INNOPOLIS UNIVERSITY

Classes 9-13

Formal Philosophy. The Ancient Age:

Language & Realism

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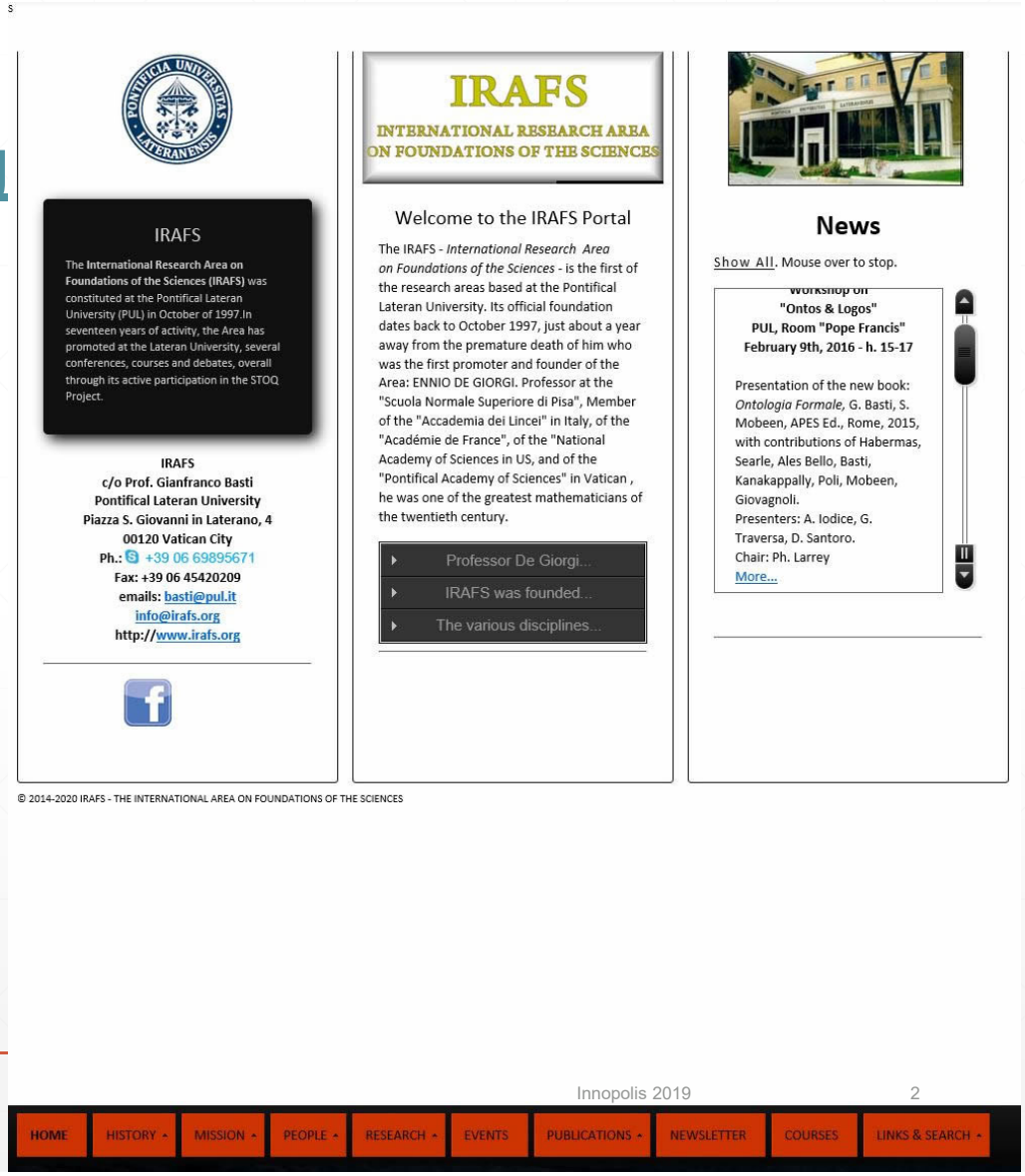
Course: Language & Perception

Syllabus I Part (1-2/11/2019)

Syllabus II Part (8-9/11/2019)



