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TOWARDS A LOGIC OF SEMIOTIC SYSTEMS

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RÉSUMÉ — Vers une logique des systèmes sémiotiques
*L'approche rationnelle dénotationnelle de la sémantique n'est pas propre à saisir la dimension structurelle de la signification qui est immanente dans les sytèmes sémiotiques. Le besoin d'une approche structurelle s'intensifie en raison d'un changement d'attitude dans le domaine de l'Intelligence Artificielle, introduit par le "Connectionism" et "l'Information retrieval". Cet article présente ce type d'approche sémantique fondée sur la phénoménologie et l'*autopoesis *et propose une formalisation par la théorie des catégories.*

ABSTRACT — *The rationalistic denotational approach to semantics is not adequate for capturing the structural dimension of meaning, which is immanent in semiotic systems. The demand for a structural approach to semantics is intensified by a turn in Artificial Intelligence, introduced by* Connectionism *and* Information Retrieval. *This paper presents such a structural approach to semantics founded on the* phenomenological *and* autopoietic *paradigms and proposes a formalization with the help of* category theory.

I. INTRODUCTION

1.1. The turn in Artificial Intelligence

It has been the result of many research projects that expert systems cannot capture the heuristic nature of human competence. The reason, from a phenomenological point of view, is that the behaviour of the human expert, that is to be simulated, cannot be analyzed in a rationalistic manner. The rule-based formalisms, immanent in expert systems, are founded on the rationalistic paradigm, which views human competence as a set of rules that operate on logical atoms, called facts. Behaviour is then modelled as a feedback driven schema, where the human acts on the environment, perceives the impact of his actions, and readjusts his rules. The reconstruction of the presentation of the relevant aspects of the environment forms thereby the objective, i.e. universally identified, situation and takes place in the mind, which receives the data from the receptors and - according to the result of the calculations - send messages to the effectors to act on the environment. The universality of the reconstruction is guaranteed by the rationalistic method, the core of which is lying in the identification of "clear" and "distinct" ideas, which form the logical atoms, and the application of inference rules to produce more complex representation entities. Since both the logical atoms and the inference rules are universal, the reconstructed reality is necessarilly imposed on each subject, i.e. it is objective. Actions are then modelled as transformations between situations, as parts of an objective reality.

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Both Phenomenology and autopoietic cybernetics demonstrated that "inside" the cybernetic schema[1] there is a predualistic domain, where perception and actions are guided by phylo- and ontogenetical automatisms[2]. This domain is what Heidegger calls *Being-in-the-world*[3] and autopoietic cybernetics calls *structural coupling*[4]. On this level, an action is no longer a force imposed on an independently existing reality, where the result is grasped in a mental act, but constitutes reality. This predeualistic domain corresponds to a closed nervous system, in the sense that the effectors are not just channels[5] that transfer information to a central processor unit and the effectors are not just action instruments, it is rather the activation of the nervous system as a whole, that determines the possible interactions with the environment. The structure of possible interactions forms the *cognitive domain*[6].

> "But what was still more fundamental was the discovery that one had to close off the nervous system to account for its operation, and that perception should not be viewd as a grasping of an external reality, but rather as the specification of one, because no distinction was possible between perception and hallucination in the operation of the nervous system as a closed network. Two immediate consequences arose from this : The first consequence required that the question 'How does the organism obtain information about its environment ?' be changed to : 'How does it happen that the organism has the structure that permits it to operate adequately in the medium in which it exists ?' A semantic question had to be changed into a structural one. The second question required the actual attempt to describe the phenomena that take place in the organism during the occurence of the phenomena of perception and cognition in a language that retained them as phenomena proper to a closed nervous system" (Maturana & Varela,1980, S.XV-XVI).

Reality is therefore not a universal representation but an intersubjectively constituted domain that emerges as a structure of invariants in a structural coupling between structurally coupled systems. In autopoietic terms[7] this domain is called *consensual domain.* A (phenomenological) situation is not the mental reconstruction of a presented - through the receptors - part of an objective reality, but arises out of the actual state of the nervous system ; and an action is in turn not a transformation of (external) situations, but a modification of structural coupling. Accordingly, an action of an expert is not a rule that is fired when the initial condition matches a part of the external situation, but an interaction leading to a new mode of structural coupling.

