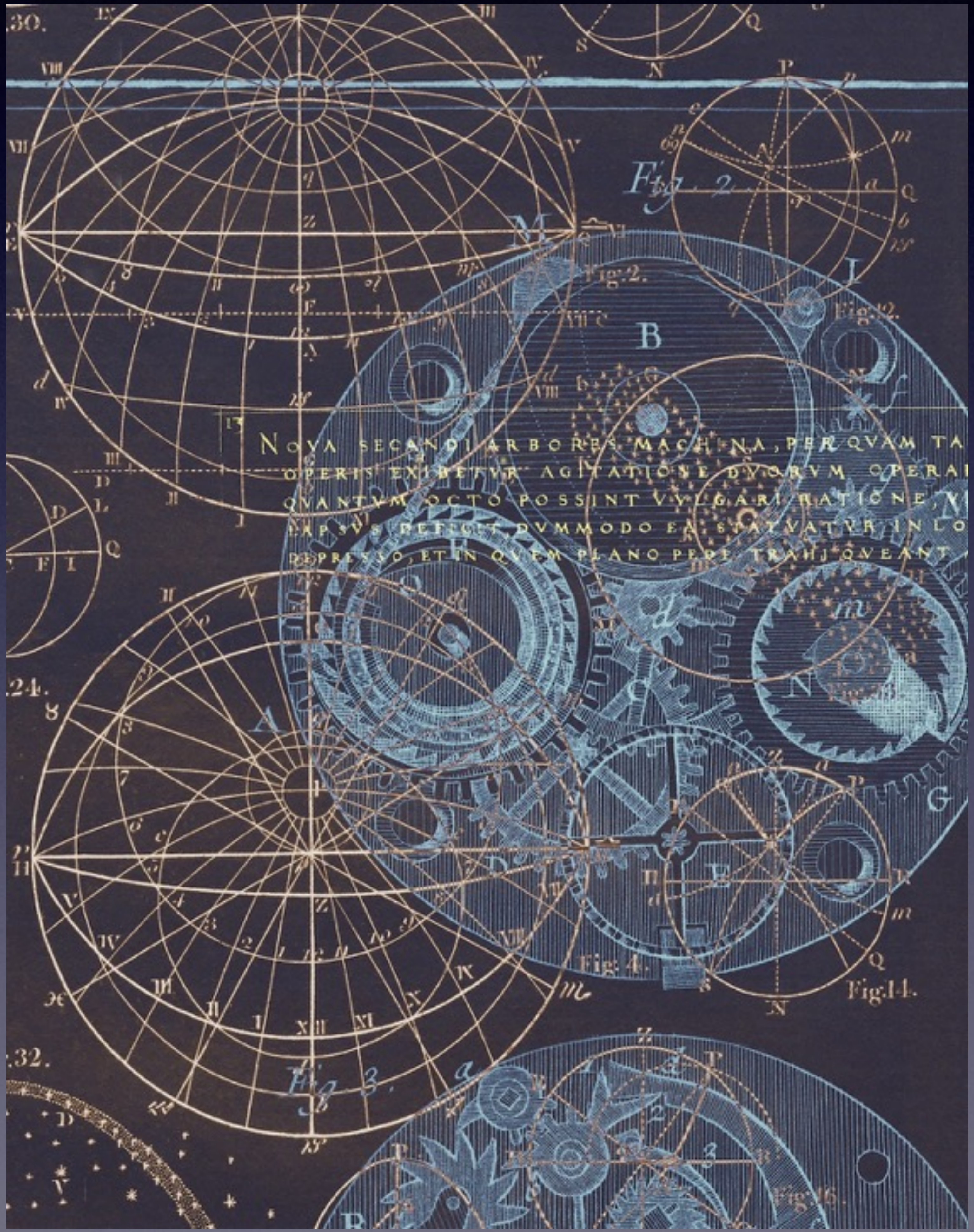
Scientific Philosophy



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Ontology

Ontology is the part of philosophy that is concerned with the most general features of reality. It aims at providing the basic framework for science, clarifying key concepts as those of physical existence, thing, property, change, causality, chance, probability, state, time, space, law, structure, system, life, mind, society, and many more.

