natural kinds, where mechanics is the fundamental physics, and its absolute *mathematical laws* with their *empirical fulfillment* are ultimately determining the truth conditions of the ontological propositions (Democritus, Newton, Laplace Wittengstein’s *Tractatus*, Carnap, …).
     - *Relational:* with “natural kinds” – the “generals” of Peirce’s semiotics –, because the *real relations* (causes) among things ultimately determine the *linguistic relations,* and then the truth conditions of the ontological propositions (Aristotle, Aquinas, Poinsot, Peirce, Kripke, …).

A taxonomy of formal ontologies depending on the foundation of predication (*universals* issue)