Aim of the classes 9-24 of the course «Language & Perception»: an Ontology for our Information Age

- «An Ontology for our Information Age» systematically based on the **ontological and logical primacy of relations over objects** in mathematical, physical and philosophical sciences, computer science included, of course.
- E.g., in fundamental (quantum) physics the primary objects are not the elementary particles in the mechanical vacuum like in classical mechanics, but the **interacting fields** of which particles are their quanta, and fields constitute a **dynamic continuum: the quantum vacuum (QV)** → therefore quantum mechanics (QM) today is essentially a **quantum field theory (QFT).**
- → Composed macroscopic bodies are condensates of particles, of which unity depends on the phase coherences (resonances) of their respective fields **= condensed matter physics** based on QFT as the fundamental physics of chemical and biological systems.

Continuing…

- → In **biology** it is untenable the old mechanistic position for which **all the information** of an adult organism (in our case 10^{17} cells) is in the DNA (in our case it would signify $2^{10^{17}}$ bit!): biological information for the ontogenesis generated by the interactions of a cell with its chemical environment for cell specialization with invariant DNA → **epigenetics** → **biosemiotics:** i.e., the centrality of **signaling** as the secret of life, but a "signal" is always a **triadic relation** vehicle-referent-interpretant.
- → In **neuroscience**, it is untenable the old position both of mechanistic and dualistic anthropologies **locating the mind in the brain:** mind is located in the continuous exchange of energy and information between the brain and its inner (the rest of the body) and outer environment **= the extended mind**
- → In **neuroethics** it is untenable that the self in charge of a moral decision be the **self-consciousness** or **the brain** because brain modifications of the sensory-motor neurons involved arrive always before of our awareness: it is the **person as individual-in-relation** – neither her consciousness or her brain alone – the subject responsible of a moral decision…

Toward an «arrow-theoretic» way of thinking

- This primality of relations and then of **the algebra of relations** in any field of contemporary research involving also the logic, the mathematics and the same philosophy → definition of a new metalanguage of logical, mathematical and philosophical sciences the **Category Theory (CT)** in many senses wider because including the same **set theory…**
- In these classes using the newborn discipline of the **formal philosophy (FP) and the CT** as common metalanguage both of pure and applied mathematics, and of pure and applied philosophy, we deepen some of the topics before presented emphasizing the fruitfulness of such a new approach, also and overall for computer scientists and for AI researchers, in particular.

Summary

- The notion of formal philosophy as formalization of philosophical doctrines using the axiomatic method, as a formal tool of interdisciplinary dialogue between human and mathematical sciences – computer science and AI before all.
- It is based on the distinction between standard **mathematical logic** (extensional interpretation of predication as membership) and **philosophical logic** (intensional interpretation(s) of predication in different contexts). The philosophical logic is based on the axiomatization of modal logical calculus, of which different intensional logics are as many semantics (ontic, epistemic, deontic) of the same modal calculus.
- Exemplifying applications to the classical ontologies of the Platonic logical realism and of the Aristotelian natural realism
- Refs.: 7. 9. 13. 15. 16.

Formal Philosophy *vs.* Analytic Philosophy

- Analytic philosophy is based on the application of Frege's **logic of classes** to the analysis of philosophical languages.
- → Disaster of the **Neo-Positivist Philosophers** consists in applying the **mathematical logic** of Whitehead's and Russell's *Principia Mathematica* also to the analysis of the philosophical language, and that goes back to the so-called "first Wittengstein" of the *Tractatus Logico-Philosophicus* (1921)*:* not distinguishing among the **different logical rules** governing the different usages of languages.
- Ultimately, the mistake consists in not distinguishing the difference between the **extensional** and the **intensional** notions of meaning governing, respectively, the ***mathematical logic*** of pure and applied mathematical sciences, and the ***philosophical logic*** of the humanistic disciplines. "Intensional logic" means, indeed, a logic intrinsically related with what people *intend* in using words according to different meanings for different contexts.

