Scientific Philosophy

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Is it possible a reasonable philosophy?

- Yes: *Scientific philosophy*, i.e. philosophy that is exact in its formulation, informed by science, and in agreement with current scientific knowledge. This kind of philosophy deals with problems that are too general for the specific sciences.

- The main goal of scientific philosophy is **to articulate the best worldview that emerges from our current scientific theories**.

- Scientific philosophy can be tested through its back-reaction and feedback with science and our most general knowledge of nature.

- A philosophical view is usually adopted by scientists when they do scientific research, mostly unconsciously.

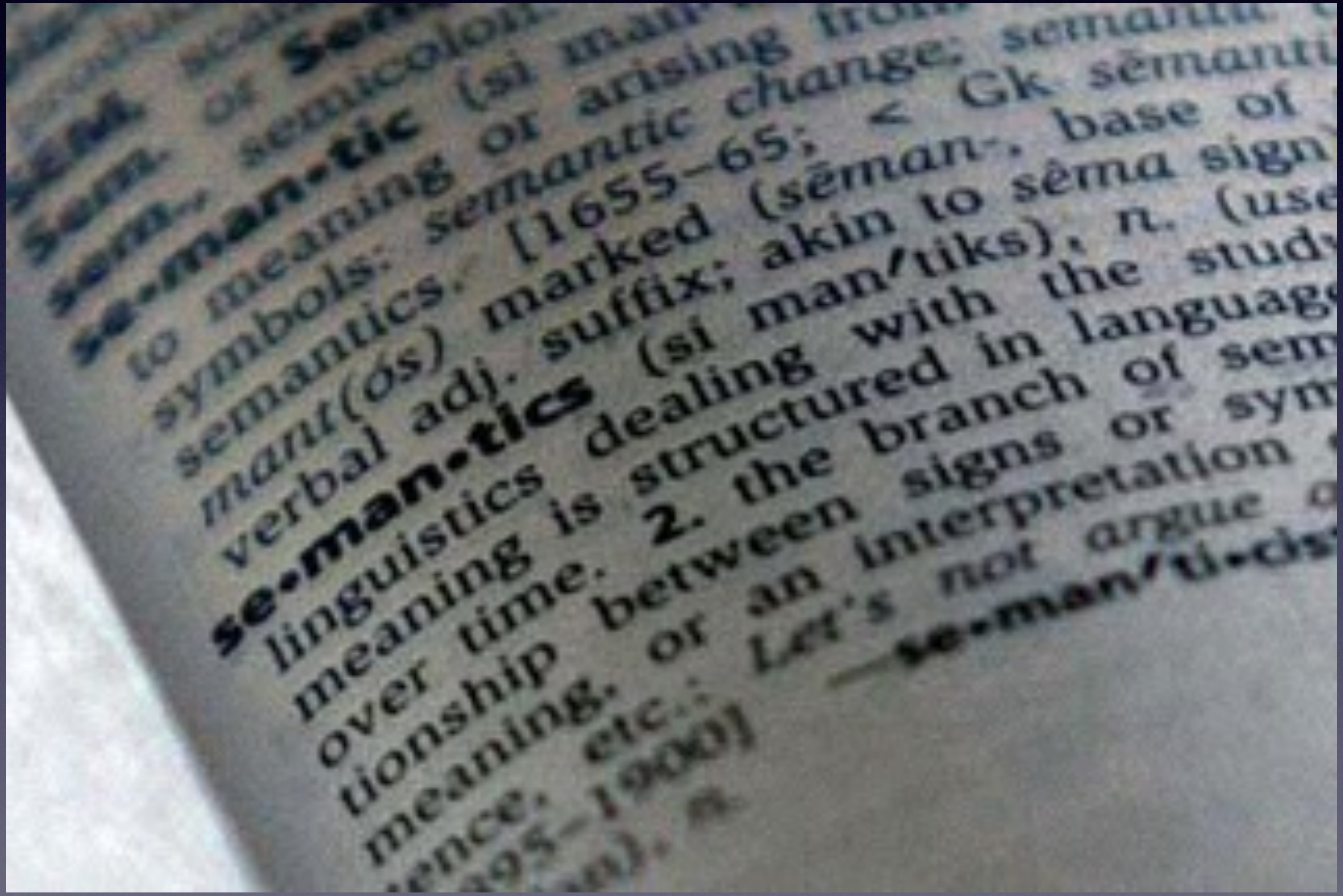
Main branches of scientific philosophy

- Semantics
- Ontology
- Epistemology
- Ethics
- Aesthetics

Some philosophical questions

- What is truth? When he say that something is meaningful?
- What is mathematics? Why mathematics can be used to describe reality?
- What is infinity? Are there infinite physical magnitudes?
- What is knowledge? How we know? How we know that we know?
- What is science? What is a physical law? What is a theory?
- What’s the difference between theory and model? What is a datum?
- What is a thing? What’s an event? What is change and how is it possible?
- What is a probability? Is there objective chance in the world?
- What is time? What’s space? What’s is space-time?
- What is causation? What is the mind? Is the World determinate?

Philosophical semantics



- Language
- Denotation
- Designation
- Reference
- Representation
- Sense
- Meaning
- Vagueness
- Truth

Language

Natural (vague)

Languages