This critique leads to the following tendencies :

- *Connectionism* tries to capture the self-organization of consciousness by looking at symbols as activations on a network, whose structure is the result of perturbations.

- *Information Retrieval systems* focus on the usersystem integration by viewing the system not as a substitute of the human expert, but as a dynamic tool of the user.

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1 A phenomenological critique of the cybernetic approach of behaviourism has been developed by Merleau-Ponty by considering the ontological implications of Gestalt theory (Merleau-Ponty, 1942).

2 The relevance of both approaches for Artificial Intelligence is shown in (Winograd & Flores, 1986).

3 In-der-Welt-sein (Heidegger, 1927).

4 Maturana & Varela, 1980.

5 That the visual pathways of the nervous system can not be considered as channels, in the sense of information theory, that transmit information to the area striata, had already been demonstrated by Hubel (Hubel, 1960).

6 Maturana & Varela, 1980.

7 Maturana & Varela, 1980.

Since both approaches are characterized by the closedness, i.e. circularity of the cognitive structure, the hierarchical method of rationalism does not help to identify logical atoms and to calculate the meaning of complex entities as a function of the meanings of the atoms. There is therefore the demand of modelling the meaning of an entity, not as a detotational mapping between different domains, but as an intensional description of how this entity is interlinked in a network[8].

1.2. Semiotic systems

The idea of an intensional meaning has been in the center of attention of Linguistics since Saussure introduced the concept of *valeur* in order to describe the positional value of language terms, i.e. their interrelation in the structure of *langue*. So while the valeur of a term is an expression of its functionality, i.e. of its "internal" meaning, its denotational meaning remains a characterization of the associated part of an objective reality. Since the hierarchic approach of rationalism guarantees that the meaning of an entity can always be reduced to the meaning of the atoms, the positional value is treated in *formal systems* as a purely syntactical, i.e. "meaningless", construction. Now if the range of the denotational function is not an objective reality but an intersubjectively constituted one, then the association of a denotation to a term is possible only because of the invariance of the positional value of this term in structurally coupled systems.

> "Human beings can talk about things because they generate the things they talk about by talking about them" (Maturana, 1978, p.56).

In contrast to formal systems *biological systems* are, in the sense of autopoiesis, circular and it is this circularity that constitutes their self-sufficiency.

> "The idea of autopoiesis capitalizes on the idea of homeostasis[9], and extends it in two significant directions : first, by making every reference for homeostasis internal to the system itself through mutual interconnection of processes ; and secondly by positing this interdependence as the very source of the system's identity as a concrete unity which we can distinguish" (Varela, 1979, p.12-13).

In closed cybernetic systems[10] the environment is not a model of the relevant aspects[11], but is constituted through the actual state of the interrelation between the components as a stabilization of fluctuations caused by perturbations.

Semiotic systems are in turn closed systems of terms, in which denotation arises out of intensional meaning.

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[8] It is therefore the structural aspect of meaning, as opposed to the referential one, that forms the focus of interest (see Rieger, 1990).

[9] The concept of homeostasis has been introduced by Cannon in 1926 to describe the internal stabilisation of biochemical processes that is characteristic for living organisms.

[10] A cybernetic system is a structure $<A,R>$ where

1. $A = \{a_1, a_2, ..., a_n\}$ is the universum and $a_i : i = 1,...,n$ are the components of the system.
2. R is the characteristic of the system and is defined as ollows : for a_0 model of the environment and r_{ij} representing the link between the input of a_i and the output of a_j R is $\{r_{ij} : i,j = 0,...,n\}$.

A closed cybernetic system is a system in which a_0 is an internal component.

[11] And since it is not possible to make a complete formalisation of what is seen as relevant, the problem of modelling - in a rationalistic manner - the actual situation results in an "open structured problem" (Dreyfus, 1972).

"Therefore it is possible to elaborate a theory of signification on the grounds of a purely intensional semantics. I am not saying that an extensional semantics is devoid of any function ; on the contrary, it controls the correspondence between a sign-function and a given state of the world, when signs are used in order to mention something. But I am stressing the fact that an extensional semantics can be elaborated (and that processes of reference or mention can be established) only because an intensional semantics is possible as a self-sufficient cultural construct (that is a code or a system of codes)" (Eco,1979, p.179).

In Heideggerian terms semiotic systems are manifestations of *meaningfulness*[12], which is - as homeostasis is the biological precondition of life - the semiological precondition of existence. It is because of meaningfulness that there is meaning.