Intensional *vs.* extensional logic

- "Intensional logic" means, indeed, a logic intrinsically related with what people **intend** in using words **according to different meanings for different contexts**.
- For this reason, the so-called "second Wittengstein" speaks about different **"linguistic games".**
- Roughly speaking, applying the rules of mathematical logic to other types of languages is as nonsensical as applying the rules of football for playing chess.
- Therefore, if we apply the rules of the mathematical logic of the *Principia* to metaphysics, epistemology and ethics in philosophy, the outcome is the nonsensical character of the largest part of the metaphysical, or epistemological, or ethical statements, simply because **we are using the wrong logic** in the analysis.

Extensionality axioms do not apply in intensional logics

- In intensional logics the **extensionality axiom** and the connected **existential generalization axioms** of the mathematical predicate logic does not hold:
  1. $(\mathbf{A} \leftrightarrow \mathbf{B}) \Longrightarrow (\mathbf{A} = \mathbf{B})$: "if two classes are equivalent it is true that they are identical" $\longrightarrow$ "if two predicates have the same extension, i.e., are defined on the same class of objects (e.g., 'being water' and 'being H_2O') they are **identical** and they can **substitute** each other without influencing the meaning of the proposition"**.**
  2. $P(a) \Longrightarrow \exists x\big(P(x)\big)$: E.g., "If Mary loves me, then it is equivalently true that something loves me".
- It is evident that both axioms if applied in humanistic contexts (e.g., "water" in religious or poetic usages for different religions/poets, or "Mary" for her boyfriend, who is not equivalent to "something") make **meaningless** the propositions.

Philosophical logics as intensional interpretations of the modal calculus

- → Against the reductionism of Wittengstein's *Tractatus (*1921*)* of the philosophical logical analysis to Frege's-Russell's mathematical logic (i.e., the logic of Whitehead-Russell's *Principia,* 1912-1915) based on the extensionality axioms the American young mathematician Carol Irvine Lewis proposed since 1912 **for the first time in the history of Western thought** an axiomatization of the ***modal calculus*** (MC)*,* as an extension of the standard *two-valued propositional calculus* (PC), by adding some proper ***modal symbols and axioms****.*
- In this way, the distinction, and at the same time the strict relationship between **mathematical and philosophical logic**, started to take its actual form using the rigor of the axiomatic method that till Lewis only the mathematical logic of the *Principia* had.
- It is possible, therefore, to define different **intensional models** or *semantic interpretations* of the modal systems, corresponding to as many notions of **truth** and **of true proposition *validation* in ML**, and then to as many meanings of the modal operators of **necessity***,* □ and **possibility** ◊ (see Ref. 9.16).

This means that…

- For understanding why MC is the proper formal calculus of philosophical theories, we must recall that, in general, *modal logic* (ML) is the logic of "necessity" and "possibility", of "must be" and of "may be".
- This means that we are dealing with truth or falsity of propositions not only concerning **one only state-of-affairs**, or **"actual world",** but also with truth or falsity **in other possible state-of-affairs or "possible worlds"** that possess some relation with the actual one.
- This means that a proposition will be *necessary* in a world, if it is true in ***all possible worlds*** **relative to that world, and *possible* in a world, if it is true *at least in another world*, relatively to the former one.**
- This implies, of course, that in MC the logical connectives **are not *truth-functional*,** at least in Frege's sense. That is, the truth of the complex propositions they form cannot be deduced from the truth of their arguments (elementary propositions), **by the usage of the classical two-valued *truth-tables*.**

E.g., tense, epistemic, alethic, and deontic logics

- For instance, from the truth of the propositions: “Julius Caesar wrote the *De Bello Gallico*” and “Julius Caesar fought in Gallia”, by applying the connective “and”, we can deduce the truth of the composed proposition “Julius Caesar wrote the *De Bello Gallico* and fought in Gallia”. On the contrary, we cannot deduce the truth of the composed proposition “Julius Cesar wrote the *De Bello Gallico* while he was fighting in Gallia”, typical of the ***tense logic****,* as one of the possible interpretations of MC.

- Equally, it is impossible to derive from the truth of the proposition “Brutus killed Julius Caesar”, the truth of the proposition “Napoleon believed that Brutus killed Julius Caesar”, and vice versa. This is, indeed, a problem typical of the ***epistemic logic,*** another possible interpretation of MC.