(conceptual systems for communication and representation)

Formal (exact)

A *formal language* is a conceptual system equipped with a set of rules to generate valid combinations of symbols.

$$L = < \Sigma,\ R,\ O >$$

where $\sum$ is the set of primitive terms of the language

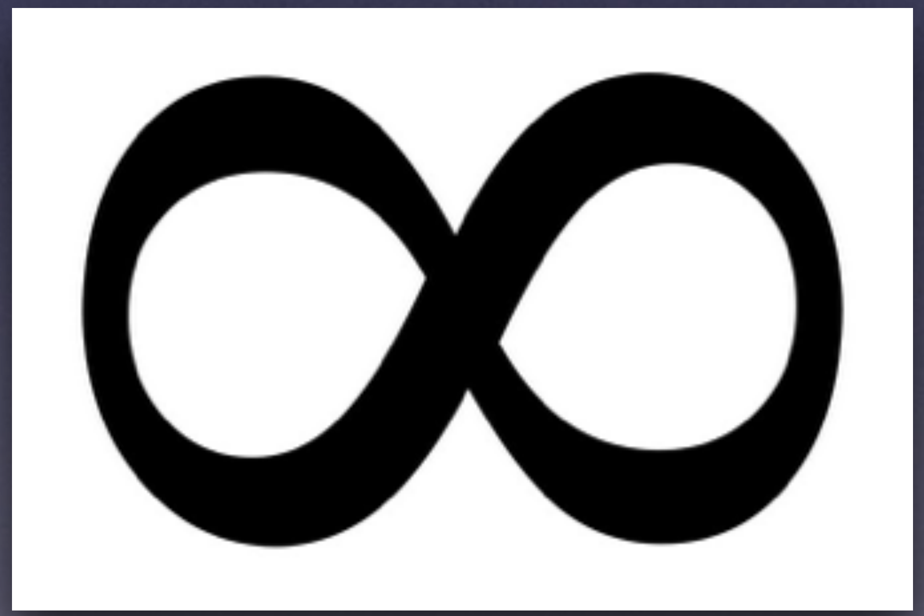
R is the set of rules that provide explicit instructions about how to form valid combinations of elements of $\sum$

O is the set of extralinguistic objects that are denoted by the elements of L

Sign/Symbol

- A sign is an object that "stands for" (denotes, designates, or represents) another object.
- A symbol is an artificial sign.

Dark clouds are a sign of possible rain



symbol of 'infinity'

The set R contains three disjoint subsets

$$R = Sy \cup Se \cup Pr$$

with Sy =def set of syntactic rules
Se =def set of semantic rules
Pr =def set of pragmatic rules

If $Se = Pr = 0 = \varnothing \Rightarrow L$ is a *logistic system* or *abstract language*

(e.g. first order logic)

The rules of a language L_1 are expressed in a second language L_2, called the *metalanguage*

First order logistic system (L_1)

The metalanguage will be formed with elements of L_1 and natural language
The elements of Σ_{L_1} are:

1. A series (finite or infinite) of predicate signs: ‘p_1’, ‘p_2’,…
2. The identity: ‘=‘
3. A series (finite or infinite) of constants: ‘*a*’, ‘*b*’,…
4. A series (finite or infinite) of variables: ‘x_1’, ‘x_2’,…
5. The basic connective ‘$\wedge$‘
6. The negation ‘¬’
7. The existential symbol ‘$\exists$ ’
8. The parentheses ‘(’ and ‘)’
9. The comma ‘,’

A *term* of L_1 is any constant, variable, or valued predicate such as '*p (a, b,c,…)*'. Valid combinations of symbols are called *formulas*.