"Den Bedeutungen wachsen Woerter zu. Nicht aber werden Woerterdinge mit Bedeutungen versehen" (Heidegger, 1927, p.161).

Again, it is circularity that characterizes meaningfulness structures, since it is closedness that establishes a semiotic system as a differentiable cultural entity. And since on circular structures the rationalistic hierarchic method breaks down there is no way to treat intensional meaning as "syntax".

In analogy to the nervous system, considered as a closed system, a phenomenological situation is not a part of an external reality[13], but a temporary[14] stabilization of perturbations that constitutes a horizon in a meaningfulness structure[15]. A situation is the result of a stabilization - as mutual constraining between activations - caused by the occurence of at least two terms[16]. This stabilization results in turn in a modification of the meaningfulness structure by influencing the interrelation between the activated components. So while the activation of one term produces a description of its intensional meaning, i.e. an interpretation[17] of how this term is interlinked in the considered semiotic system, an activation of two or more terms ends with the focussing of a substructure that determines the environment, as the relevant parts of the meaningfullnes structure[18]. The achieved stabilization increases the strength of connection between the activated terms and causes therefore the self-organizing modification of the system[19].

[12] Bedeutsamkeit (Heidegger, 1927).

[13] Situation semantics (Barwise & Pery, 1983) is an improvement of model theoretical semantics, since it focus on the cognitive dimension of meaning, but remains in the frame of rationalism by considering situation as logical atoms of an external reality}.

[14] In the sense of Augenblick (Heidegger, 1927).

[15] This corresponds to the conception of perception developed by Merleau-Ponty as "belief in a world", "belief" i the sense that it is a selection of perceptual data according to the phylo - and ontogenetical attunement (Merleau-Ponty, 1942) and (Merleau-Ponty, 1945).

[16] A meaningfulness structure is, in the language of Glossematics (Hjelmslev, 1961), the system - as a structure of invariants - that underlies the process. In order to establish links between the invariants there must be contexs that contain at least two terms.

[17] In the sense of *Auslegung* (Heidegger, 1927).

[18] This corresponds to the Husserlian notion of *actual noemata* as a substructure of the *possible noemata* that constitute the world (Husserl, 1976).

[19] The oscillation of the strength of connections corresponds to the rule of Heb concerning the activity of neurons. A self-organizing mechanism based on this model is given in (Thiopoulos, 1990).

2. THE FORMALISM

Category theory focus on the operational aspects of mathematical constructions and seems therefore to be the most promising tool towards an intensional semantics to capture the notion of meaning arising out of the phenomenological and autopoietical approaches.

2.1. Categories

DEFINITION 2.1. *A category A consists of*:
1. *a class of objects* $OBJ(A)$
2. *a class of morphisms* $MORPH(A)$
3. *two operations* $dom, cod : MORPH(A) \rightarrow OBJ(A)$ *with* $f : a \rightarrow b$ *iff* $dom(f) = a$ *and* $cod(f) = b$
4. *an operation* $\circ : MORPH(A) \times MORPH(A) \rightarrow MORPH(A)$ *such that* $f \circ (g \circ h) = (f \circ g) \circ h$
5. *an operation* $id : OBJ(A) \rightarrow MORPH(A)$ *with* $id(a) = id_a : a \rightarrow a$, *where* id_a *is the identity function on a.*

DEFINITION 2.2. $A(a,b) = \{f \mid f \in MORPH(A) \wedge f : a \rightarrow b\}$.

DEFINITION 2.3. *B is a subcategory of A* ($B \subseteq A$) *iff*
1. $OBJ(B) \subseteq OBJ(A)$
2. $\forall a,b \in OBJ(B)\ B(a,b) \subseteq A(a,b)$.

DEFINITION 2.4. *B is a full subcategory of A iff*
1. $B \subseteq A$
2. $\forall\ a,b \in OBJ(B)\ B(a,b) = A(a,b)$.

DEFINITION 2.5. *A diagram D in a category A consists of*
1. *a subset* $OBJ(D)$ *of* $OBJ(A)$.
2. *a subset of* $MORPH(A)$ *defined between elements of* $OBJ(D)$.