I will offer a specific ontology based on things that is

1. Realist
2. Materialist
3. Systemic
4. Deterministic
5. Emergentist

For an alternative ontology based on events see: G.E. Romero, Found. Sci., Vol. 18, pp 139-148 & Philosophia, pp. 1-16, 2016

Things and composition

O_1. There exist concrete objects named ***things***. The set of all things is denoted by Θ

O_2. Things can ***juxtapose*** ($\dot{+}$) and ***superpose*** ($\dot{\times}$) to give new things according to the following definitions:

O_2D_1. A thing *X* is a physical sum or a juxtaposition of all individuals of a given set $\{X_i\}$, i=1, 2, …,n iff every part of *X* is a part of at least one of the members of the set $\{X_i\}$

e.g.: $e \dot{+} p \rightarrow H$

O_2D_2. A thing *X* is a physical product or a superposition of all individuals of a given set $\{X_i\}$, i=1, 2, …,n iff every part of *X* is a part of every member of the set $\{X_i\}$

e.g. The superposition of waves or fields.

Juxtaposition and superposition are instances of ***composition***: the association of things to form more complex things.

We differentiate just two ways of composition because our experience of the world suggests that things combine this way.

O_3. The ***null thing*** $\diamondsuit$ is a fiction introduced in order to give the structure of a Boolean algebra to the laws of composition of things.

$$X \dot{+} \diamond = X$$

$$X \dot{\times} \diamond = \diamond$$

O_4. Two things are ***separated*** if they do not superpose.

$$X \rceil Y \leftrightarrow X \dot{\times} Y = \diamond$$

Since modern science admits the existence of fields that fill the whole universe, there are not fully ***isolated*** things, i.e. things that are separated from all other things.

$$\neg\exists X\ (\forall Y\ \ X \rceil Y)$$

O_5. Let T be a set of things. The aggregation of T ([T]) is the supremum of T with respect to the operation $\dot{+}$.

O_6. The ***universe*** ($\square$) is the aggregation of all things.

$$\square = [\Theta] \leftrightarrow (X \sqsubset \square \leftrightarrow X \in \Theta)$$

The symbol $\sqsubset$ means ‘is part of’. It stands for a relation between concrete things and should not be mistaken with $\in$, which is a relation between elements and sets. The universe is a thing, the supreme or maximal thing, and not a set of things (sets are concepts).

We define the composition of a thing *X* as

$$\mathrm{Comp}(X) = \{Y : \ Y \sqsubset X\}$$

O_7. All things are composed of ***basic things*** by means of superposition of juxtaposition.

$$X \in \Xi \subset \Theta$$

Basic things are elementary or primitive

$$X,\ Y \in \Xi \wedge \ (X \sqsubset Y) \rightarrow X = Y \quad , \ Y \in \Xi \rightarrow \neg \exists X \ (X \sqsubset Y)$$

O_8. All things have ***properties*** *P.* These properties can be ***intrinsic*** (if they only depend on the thing) or ***relational*** (if they depend on the thing and on other things).

e.g. *Charge*: intrinsic property. *Velocity* or *position*: extrinsic properties.
In the case of photons and massless bosons velocity is an intrinsic property.

Conceptually, we can represent a thing as an ordered pair formed by an individual and its properties.

$$X = \langle x,\ P(x) \rangle$$

Energy and existence

There is only one universal property shared by all material objects: ***energy.***

Energy is the potential to change. Only material things can change. Concepts do not change. Then, *to be material is to have energy, to be able to change*. Materiality is not related to mass. Massless things have energy, are material, and can change.

Material existence is identified with changeability. Conceptual existence, instead, is identified with being part of a conceptual system. We feign that conceptual objects have autonomous existence. They do not have it. They are convenient fictions we invent to represent the world and to simplify our language.