The syntactic rules (elements of R=Sy) are:

Sy_1. If '*p*' is a predicate and '*a*', '*b*', '*c*', …are terms, then '*p (a, b, c, …)*' is a formula.

Sy_2. If ' ϕ ' and ' ξ ' are formulas, then ' $\phi \wedge \xi$ ' is a formula.

Sy_3. If ' ϕ ' is a formula, then ' $\neg\phi$ ' is a formula.

Sy_4. If '*a*' and '*b*' are terms, then '*a=b*' is a formula.

Sy_5. If ' ϕ ' is a formula and 'x' is a variable, then ' $(\exists x \ \phi x)$ ' is a formula.

Sy_6. There is not any further sequence of primitive symbols that is a formula.

Some definitions

$$(A \vee B) = [\neg(\neg A \wedge \neg B)]$$

$$(A \to B) = (\neg A \vee B)$$

$$(A \equiv B) = (A \to B) \wedge (B \to A)$$

$$(\forall x \ \phi x) = [\neg \exists x \ (\neg \phi x)]$$

The operation of *deduction* allows to obtain valid formulas from valid formulas. Deduction is the successive application of syntactic rules.

Formulas obtained through deduction are called ***theorems***.

$\vdash$ =def ‘is a theorem’ or ‘is entailed’

A set of formulas *S* is ***consistent*** iff $\neg(S \rightarrow \phi \wedge \neg\phi)$ for any $\phi \in S$

Contradiction: $\phi \wedge \neg\phi$

Interpreted language

To interprete a language we need to add a collection of extralinguistic items *0*, that conform the *universe of discourse*, and a set of semantic rules to relate them with the elements of the language.

$$L =< \Sigma,\ R,\ O >$$

R=Sy $\cup$ Se $\quad O \neq \emptyset$

The main semantic concepts that are used in the semantic rules are those of *denotation/designatition*, *reference*, and *representation*.

Denotation/designation

Denotation (D) is a relation that assigns symbols to objects of the universe of discourse

$$D : \Sigma \to O$$

Example: e denotes an electron

Designation ($\mathcal{D}$) is a relation that assigns symbols to concepts

$$\mathcal{D} : \Sigma \to C$$

Example: C designates a set

C is a set of *constructs*, i.e. conceptual entities constructed by abstraction. Abstraction proceeds by imposing an equivalence relation to a set. This operation results in the partition of the set in different disjoint sets, each of them identified with a construct.

Equivalence relation

An equivalence relation is a binary relation that is at the same time a reflexive, symmetric and transitive relation.

Any equivalence relation, as a consequence of the reflexive, symmetric, and transitive properties, provides a partition of a set into equivalence classes. These classes can be identified with abstract concepts (constructs)

Equivalence relation

A given binary relation ~ on a set X is said to be an equivalence relation if and only if it is reflexive, symmetric and transitive. That is, for all a, b and c in X:

a ~ a. (Reflexivity)
a ~ b if and only if b ~ a. (Symmetry)
if a ~ b and b ~ c then a ~ c. (Transitivity)

X together with the relation ~ is called a setoid. The equivalence class of a under ~, denoted [a], is defined as $[a] = \{b \in X \mid a \sim b\}$

Reference

Reference is a relation between constructs and objects of any kind, either factual items of the world or other constructs.

