Workshop on semiotics, cognitive science and mathematics Fields Institute 2011

What mathematical structure is semiosis (if any at all)?

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Tartu semiotics



Jakob von Uexküll 1864–1944 biosemiotics 'umwelt'

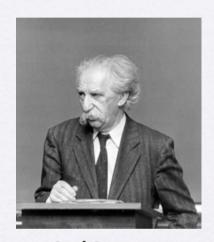
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Sign Systems Studies

37(3/4)



Juri Lotman 1922–1993 semiotics of culture 'semiosphere'

(communication paradox)

- task to convey understanding
- difficulty to find the words

semioticians are usually not mathematicians

- semiotics as well as semiotic biology (a qualitative biology) has not been active in building mathematical models; however,
 - Uexküll's early work criticized the ambiguous concepts of animal behaviour studies
 - Tartu-Moscow semiotic school of 1960s–70s was influenced by A. Kolmogorov's contribution, mathematical linguistics, cybernetics, I. Prigogine's work, etc.

- what is sign (= semiosis) from the mathematical point of view
- whether sign is a simple or complex object
- why semiosis resists mathematical modelling
- what will we need to put into a model in order to have semiosis itself modelled

what is sign

- sign relation (code relation)
- sign process (semiosis)

what is code

- a correspondence that can be reproduced (thus inherited), repeated (but that cannot establish itself via self-assembly from scratch; non-stereochemical)
- e.g., morse code, genetic code, etc
- machines are full of codes, but these are all formed (built) by us, organisms
- organisms are full of codes, all designed by organisms
- code is a product of semiosis, not vice versa
- semiosis is a sign-formation and code-creating process

sign relations in semiosis

- recognition (representing indistinguishability) iconic vegetative level
- association (representing correlation) indexical animal level
- replacement (representing convention) symbolical — cultural level

polysemy v. monosemy semiosis v. code

- poetry *v*. formal logic
- life v. automaton
- natural language v. formal language
- humanities v. exact sciences

the latter is a product of the former!

attempts of modelling semiosic systems

There exists a long and rich tradition of modelling of some semiosic objects, as well as a search for proper mathematical tools for their modelling, e.g., of organisms and languages. Yet, mathematical biology and mathematical linguistics (also mathematical sociology, mathematical psychology, etc.) have challenged the problem of limitedness of mathematization of their theoretical core. In its general form, this is the problem (the difficulty) of mathematical description (modelling) of semiosis.

The examples about the searches for mathematical description (formalization) of semiosis — Robert Rosen's approach, computational semiotics, algebraic semiotics, etc.

semiotic models of semiosis

- binary (Saussure)
- double-binary (Greimas)
- triadic (Peirce)
- cyclic (Uexküll)
- Jakobson's model; Lotman's model; etc.

Krampen, Martin 1997. Models of semiosis. In: Posner, R.; Robering, K.; Sebeok, T. A. (eds.), *Semiotics: A handbook on the sign-theoretic foundations of nature and culture*, vol. 1. Berlin: Walter de Gruyter, 247–287.

• A feature that is in the focus of modelling of semiosis has to be the feature that natural languages (a living conversation) possess and the formal languages (and formal logic) do not. If this feature resists formalization, then how to explain that mathematics can describe the physical world, whereas it (as if) cannot describe the non-mathematical or natural language from which it is a derivative?

Sebeok's Thesis

- Life is semiosis.
- Semiosis sign process the ability to create meaning-generating processes is the central distinguishing mark of a system that is *alive*. This is one of the basic positions held in contemporary biosemiotics.
- Myrdene Anderson: The deeper structures closer to primary modeling systems (Sebeok 1991), enable and limit the more surface structures.
- Understanding mathematics requires understanding language, requires understanding the work of sign systems, requires understanding life.

• Modelling of semiosis appears to be particularly a problem for biosemiotics. Because if to accept Sebeok's thesis that semiosis is the criterion of life, then a model of sign is simultaneously a model of life. Thus the problem of distinction between natural and formal languages goes beyond languages, i.e., it is just a special case of an analogical distinction within any (both symbolic or language-based, and non-symbolic) sign systems. If languages are defined as systems that use symbols, then there exist many semiosic systems that are not languages, i.e. which include merely non-symbolic semiosis (usually called 'non-human life forms'). This is, in other words, an old question whether it is possible to distinguish between living and non-living systems, i.e. between non-formal (or natural) and formal sign systems on the basis of their formal (mathematical) descriptions.

• There exist many mathematical models in biology, linguistics, sociology, etc. However — how to recognize *from the model itself*, whether it is a model of a living system (of semiosis) or of something else?