A thing can be modelled representing its properties by functions defined over a domain *M.*

O_8D_1. A thing *X* can be modelled by a pair $X_m = < M, F >$, where *F* is a collection of functions $F_1, F_2, \ldots, F_n$ over *M* and

$$F_i \triangleq P_i \in P(x)$$

Then, $$X_m \triangleq X$$

O_9. The ***state*** of a thing is the set of functions $\{F_i: M \longrightarrow \Re$, i=1,2,…,n$\}$ such that $F_i \triangleq P_i$

The set of accesible states of a thing X is the lawful space state of X: $S_L(X)$. The state of a thing is represented by a point in the n-dimensional space $S_L(X)$.

O_{10}. A ***law statement*** is a restriction upon the state function of a given class of things.

Since law statements are restrictions upon functions, they take the form of *differential equations* if the restriction are purely local or *integro-differential* equations otherwise

O_{11}. A ***natural law*** is a property represented by an empirically corroborated law statement. Laws are objective patterns of repetition of events occurring to some clase of things.

O_{12}. There are not lawless things, i.e. all things have properties restricted in regular ways. There are not magical things.

O_{13}. The ***history h(X)*** of a thing X is the part of $S_L(X)$ defined by

$$h(X) = \{\langle t,\ F(t)\rangle : t \in M\}$$

where *t* is an element of some auxiliary set *M*, and *F* are the functions that represent the properties of *X*. The history is a (n+1)-dimensional curve in the lawful state space.

O_{14}. Two things ***interact*** if each of them modifies the history of the other.

$$X \bowtie Y \leftrightarrow h(X\ .\ Y) \neq h(X) \cup h(Y)$$

where '.' stands for composition: either juxtaposition or superposition

We can define that a thing *X* acts upon another thing *Y* if we previously introduce the ***conditional history*** of a thing

h(X/Y): "history of *Y* in the presence of *X*"

Then, $X \triangleright Y:$ '*X* acts on *Y*'

$$X \triangleright Y \stackrel{\text{def}}{=} h(Y/X) \neq h(Y)$$

O_{15}. An ***event*** *e* is a change of a thing *X*. It can be represented by an ordered pair of states.

$$e = \{s_1,\ s_2\} \in E_L(X) = S_L(X) \times S_L(X)$$

The space $E_L(X)$ is called ***event space*** of *X*

A ***process*** *p* is an ordered series of events: $p = <\{e_i,\ e_{i+1},\ \ldots,\ e_f\},\ \prec\ >$ where $\prec$ is an ordering relation. If the events are continuous $p = e(t)$, with *t* a parameter.

The basic ontology sketched here is

1. Realistic
2. Objective
3. Materialistic
4. Deterministic

In what follows we shall show that it is also emergentist

Levels

Composition leads to a hierarchy of things. Reality seems to have ***levels*** of organisation.

A level is a *collection of things that share certain properties and undergo changes according to some common laws* that apply to all of them.

e.g. All chemical objects share some properties and obey to chemical laws, but do not have biological properties or are constrained by social laws

Higher levels have things with some properties belonging to lower level in addition to specific ones. E.g. I have mass, experience chemical reactions, and have biological functions. Conversely, an atom has not biological properties.

Levels

Reality (the collection of all real objects) seems to be composed by ***5 major levels***: *physical, chemical, biological, social, and technical*. The objects of any level above the physical level are composed by entities belonging to lower levels. The individuals of higher levels have emerged along time from the association of individuals of lower levels.

There is no mental level. This is so because the ontology outlined here is materialist: the mind is a system of functions of the brain, as the digestion is a system of functions of the digestive organs. Mind is not an entity.

Levels

The structure of the ***level system*** is: $\mathcal{L} = \langle L, \ < \rangle$

where *L* is a set of levels and < is an ordering relation (precedence).