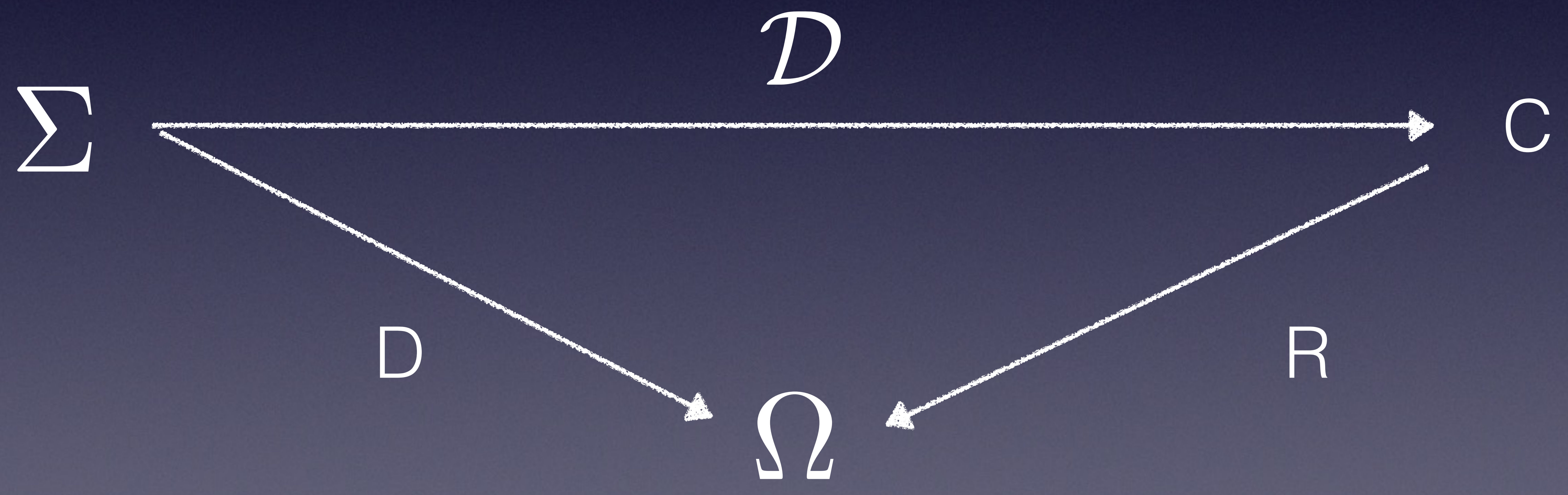
$$R : C \to \Omega \qquad \qquad \Omega = O \cup C$$

If $\Omega = O$ we say that the reference is *factual*.

If $\Omega = C$ we say that the reference is *formal*.

Given some *c* in *C*, the reference class of *c* is the set of all objects of any kind that are referred to by *c*:

$$[c]_{\mathrm{R}} = \{x \in \Omega : \; R(cx)\} \, .$$



The relation of reference can be specified to become a function in the case of predicates and statements

A predicate is a function from some multiple domain of objects to statements

$$P : A_1 \times A_2 \times ... \times A_n \to S$$

The value of *P* at $\langle a_1, a_2, ...a_n \rangle \in A_1 \times A_2 \times ... \times A_n$

is the atomic statement $Pa_1 a_2 ... a_n$

The reference class of a predicate is the domain of its arguments

$$R(P) = \bigcup_{i=1}^{n} A_i$$

The reference class of a statement is the set of all values of its arguments

$$R(Pa_1 a_2 ... a_n) = \{a_1, a_2, ..., a_n\}$$

The reference class of a composed statement is the union of all sets of values of its arguments

$$R(W(s_1, s_2, ..., s_n)) = \bigcup_{i=1}^{n} R(s_i)$$

Quantification does not have referential import. The reference class of a quantified predicate is the reference class of the predicate.

For instance: ‘All ravens are black’ refers to ravens.
‘Not all ravens are black’ refers to ravens
‘There is at least one raven that is black’ refers to ravens
‘Ravens are black’ refers to ravens (not quantified at all)

Individuals do not refer. They are referred to.

A ***theory*** is a set of statements that is closed under the operation of entailment.

$$T = \{s \;:\; A \vdash s\}$$

A is a set of statements that entail all stamens in T.
They are called axioms.

Any statement of the theory is either an axiom or a consequence of axioms (axioms are primitive statements).

The reference class of a theory is

$$R(T) = \bigcup_{i=1}^{n} R(A_i)$$

Deduction preserves reference.

We can establish the reference class of a theory from its axioms.

Reference is not *extension*

Extension: the extension of a predicate are those objects that make the statement ***true***.

Reference does not presupposes the concept of truth.

Example: the extension of $(\forall x)(Px \vee \neg Px)$ is everything.

The corresponding reference is empty. Since it is an abstract formula it does no refer.