- Or, in ***alethic*** **logic,** given the truth of Galilei law in physics, it is surely possible to derive: “if it is necessary that all the heavy bodies fall down (in all possible worlds), then this body falls (in the actual world)”. On the contrary, given the truth of the moral law of paying taxes in ethics, it is not possible to derive in ***deontic logic***: “if it is necessary that all Italians pay taxes, then all Italians pay taxes (in the actual world)”. The **alethic *necessity***, indeed, it is not the **deontic *obligatoriness*** that evidently cannot mean “true in all the possible worlds”, neither in the *legal*, nor in the *moral* sense, which, on their turn, do not superpose each other. “Alethic logics” and “deontic logics” are therefore other two possible interpretations of MC, with their own *truth criteria.*

Main modal axioms

D	$\stackrel{\text{def}}{\equiv}$	$\Box A \rightarrow \Diamond A$
T	$\stackrel{\text{def}}{\equiv}$	$\Box A \rightarrow A$
4	$\stackrel{\text{def}}{\equiv}$	$\Box A \rightarrow \Box\Box A$
E	$\stackrel{\text{def}}{\equiv}$	$\Diamond A \rightarrow \Box\Diamond A$
B	$\stackrel{\text{def}}{\equiv}$	$A \rightarrow \Box\Diamond A$
Tr	$\stackrel{\text{def}}{\equiv}$	$\Box A \equiv A$
M	$\stackrel{\text{def}}{\equiv}$	$\Box\Diamond A \rightarrow \Diamond\Box A$
G	$\stackrel{\text{def}}{\equiv}$	$\Diamond\Box A \rightarrow \Box\Diamond A$
H	$\stackrel{\text{def}}{\equiv}$	$(\Diamond A \wedge \Diamond B) \rightarrow [\Diamond(A \wedge B) \vee \Diamond(A \wedge \Diamond B) \vee \Diamond(B \wedge \Diamond A)]$
Grz	$\stackrel{\text{def}}{\equiv}$	$\Box(\Box(A \rightarrow \Box A) \rightarrow A) \rightarrow A$
Dum	$\stackrel{\text{def}}{\equiv}$	$\Box(\Box(A \rightarrow \Box A) \rightarrow A) \rightarrow (\Diamond\Box A \rightarrow A)$
W	$\stackrel{\text{def}}{\equiv}$	$\Box(\Box A \rightarrow A) \rightarrow \Box A.$

Main modal systems

KT	=	T = logic of Gödel/Feys/Von Wright
KT4	=	S4
KT4B	=	KT4E = S5
K4E	=	K45
KD	=	deontic T
KD4	=	deontic S4
KD4B	=	deontic S5
KTB	=	Brouwer logic
KT4M	=	S4.1
KT4G	=	S4.2
KT4H	=	S4.3
KT4Dum	=	D = Prior logic
KT4Grz	=	KGrz = Grzegorczyk logic
K4W	=	KW = Löb logic
KTr	=	KT4BM = trivial logic.

Kripke relational modal logic

Correspondences in Kripke semantics

Given a modal axiom the question is what Kripke frames validate the axiom. If the property is expressed in the classical first-order logic then we have a *correspondence* between modal axiom and the first-order property.

Examples of correspondences

Formula	Property of R
D	$\forall x.\exists y.R(x,y)$ (R is serial)
T	$\forall x.R(x,x)$ (R is reflexive)
4	$\forall x,y,z.(R(x,y)\wedge R(y,z)) \rightarrow R(x,z)$ (R is transitive)
E	$\forall x,y,z.(R(x,y)\wedge R(x,z)) \rightarrow R(y,z)$ (R is Euclidean)
B	$\forall x,y.(R(x,y) \rightarrow R(y,x))$ (R is symmetric)
Tr	$\forall x,y.(R(x,y) \equiv x=y)$ (R is trivial)
G	$\forall x,y,z.((R(x,y)\wedge R(x,z)) \rightarrow \exists w(R(y,w)\wedge R(z,w))$ (R is directed)
$\Diamond\alpha \rightarrow \Box\alpha$	$\forall x,y,z.(R(x,y)\wedge R(x,z)) \rightarrow y=z$ (R is a partial function)
$\Diamond\alpha \equiv \Box\alpha$	$\forall x.\exists! y.R(x,y)$ (R is a function)
$\Box\Box\alpha \rightarrow \Box\alpha$	$\forall x,y.R(x,y) \rightarrow \exists z(R(x,z)\wedge R(z,y))$ (R is dense)