For any level L_n, $L_n < L_{n+1}$ iff $\forall \sigma \ [\sigma \in L_{n+1} \rightarrow \mathrm{Comp}(\sigma) \in L_n]$

<u>Ordering of levels</u>

Physical < chemical < biological < social < technical

Systems

Within each level things compose to form more complex things. A composed thing is a ***system***. Every existent is a system, except the basic entities if they exist.

A system is a composed thing characterised by its composition, environment, structure, and mechanism.

Systems

The ***composition*** of a system is the collection of its parts.

The ***environment*** of a system is the collection of things that interact with the system.

The ***structure*** of a system is the collection of relations (bonds or links) among its components, as well as with environmental objects. The former is the ***endostructure*** whereas the latter are the ***exostructure***. The total structure is the union of the two.

The ***mechanism*** is the collection of all internal processes that occur in the system.

A ***subsystem*** is a system such that its composition and structure are part of another system.

The maximal system is the ***universe***, i.e. the system of all systems.

Any system can be modelled by an ordered quadruple:

$$\mu(\sigma) = \langle C(\sigma),\ E(\sigma),\ S(\sigma),\ M(\sigma) \rangle$$

All these components of the system can be functions of time

The composition of a system at level L is $\mathrm{Comp}_L(\sigma) = \mathrm{Comp}(\sigma) \cap L$

Causality

Causality is a relation between events, i.e. a relation between changes of material things. It is <u>*not*</u> a relation between things.

$\mathfrak{C}(X)$: 'an event in a thing X is caused by some other event $e^{X}_{X_i}$ '

$$\mathfrak{C}(X) \overset{def}{=} (\exists X)(\exists e^{X}_{X_i})\left[e^{X}_{X_i} \in E_{\mathrm{L}}(X)\right] \Leftrightarrow (\exists X_i)(X_i \rhd X).$$

$C(X,Y)$: "an event in a thing X is caused by an event in a thing Y".

$$C(X,Y) \overset{def}{=} (\exists X)(\exists Y)(\exists e^{X}_{\mathrm{Y}})\left[e^{X}_{\mathrm{Y}} \in E_{\mathrm{L}}(X)\right] \Leftrightarrow Y \rhd X.$$

In these definitions, the notation 'e^{X}_{Y}' indicates with the superscript the thing to whose event space belongs the event e, whereas the subscript denotes the thing that acted triggering the event. The implicit arguments of both $\mathfrak{C}$ and C are events, not things. For simplicity in the notation we refer to the things that undergo the events.

Causation is a form of event generation. A crucial point is that a given event in the lawful event space $E_{\mathrm{L}}(X)$ is caused by an action of a thing Y iff the event happens only conditionally to the action, *i.e.*, it would not be the case of e_{Y}^{X} without an action of Y upon X. Time does not appear in this definition, allowing backward causation and non-local causality.

An alternative and equivalent definition is this:

Two events e_1 and e_2 are causally related iff there is at least a process p (a series of events) such that e_2 is a component of p and e_1 is a component as well, and it is never the case that e_1 is not a component of p. Then I say that e_1 is a cause of e_2. The event e_2 is an effect of e_1. In symbols:

$$e_1 \rhd e_2.$$

The process p involving e_2 can never occur without the existence of e_1. The world is legal and determinate, but not strictly causal. There are events that are not causally related and processes that are not causally originated.

Chance and probability

In epistemology the word ‘chance’ designates the unpredictable character of some events in some theoretical framework. Chance, in this sense, equals ignorance.

The ***ontological sense of chance*** is that some events belongs to a random sequence. A random event has an objective stochastic ***propensity*** that can be quantified by a probability.

Propensity, in turn, is the property of a system to go from one state to another.

Causal: if the system is in a state A then will evolve to a state B

Propensity

Stochastic: if a system is in a state A then there is a probability *P* that will change to a state B

Stochastic propensity is represented by the probability function $P: E \longrightarrow [0, 1]$, which is defined by the following axioms:

A1. If F is a set and E_i is a subset of F, then all unions and intersections of E_i are in F. $E=\{E_i\}$.