The extension of ‘Prague is the most beautiful city in the world ***and*** Prague is not the most beautiful city in the world’ is the empty set, but its reference class is {Prague}, and the statement refers to Prague.

Pure logistic systems do not refer since they are not interpreted.

Logic does not have any reference class.

Mathematics has purely formal reference classes: it refers only to constructs.

Factual science refers to the objects that populate the world

Representation

Some constructs not only refer, but also ***represent*** properties of things, and their changes. We can then introduce a ***relation of representation***, that assigns constructs to facts (states or changes of states of things).

$$\hat{=} : C \rightarrow F$$

In particular, statements represent facts of their referents

Rules of representation

- Repr. 1 - Properties of real things are represented by predicates (in particular, functions).
- Repr. 2 - Real things are represented by sets equipped with relations, functions, or operators.
- Repr. 3 - Events (changes) in things are represented by sets of statements (either singular or existential).
- Repr. 4 - Laws (regular patterns of events) are represented by sets of universal statements.

The representation relation is not symmetric (facts do not represent constructs), nor reflexive (constructs do not represent themselves), nor transitive (facts do not represent anything at all).

Representations are not necessary unique. The same feature of reality can be represented in different ways. Two representations, c and c’ of an item of a theory T are equivalent iff they are interchangeable in all law statements of T.

Let T and T’ be two theories with the same referents. Let us designate {P} and {P’} their respective predictive basis (i.e. the set of predictive statements of the theories). Then, T and T’ are semantically equivalent iff there exists a set of transformations for {P} and {P’} that allows to convert T into T’ preserving the truth value of all statements.

Examples

- Schrödinger and Heisenberg pictures of Quantum Mechanics
- Lagrangian and Hamiltonian formulation of Classical Mechanics

Instead: Classical Mechanics and Special Relativity share referents but are not semantically equivalent.

Sense

The *sense* S of a construct c in a theory T is the union of the items of the same type that entail or are entailed by it

$$S(c) = \{x : x \vdash c\} \cup \{y : c \vdash y\}$$

$$S(c) = A(c) \cup J(c)$$

A(c) is the purport or logical ancestry and *J(c)* is the import or logical progeny of *c*

If c is any proposition of a theory T, then $A(c)$ and $J(c)$ are sets of propositions. We say that the sense of $S(c)$ is the ***content*** of the proposition c.

If c is not part of a theory, then the sense is not well defined and it is called the ***intension*** of c. The intension is the complement of the extension. The greater the intension, the smaller the extension. The intension is what a proposition “says”.

Example: - ‘A human population was sick’, ‘A population in Australia was sick’, ‘A 1/3rd of the population of Melbourne, Australia, was sick with chicken pox in 1897’.

Intension ↑ Extension ↓

Meaning

Meaning is an attribute of constructs in a certain theory.