- Robert Rosen, Life itself (1991: 280):
- But complexity, though I suggest it is the habitat of life, is not itself life. Something else is needed to characterize what is alive from what is complex. Rashevsky provided this too, in his idea that biology was relational, and that relational meant (as we stated it) throwing away the physics and keeping the organization. A rough analog would be: throwing away the polypeptide and keeping the active sites. Organization in its turn inherently involves functions and their interrelations; the abandonment of fractionability, however, means that there is no kind of 1 to 1 relationship betweeen such relational, functional organizations and the structures which realize them. These are the basic differences between organisms and mechanisms or machines.

Louis H. Kauffman (2005) – The one and the many. Cybernetics and Human Knowing 12: 159–167. singletons

• A set with single element

Element L
Singleton set {L}

Principle of collection – any sets that already exist can be selected as members of a new set that is created from them

```
L

{L}

{{L}}

{{L}}

{{L}}}

{{L}, {L}}}

...

{L, {L}}

{L, {L}}
```

- Semiotic world singletons are distinct from their members
- *Physical world* the difference between singleton and its element collapses

- Note 1. Mathematical world is semiotic the world of relations and possibilities. This creates a permanent tension between *mathematical* description and *purely physical* world.
- Note 2. Meaningfulness means that a thing exists in many ways; that in a *purely semiotic* world everything is locally plural.

MODELLING	Semiotic approach	Physical approach
Non-living realm	one wany	one ▼ one
Living realm	many T many	many V one

The sciences that are dealing with everything that can be described in an unambiguous (formal) way can be called phi-sciences (physical sciences), whereas the sciences that can deal with equivocal (polysemous, like natural language, poetry and life itself) descriptions can be called sigma-sciences (semiotic sciences).

• Formal sign systems are derivatives from natural sign systems - similarly to artefacts, dead languages, machines. What makes them formal is the lack of that very feature the modelling of semiosis is addressing — the semiosity, the life itself. The existence of codes is a necessary but not a sufficient condition for semiosis, because constructions of non-living machines (i.e., certain artefacts) also include codes.

Jakob von Uexküll (1930: 9):

"Structure is not a material thing: it is the unity of immaterial relationships among the parts of an animal body. Just as plane geometry is the science not of the material triangles drawn on a blackboard with chalk but of the immaterial relationships between the three angles and three sides of the closed figure [...] so biology treats of the immaterial relationships of material parts united in a body so as to reconstitute the structure in imagination."

Lotman's model



Sign always requires more than only one code

- Juri Lotman's model of semiosis states that semiosis necessarily includes at least two mutually incompatible (incommensurable) sign systems.
- Thus the general problem of the mathematical structure of semiosis can be reduced, e.g., to the problem of formalizability of Lotman's model.
- Cf. code duality model (Hoffmeyer & Emmeche 1991).
- I.e., Lotman's code plurality model asks to model non-translatability.

- to model semiosis is to model a contradiction because two codes are two codes if they are incompatible
- incommensurable
- qualitatively different
- as different form formal language, a natural language certainly includes homonymy (polysemy) — the permanent source of contradictions

life process

- meaning-making is the struggle between what does not fit with each other (i.e., being in a contradiction)
- life is a being in a permanent condition of contradictions; in recognizing absence of something (having a need)
- the unfittedness is simultaneously the source of freedom and intention

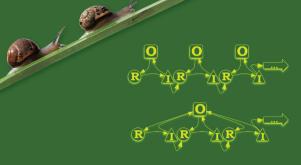
in semiotics

- why mathematics resists the modelling of semiosis is because semiosis is a contradiction (= the process of contradiction)
- semiosis is a translation in the situation of non-translatability
- from semiology to semiotics
- interpretation is a general process of life
- semiotic modelling modelling of semiosis means a modelling of contradictions — of qualitative, irreducible differences, of qualitative diversity

living balance is the maintenance of qualitative (incommensurable) diversity

• "Semiosis is, in fact, the instrument which assures the maintenance of the steady state of any living entity, whether in Liliputian microspace, dealt with by molecular geneticists and virologists; the Gulliver-sized world of our daily existence; or [...] the biosphere viewed as a Brobdingnagian macrostructure that subsists upon a splendid blue marble" (Sebeok 1988: 1085)



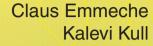


TOWARDS A SEMIOTIC BIOLOGY Life is the Action of Signs

This book presents programmatic texts on biosemiotics, written collectively by world leading scholars in the field (Deacon, Emmeche, Favareau, Hoffmeyer, Kull, Markoš, Pattee, Stjernfelt). In addition, the book includes chapters which focus closely on semiotic case studies (Bruni, Kotov, Maran, Neuman, Turovski).

According to the central thesis of biosemiotics, sign processes characterise all living systems and the very nature of life, and their diverse phenomena can be best explained via the dynamics and typology of sign relations. The authors are therefore presenting a deeper view on biological evolution, intentionality of organisms, the role of communication in the living world and the nature of sign systems — all topics which are described in this volume. This has important consequences on the methodology and epistemology of biology and study of life phenomena in general, which the authors aim to help the reader better understand.





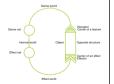
Editors

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