A2. $P: E \longrightarrow [0, 1]$.

A3. For any subset A of E, $0 \leq P(A) \leq 1$.

A4. If $(A \in E) \wedge (B \in E) \wedge (A \cap B) \neq 0 \rightarrow P(A \cup B) = P(A) + P(B)$

A5. $P(F) = 1$.

This is a version of the Kolmogorov's axioms

Probability is the quantitative measure of stochastic propensity, and hence a measure of a physical property. It is incorrect to assign probabilities to hypotheses, statements, or propositions. Probabilities can be assign only to events.

Disposition is a parent ontological concept. A property of a thing is ***actual*** or ***manifest*** if the thing possesses it, and ***potential*** or ***dispositional*** if the property emerges under adequate conditions.

A thing *X* has the disposition *D* =def *X* has the actual property *A* and *X* interacts with another thing *Y* *then* as a consequence *X* acquires the relational property *R*:

$$D_X \leftrightarrow AX \wedge \exists Y \exists R \, (Y \neq X \wedge X \bowtie Y \wedge RXY).$$

E.g. Longevity is a dispositional property of some individuals. Instead, life expectancy at birth is a statistical or collective property. In general, *probability quantifies dispositional properties of individuals, whereas statistical parameters such as averages and variances are manifest properties of collections of individuals*.

Space, time, and space-time

Substantivalism: space and time are things (Newton)

Relationalism: space and time do not have autonomous existence.
They are subsidiary to the existence of things (Leibniz).

According to the latter view time is a relational property of changing things and space a relational properties of interacting things.

Space-time: Space and time are different aspects of a larger entity (Minkoswki, Einstein, Weyl).

The metric and other properties of space-time are determined by things. But also the motion of things is affected by the properties of space-time. So, the controversy continues.

Is space-time an entity that can exist without other objects? Or is it an emergent relational property of all existents. The problem is open.

Matter

What is matter?

An object is ***material*** iff its lawful space state has more than one point, i.e if the object can change.

Materiality is co-extensive with changeability. The capability to change is called ***energy***. *Energy is the only universal property of all existents: it is the potential to generate change*. Concepts and fictions do not change or interact.

Notice that *mass is not a requirement for materiality*: photons and other massless bosons have energy and can change. They are material. The same is true of fields.

Matter itself is not material since it is a concept, not a thing with energy.

Matter is the class of all material objects.

$$M = \{X : \ X \text{ is material}\}$$

Similarly, ***reality*** is not real: it is the set of all real things (i.e. existing independently of the mind). Since set are concepts, reality is not real. It is a convenient fiction.

Mind

The mind is the set of cognitive functions of the brain that enables consciousness, perception, thinking, judgment, and memory, among others.

The set of mental events is a subset of the set of the events in the plastic neural systems of the human brain. Hence, all mental processes are neural processes.

If the mind is a set of functions of the brain, it is not a thing, but a concept abstracted from a class of activities of a given thing (the brain).

“The power of the mind”: Nonsense.

Information

Information is a concept associated with the transmission of signals that codify some statements in some language.

Information is defined on the set of pairs signal-receiver, where a receiver is a system (biological or not) competent to decode the signal.

Not being a thing, information has no energy and has not independent existence.

Definition: If a signal (mark, sign, inscription, sound, etc.) is a sentence or represents a sentence, then the ***information*** conveyed by the signal is the proposition designated by the sentence.

If *S* and *S'* are sets of signals representing the sets of propositions *P* and *P'* respectively, then

(i) the information conveyed by *S* is *larger than or equal to* the one conveyed by *S'* iff *P'* is a proper subset of *P;*
(ii) the *information gain* accompanying the substitution of *S* for *S'* equals *P-P'* = $P \cap P'$.

These propositions define what can be called *semantic concept of information.*

The information or message conveyed by a signal consists of the proposition or propositions the signal stands for. It follows

(a) that non-propositional signals convey no information,

(b) that the greater the content of a proposition the richer the information carried by the signal representing that proposition, and

(c) that the truer a proposition the more accurate the information carried by the signal representing that proposition.