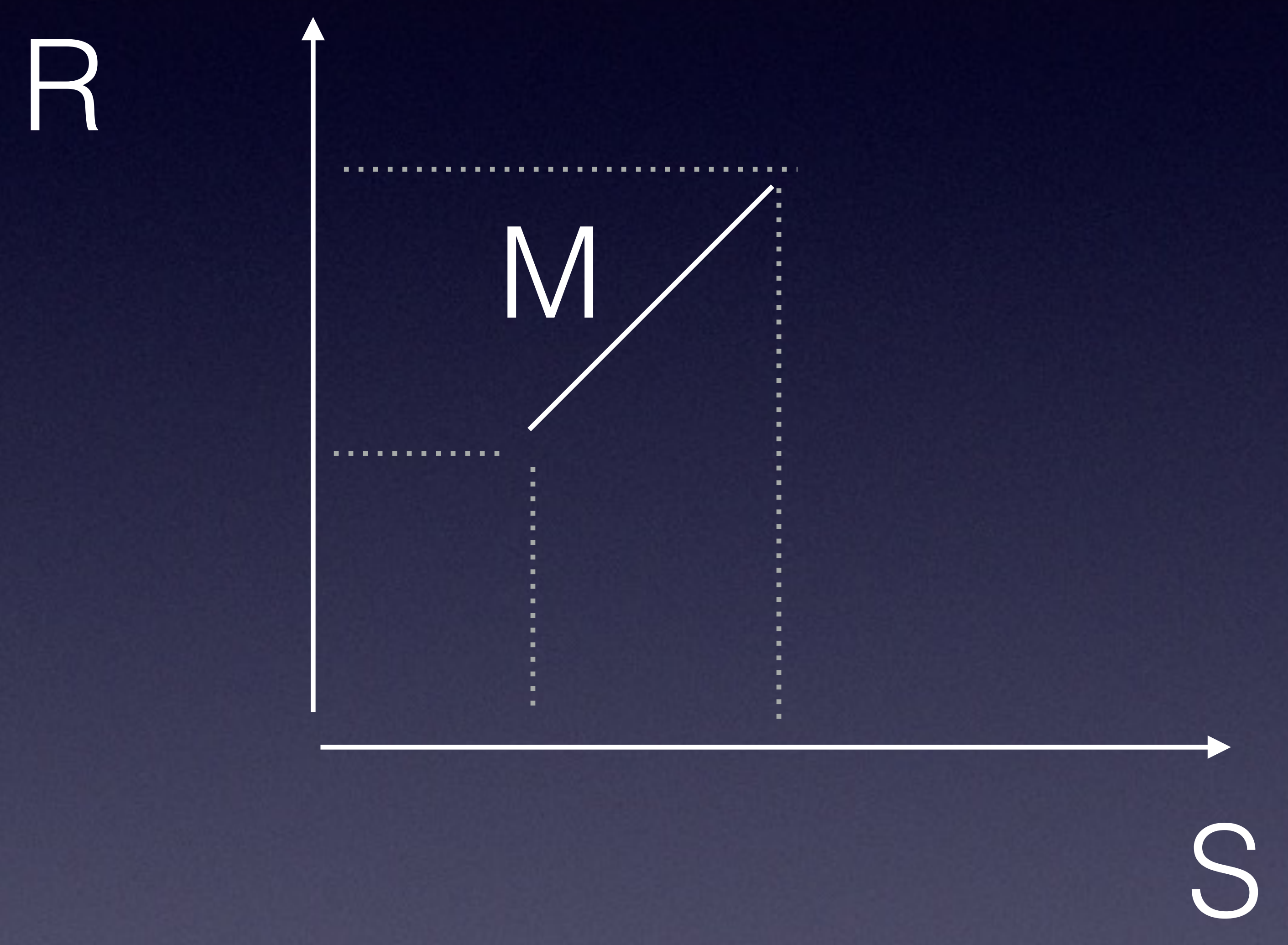
If *c* is a construct of a theory *T*, with reference *R(c)* and sense *S(c)*, the meaning of *c*, *M(c)*, is the ordered pair:

$$M(c) = \langle R(c),\ S(c) \rangle$$

where $R:\ C \to \mathcal{P}(\Omega)$ $\quad S:\ C \to \mathcal{P}(C)$

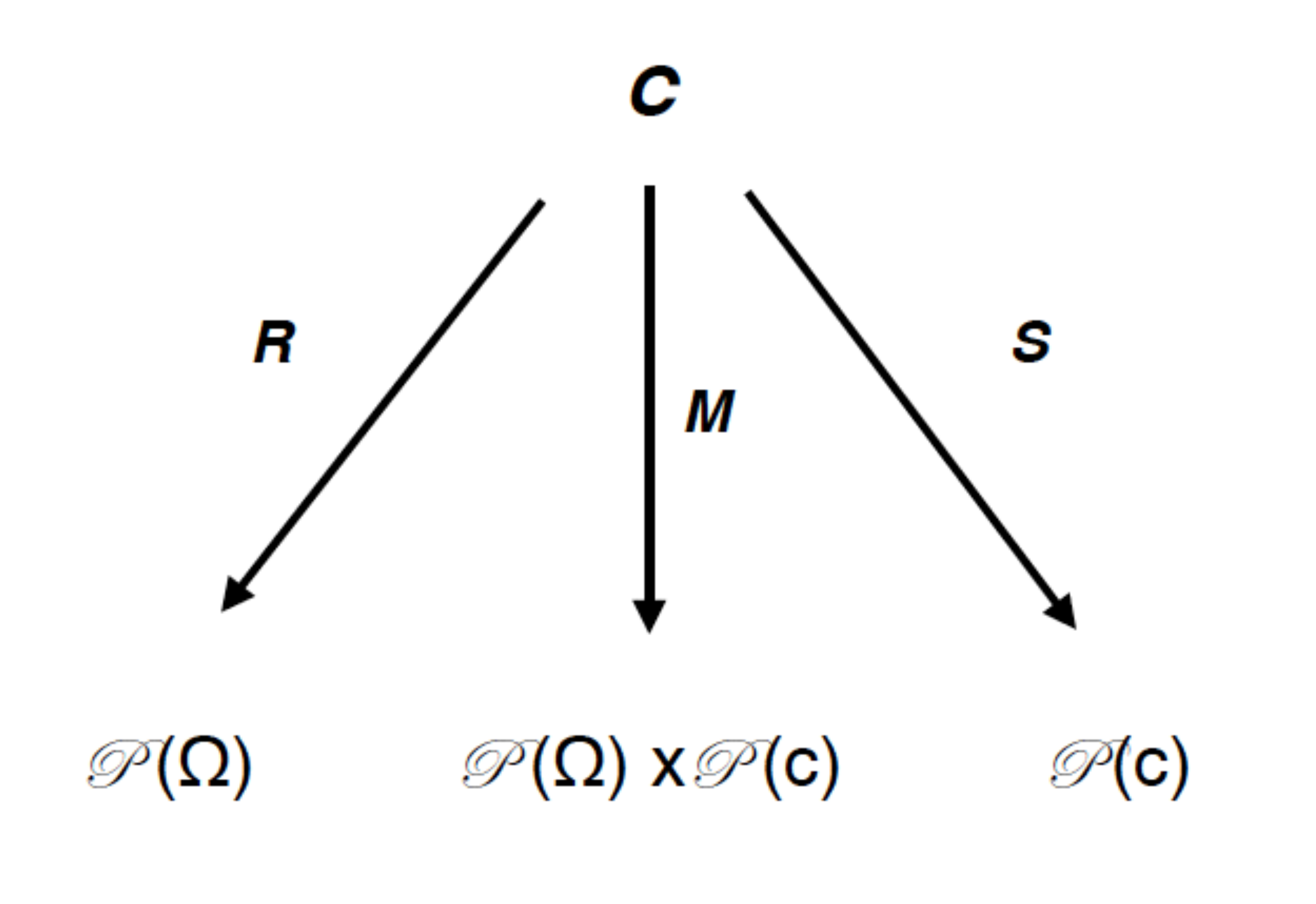
$$M:\ C \to \mathcal{P}(\Omega) \times \mathcal{P}(C)$$

Meaning is a two-dimensional concept . It can be represented in the real plane.



$$M = \langle R,\ S \rangle$$

Relations between constructs C and all kind of objects Ω



$$C \subset \Omega$$

The identity of meaning of two statements, *p* and *q* is given by

$$M(p) = M(q) \leftrightarrow R(p) = R(q) \ \wedge \ S(p) = S(q)$$

Using concepts from set theory we can define a ***calculus of meanings***

Two propositions *p* and *q* are said to be synonymous iff they have the same meaning :

p Syn *q* iff *M(p)=M(q)*

See Bunge 1974, and Bunge 1973.

Symbols do not have meaning, they have ***significance***. Significance is the composition of designation and meaning: the symbols designates a construct, and the construct has meaning. If a sign does not designate, it is not a symbol, and we call it ***syncategorematic***.

The difference in meaning between two concepts is:

$$\delta_M(c,\ c') = \langle \delta_R(c,\ c'),\ \delta_S(c,\ c') \rangle$$

where

$$\delta_R(c,\ c') = R(c) \bigtriangleup R(c')$$

$$\delta_S(c,\ c') = S(c) \bigtriangleup S(c')$$

Symmetric difference $A \bigtriangleup B = (A \cup B) - (A \cap B)$

Summing up: Languages are ***conceptual systems*** with a vocabulary, formation rules, and a universe of discourse. If the latter is lacking, the language is ***abstract***. Otherwise it is ***interpreted***. Symbols ***denote*** objects and ***designate*** concepts. Concepts ***refer*** to individuals of any kind. Some concepts can be used to ***represent*** things, properties, and facts. All concepts have a ***meaning***, formed by sense and reference.