Three main intensional logics in philosophical logic: 1. alethic logics

- Therefore, the main semantics of the MC generally admitted are the following:
- The **alethic logics**, where the meaning of the modal operators is world states, and in the different senses of the *logical,* and of the *ontological* (physical and metaphysical) truth, that is, without confusing the *ontic* (causal, real) and the *logical* (linguistic, abstract) possibility/necessity, as well as their relations. Of course, the alethic interpretation of MC is the proper logic of ***formal ontology***.
  - For instance, it is ***logically* true** saying that "*necessarily* (at the sea level), water is boiling if and only if (*iff*) it is at 100°C", and vice versa. Nevertheless, ***ontically***, when we examine the **causal relations to which this composed statement refers for being true**, we are no longer faced with an equivalence (symmetrical bi-conditional). In fact, it is the water heat (molecular agitation) that causes *necessarily,* beyond a given threshold, the *phase transition* gas-liquid states of its boiling, and not vice versa. More significant examples, where a many-world modal semantics is today essential in philosophy of nature and of science, concern the formal ontology of the contemporary evolutionary quantum cosmology.

Three main intensional logics in philosophical logic: 2. epistemic logics

- The *epistemic logics,* where the meaning of the modal operators possible/necessary is related to different levels of knowledge *certainty*, and then to the distinction between *belief/knowledge* (*dóxa-epistéme*, in the Platonic language) [19, 18, 31]. The "possible worlds" here concerned are the *believed representations* of the world inside a knowing agent, and the passage from "believing that *p*", **B***p,* to "knowing that *p*", **K***p,* depends on the satisfaction of a *foundation clause* **F** – i.e. $\mathbf{K} \Leftrightarrow \mathbf{B} \wedge \mathbf{F}$ – in the sense that the certain beliefs or "knowledges" are founded in the "real world".
- Of course, the clauses **F** will be different for different epistemologies, and of course for different underlying ontologies.

Three main intensional logics in philosophical logic: 3. deontic logics

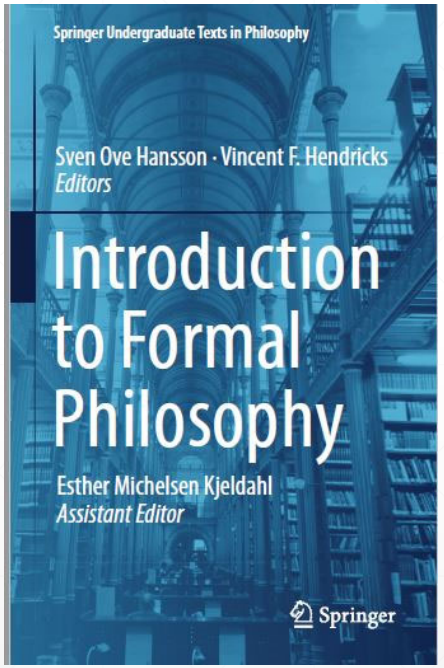
- The *deontic logics*, where the meaning of the modal operators possible/necessary is related to different levels of *obligation*, and then the possibility/necessity operators of MC must be interpreted as **deontic operators** of **permission/obligation**. The "possible worlds" here concerned, the worlds of the *ought to be*, as distinct from the "real world" of the *to be,* are those related with the "values" or "goals" to be pursued – or with axiological *optimality* criteria for actions to be satisfied – so to justify ethical/legal constraints or "obligations" for the **effective pursuing** of the goals in the "real world" by the human agents.
- Therefore, in the case of **moral/legal obligatoriness** as distinct from **logical necessity** the "possible worlds" *x* concerned are the *optimal states of the world,* for a *given subject s* **Op**(*x,s*). Therefore, the ethical obligatoriness expressed by the moral/legal norm *P*, i.e. **Ob***P* about the behavior for pursuing effectively a given optimal *x* by *s,* i.e. **Ob***P*(*x,s*) satisfies the following scheme: $(\mathbf{Op}(x,s) \wedge c_a \wedge c_{ni}) \leftrightarrow \mathbf{Ob}P(x,s)$, where the two clauses c_a and c_{ni} express, respectively, the "condition of acceptance" by *s* of the optimal ordering **Op,** and the "condition of non-impediment" for *s* of pursuing *x.*