Biological systems

We assume that an organism is a system such that

(i) its *composition* includes proteins (both structural and functional, in particular enzymatic, the latter enabling it to exploit its environment) as well as nucleic acids (which make for its reproducibility and the likeness of its offspring);
(ii) its *environment* includes the precursors of all its components (and thus enables the system to self-assemble most if not all of its biomolecules);
(iii) its *structure* includes the abilities to metabolize, to self-repair, and to reproduce.

Proposed problems:

1. Might be there non-biological organisms?
2. Can sophisticated robots and artificial systems be considered organisms?
3. Can computers think?

Social systems

A ***society*** is a system of interrelated individuals sharing an environment. This idea is formalised as follows: A society σ is representable as an ordered quadruple <Composition of σ, Environment of σ, Structure of σ, the Mechanisms of σ> , where the structure of σ is the collection of relations (in particular connections) among components of σ. Included in the structure of any σ are the relations of work and of managing which are regarded as typical of human society in contrast to animal societies.

A human society has four sub-systems:
biological, political, economical, and cultural.

Proposed problems:

1. Can you identify social laws?
2. What is the minimal social system?
3. What is the difference between social laws and the laws of the legal system of a society?

Summing up: I propose an ontology based on ***things***, changeable entities endowed with properties. Things combine with other things and form ***systems***. Systems are grouped into ***levels*** according to their shared properties: physical, chemical, biological, social, and artificial. The systems that populate each level emerge from the previous level when new functions appear with increasing complexity. The changes of things are restricted by ***natural laws***. There are no lawless changes. Some changes are ***causal*** (triggered by previous events) and others are ***probabilistic*** (stochastic but lawful). The common property of all things is ***energy***, the capability to change. Objects endowed with energy are call ***material***. Otherwise, they are ***fictions***. ***Information*** is not a physical property or a thing. Information is the propositional content of encoded signals, and hence it is a concept.

back ups

A ***Boolean algebra*** is a six-tuple consisting of a set A, equipped with two binary operations $\wedge$ (called "meet" or "and"), $\vee$ (called "join" or "or"), a unary operation $\neg$ (called "complement" or "not") and two elements 0 and 1 (called "bottom" and "top", or "least" and "greatest" element, also denoted by the symbols $\bot$ and $\top$, respectively), such that for all elements a, b and c of A, the following axioms hold:

$a \vee (b \vee c) = (a \vee b) \vee c \quad a \wedge (b \wedge c) = (a \wedge b) \wedge c$ associativity

$a \vee b = b \vee a \quad a \wedge b = b \wedge a$ commutativity

$a \vee (a \wedge b) = a \quad a \wedge (a \vee b) = a$ absorption

$a \vee 0 = a \quad a \wedge 1 = a$ identity

$a \vee (b \wedge c) = (a \vee b) \wedge (a \vee c) \quad a \wedge (b \vee c) = (a \wedge b) \vee (a \wedge c)$

distributivity

$a \vee \neg a = 1 \quad a \wedge \neg a = 0$ complements

== Axioms ==

=== First axiom ===

The probability of an event is a non-negative real number:

$P(E) \in \mathbb{R}, P(E) \geq 0 \qquad \forall E \in F$

where F is the event space. In particular, $P(E)$ is always finite, in contrast with more general measure theory. Theories which assign negative probability relax the first axiom.

=== Second axiom ===

The probability that some elementary event in the entire sample space will occur is 1. More specifically, there are no elementary events outside the sample space.

$P(\Omega) = 1.$

If it is not precisely defined the whole sample space, then the probability of any subset cannot be defined either.

===Third axiom===

This is the assumption of σ-additivity:

Any countable sequence of disjoint sets—disjoint (synonymous with "mutually exclusive") events $E_1, E_2, ...$ satisfies

$P(E_1 \cup E_2 \cup \cdots) = \sum_{i=1}^{\infty} P(E_i).$