DEFINITION 2.6. *A cone for a diagram D in a category A consists of a* $c \in OBJ(A)$ *together with* $f_i : c \rightarrow d_i$ *for each* $d_i \in OBJ(D)$ *such that for each* g :

$$d_i \rightarrow d_i \quad f_i \circ g = f_i.$$

Such a cone will be notated as $\{f_i : c \rightarrow d_i\ ;\ d_i \in OBJ(D)\}$.

DEFINITION 2.7. *A limit for a diagram D is a cone* $\{f_i : c \rightarrow d_i\ ;\ d_i \in OBJ(D)\}$ *such that for any other cone* $\{f_i' : c' \rightarrow d_i\ ;\ d_i \in OBJ(D)\}$ *there is exactly one* $f : c' \rightarrow c$ *such that* $f \circ f_i = f'_i$.

DEFINITION 2.8. *A category A is finetely complete iff every finite diagram in A has a limit.*

DEFINITION 2.9. *The exponent from* $a,b \in OBJ(A)$ *is* $b^a \in OBJ(A)$ *together with* $ev : b^a \times a \rightarrow b$, *so that* $\forall c \in OBJ(A)\ \exists! g : c \rightarrow b^a$ *with* $ev \circ (g \times id_g) = g$.
Thereby $g(x) = g_x\ \forall x \in c$ *with* $g_x = g(<x,y>)\ \forall y \in a$.

DEFINITION 2.10. *A category A is cartesian closed iff*
1. *A is finetely complete.*
2. *A has exponentiation.*

A cartesian closed category has products and coproducts.

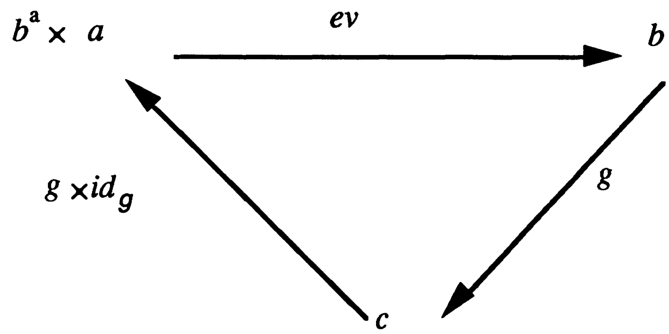

Figure 1. Exponentiation

DEFINITION 2.11. *The product from* $a,b \in OBJ(A)$ *is* $a \times b \in OBJ(A)$ *together with* $pr^1 : a \times b \rightarrow a,\ pr^2 : a \times b \rightarrow b \in MORPH(A)$,
so that $\forall c \in OBJ(A)\ \exists!\ \langle f,g \rangle : c \rightarrow a \times b \in MORPH(A)$
with $pr^1 \circ \langle f,g \rangle = f \wedge pr^2 \circ \langle f,g \rangle = g$.

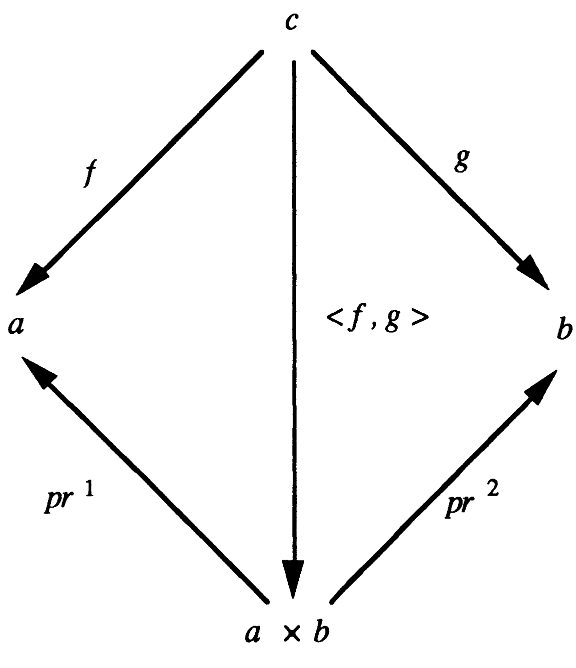

Figure 2. Product

DEFINITION 2.12. *The coproduct from* $a,b \in OBJ(A)$ *is* $a + b \in OBJ(A)$ *together with* $\kappa^1 : a \rightarrow a + b,\ \kappa^2 : b \rightarrow a + b \in MORPH(A)$,
so that $\forall c \in OBJ(A)\ \exists!\ (f,g) : a + b \rightarrow c \in MORPH(A)$
with $(f,g) \circ \kappa^1 = f \wedge (f,g) \circ \kappa^2 = g$.