Usefulness of formal philosophy in our Communication Age

- From this survey it is evident that ML is an **essential tool of formal philosophy**, before all, for analyzing and comparing rigorously different philosophical theories – distinguishing each other for the **adding of non-logical axioms** to the logical ones of MC and of its intensional semantics – **beyond the temporal and cultural distances** of their authors, so to become an essential tool for the contemporary *intercultural dialogue* in our Post-Modern or "Communication Age".
- Moreover, formal philosophy becomes also an essential tool for the contemporary *interdisciplinary dialogue,* for overcoming the disastrous modern opposition between the *two cultures,* the humanistic and the scientific one (see Ref. 7)
- → Actual improvement of **formal philosophy** under the stimulus of AI research and applications in Departments of Computer Science and Philosophy (see Ref. 15)

Computer scientist as a formal philosopher

- Not casually **Dov M. Gabbay** said in the Editorial Preface of the second edition of the monumental *Handbook of Philosophical Logic* now arrived at its 17th volume, and of which Gabbay is co-editor:
  - As computer science and artificial intelligence deal more and more with distributed and interactive systems, processes, concurrency, agents, causes, transitions, communication and control (to name a few), the researcher in this area is having more and more in common with the traditional philosopher who has been analyzing such questions for centuries (unrestricted by the capabilities of any hardware). (…) I believe the day is not far away in the future when the computer scientist will wake up one morning with the realization that he is actually a kind of formal philosopher! [36, pp. viii-ix].



The typical example of formal ontology in computer science…

- Today the term **formal ontology** is widely used in the computer science environment, particularly in the so-called **"knowledge engineering"** for the development of **semantic databases** in AI.
- In this sense, "ontologies" refer to the fundamental "conceptual categories" by which different linguistic groups organize their knowledges about the objects of their specific environments, that is, **their representations of reality.**
- For instance, the databases of the US *National Institute of Health*, uses formal ontology algorithms specialized over the **medical languages**. Or, the database of the *Stanford Encyclopedia of Philosophy* uses formal ontology algorithms, specialized over the **philosophical language**, etc. This usage of "formal ontology" in computer science

…And in formal philosophy

- Starting from Husserl and the phenomenological school who invented the term «formal ontology», by the notion of formal ontology we intend in philosophy something related to the foundation of the **notion of predication** in logic as far as it is not simply reducible to the notion of **set/class membership** $\in$**.**
- The main theories of predication are, indeed, in the history of logic are: **nominalism, conceptualism, realism***,* which historically can be viewed like as many *theories of universals.* By “universal” we intend, again with Cocchiarella, “what can be predicated of a name”, according to Aristotle’s classical definition (*De Interpretatione,* 17a39)*.*

The main formal ontologies in te history of philosophy

- We can distinguish among at least *three types of ontology*, with the last one subdivided into two others:
- **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, …).
- **Conceptualism:** the predicable universals are expressions of *mental concepts,* of some conscious (individual or collective) subject, so that the laws of thought determine the truth conditions of the ontological propositions (Kant, Husserl, Stein, Scheler…).
- **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, Fraenkel, Gödel…);
  - ***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:

Two types of naturalistic formal ontologies

- ***Atomistic:*** without natural kinds, where *mechanics* is the fundamental physics, where the combinatorial rules for aggregating elements ultimately determine its *mathematical laws* in their functional form (polynomials), then determining also the truth conditions of the ontological propositions (Democritus, Newton, Laplace, Wittengstein, Carnap, …).
- ***Relational:*** with "natural kinds" – the "generals" of Peirce's semiotics –, because the *real relations* (causes) among genera of things ultimately determine the *logic relations* among classes of objects in language, and then the truth conditions of the ontological propositions. In this way, *dynamics* is the fundamental physics determining the relative truth conditions of the *mathematical laws* of physics (Aristotle, Aquinas, Poinsot, Peirce, Kripke, Deely…).

Formal Ontologies Scheme