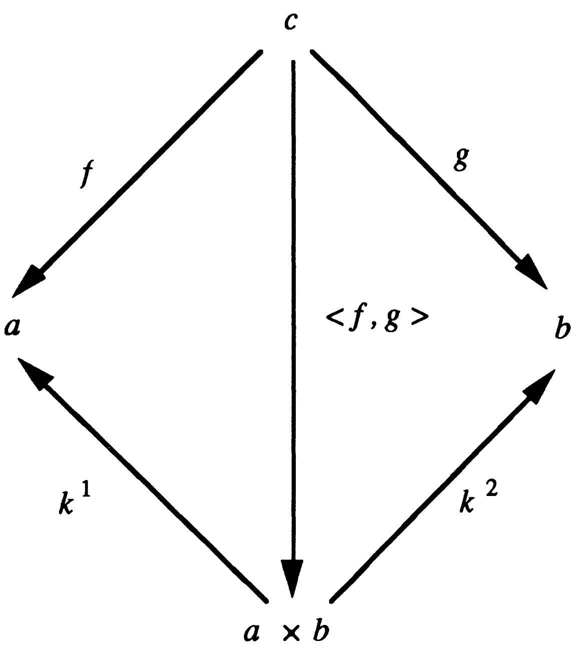

Figure 3. Coproduct

Mappings between categories are called functors.

DEFINITON 2.13. *For A,B categories a functor is a mapping* $F : A \to B$ *with* :
1. $F : OBJ(A) \to OBJ(B)$
2. $F : MORPH(A) \to MORPH(B))$

such that

1. $\forall a \in OBJ(A)\ \ F(id_a) = id_{F(a)}$ *and*
2. $\forall f,g \in MORPH(A)\ \ F(f \circ g) = F(f) \circ F(g)$

Functors can be used as morphisms in a category, which has a objects categories. The category of cartesian closed categories is cartesian closed[20].

Mappings between functors are called *natural transformations.*

DEFINITION 2.14. *For F,G functors a natural transformation* $\tau : F \to G$ *is a mapping*
$a \in OBJ(A) \mapsto \tau_a = \tau a : F(a) \to G(a) \in MORPH(B)$
such that $\forall f : a \to a' \in MORPH(A) \tau a \circ G(f) = F(f) \circ \tau_{a'}$

The categorial version of the concept of sieve, as a filter on the lattice of the open sets of a topological space, is a collection of morphisms that is closed under left composition.

DEFINITION 2.15 *A sieve on an object a of a category C is a set of morphisms*
$R = \{f \mid cod(f) = a\}$ *such that* $\forall f : b \to a \in R\ (g : c \to b \Rightarrow g \circ f : c \to a \in R)$.

DEFINITION 2.16.
1. $SIEV(a) = \{R \mid \text{R } sieve\ on\ a\}$.

2. $SIEV(OBJ(C)) = \{SIEV(a) \mid a \in OBJ(C)\}$.

[20] Lawvere, 1966.

The notion of covering sieves, *i.e.* of sieves over an open set such that the joint of their elements is a cover of the open set, is captured in the idea of the Grothendieck topology.

DEFINITION 2.17. *A Grothendieck topology on a category C is a function*

$$\mathcal{F} : OBJ(C) \rightarrow SIEV(OBJ(C))$$

such that :

$1. \forall a \in OBJ(C)\ \{f \mid cod(f) = a\} \in \mathcal{F}(a)$.

$2. (R \in \mathcal{F}(a) \wedge g : b \rightarrow a) \Rightarrow R_{\downarrow g} = \{f : c \rightarrow b \mid f \circ g \in R\} \in \mathcal{F}(b)$.

$3. R \in \mathcal{F}(a) \wedge S \in SIEV(a)$ *such that* $(\forall f : b \rightarrow a \in R\ S_{\downarrow f} \in \mathcal{F}(b)) \Rightarrow$
$S \in \mathcal{F}(a)$.

The elements of $\mathcal{F}(a)$ are the *covering sieves* on *a*. A category equiped with a Grothendieck topology is called a *site*[21]

2.2. Semiotic categories

DEFINITION 2.18. *A semiotic system S over an alphabet A is a weighted directed graph* $S = <A,W>$, *where* $W(a,b)_{a,b \in A}$ *is the matrix of weighted links.*

DEFINITION 2.19. *A semiotic category generated out of a semiotic system* $S = <A,W>$ *is a category C(S) with :*

- $OBJ(C(S)) \subseteq A$

- $MORPH(C(S)) = \{f : a \rightarrow b \mid W(a,b) \neq 0\}$

DEFINITION 2.20. *The weight of the morphisms is given as a function :*

$$conf(f) = W(a,b) \text{ iff } dom(f) = a \wedge cod(f) = b$$

For morphism composition conf is extended to :

$$conf(f \circ g) = conf(f)\, conf(g).$$

DEFINITION 2.21. *The interpretation on a semiotic category C is a topology*

$$* : OBJ(C) \rightarrow SIEV(OBJ(C))$$

defined as :

$$a \mapsto \{f \mid cod(f) = a \wedge conf(f) \geq B\} \quad \text{for}$$
$$min\{W(a,b)\} \leq B \leq max\{W(a,b)\}.$$

THEOREM 2.1. $*$ *is a Grothendieck topology since :*

1. $\{f \mid cod(f) = a\} \in a^*$ *for* $B = min\{W(a,b)\}$

2. $(\{f \mid cod(f) = a \wedge conf(f) \geq B\} \wedge g : b \rightarrow a) \Rightarrow (\forall h : c \rightarrow b\ h \circ g \in \{f \mid cod(f) = a \wedge conf(f) \geq B\} \Rightarrow h \in \{f \mid cod(f) = b \wedge conf(f) \geq B\} \in b^*)$

3. $(R = \{f \mid cod(f) = a \wedge conf(f) \geq B\} \wedge S = \{g_1, \ldots, g_n \mid cod(g_i) = a, i = 1, \ldots, n\}$ *such that* $\forall f : b \rightarrow a\ S_{\downarrow f} = \{h : c \rightarrow b \mid h \circ f \in S\} = \{f \mid cod(f) = b \wedge conf(f) \geq B'\}) \Rightarrow S = \{g \mid cod(g) = a \wedge conf(g) \geq min\{conf(g_i) : g_i \in S\}$

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[21] The Grothendieck topology marked the begining of the development of topos theory out of category theory (Johnstone, 1977, Bell, 1982).

a^* is the interpretation of a in C relative to B. Since a^* is an expression of how a is interlinked in a semiotic category, according to the depth of activation given by B, it can be used to model the positional value of a in a semiotic category.

DEFINITION 2.22. *A semiotic cartesian closed category CC(S) is a category C(S) augmented with the constructions that constitute cartesian closedness.*

DEFINITION 2.23. *For C semiotic cartesian closed category* :

$$prod(a,b) = \{c \mid \exists f \in MORPH(C) f : c \rightarrow a \times b\}$$
$$coprod(a,b) = \{c \mid \exists f \in MORPH(C) f : a + b \rightarrow c\}$$

conf is extended as follows :

$$conf(\langle f,g \rangle) = min\{conf(f), conf(g)\}$$

$$conf((f,g)) = max\{conf(f), conf(g)\}.$$

DEFINITION 2.24. *The situation generated out of a,b in a semiotic cartesian closed category C is the full subcategory SIT(a,b) with*

$$OBJ(SIT(a,b)) = prod(a,b) \cup coprod(a,b).$$

A situation is thus a substructure of the original semiotic category that is determined through mutual constraining between activations and can be therefore understood as a model of a phenomenological situation, because - as a full subcategory - is a stabilized structure, i.e. an application of a morphism of the semiotic category on an object of the situation does not lead outside it ; it is a structure closed under functional application. A situation represents the part of the semiotic system, which contains the relevant interactions in the actual state of structural coupling. The $*$ topology on a situation enables to identify the intensional meaning of an entity *relative* to a situation, capturing thus the contextsensitiveness of semiotic systems.

DEFINITION 2.25. *The situational category generated out of a semiotic cartesian closed category C is a category SIT(C) with :*
- $OBJ(SIT(C)) = \{SIT(a_1,\ldots,a_n) \mid a_i : i = 1,\ldots,n \in OBJ(C)\}$

- $MORPH(SIT(C)) = \{f \mid f$ *functor between two SIT-categories*$\}$.

The situational category is a model - since it is the structure of all possible interactions - of the cognitive domain.

DEFINITION 2.26. *A hypercategory HYP(A) is a category that has as objects semiotic categories over the same alphabet A and as morphisms the functors between them.*

A hypercategory models a structure of semiotic systems as a semiotic system. And since $*$ is defined on these systems, it is possible to compare them, not only geometrically but also topologically expressing thus their structural analogy.

DEFINITION 2.27. *A communication category COMM(A) is a category that has as objects the situational categories of semiotic categories and as morphisms the functors between them.*

The invariant morphisms of the communication category - as the structure of functions between all possible situations between structurally coupled - systems - can be used to model the consensual domain constituted between different semiotic systems. Again, the $*$ topologies enable the topological comparison between the situational categories of different semiotic systems so that "invariant" means topological, i.e. structural, invariant.

3.APPLICATIONS

3.1.Connectionistic logic

$W(a,b)_{a,b\in A}$ is the actual matrix of connections resulting out of a sequence of perturbations. a^* is, as an activation that produces a structural description of how a is interlinked in this matrix, the meaning of *a for the system*. *SIT*(a,b) is a substructure determined through mutual constraining between the activations of a and b and is therefore a model for the phenomenological situation - as a horizon in a meaningfulness structure - that emerges from the perturbation of a and b. c^* in *SIT*(a,b) models the meaning of c *relative* to the situation activated by a and b. The situational category models the "world" for the system and the communication category models the interaction between different systems. The intersubjectively constituted reality can be described as "invariants" in the communication category.

3.2. Semantics for information retrieval

$W(a,b)_{a,b\in A}$ is the matrix of links between document items. a^* determines, as a desription of the position of a in the knowledge base, the information to be retrieved if a is given as a query. *SIT*(a,b) determines the substructure of the knowledge base, which contains the information relevant to both a and b and represents therefore the restriction of the focus of interest of the user if "a and b" is given as a query. c^* in *SIT*(a,b) models the information to be retrieved if c is given as a query *relative* to the relevant substructure. The situational category corresponds to all possible restrictions of the knowledge base and the communication category captures the difference between the information that can be extracted from different knowledge bases.

3.3. Text analysis

$W(a,b)_{a,b\in A}$ can be seen - in the sense of Hjelmslev[22] - as the matrix of weighted determinations between invariants on a certain level of analysis that forms the system underlying the process. a^* is, as a desription of the positional value of a the (intensional) meaning of a. *SIT*(a,b) models the meaning of the syntagm consisting of a and b as the portion of the network of determinations that is relevant for the analysis of the text "a b". The situational category represents all texts that can be analyzed with this structure of invariants and the communication category models how a text can be analyzed in different ways, according to different invariant structures.

3.4. Change of level of representation

SIT(a,b) can be seen as a higher level entity emerging out of a network of lower level entities. If, for example, $W(a,b)_{a,b\in A}$ represents a matrix of light intensity gradients in Image Processing, *SIT*(a,b) can be used to identify the "object" lying between a and b. The generated situational category can be used to establish relations between these "objects" and the communication category to capture differences in the interpretation of the image.

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[22] Hjelmslev, 1961.

REFERENCES

BARWISE, J. & PERRY, J., *Situations and attitudes*, Cambridge, MIT Press, 1983.

BELL, J. L., "Categories, toposes and sets", *Synthese*, 51, 293-337, 1982.

DREYFUS, H. L., *What computers can't do*, New York, Harper & Row, 1972.

ECO, U., *The role of the reader,* Bloomington, Indiana University Press, 1979.

EILENBERG, S. & HARRISON, D.K. & MAC LANE, S. (Eds.), *Proceedings of the conference on categorical algebra, La Jolla 1965*, Berlin, Springer, 1966.

GOLDBLATT, R. TOPOI, *The categorial analysis of logic*, Amsterdam, North-Holland, 1979.

HEIDEGGER, M., *Sein und Zeit,* Tübingen, Max Niemeyer, 1979, first print : 1927.

HJELMSLEV, L., *Prolegomena to a theory of language*, Madison, University of Wisconsin, 1961.

HUBEL, D. H.," The visual cortex of the brain", *Scientific American*, November, 1963.

HUSSERL, E., *Ideen zu einer reinen Phaenomenologie und phaenomenologischen Philosophie. Husserliana Band III1*, Den Haag, Martinus Nijhoff, 1976.

JOHNSTONE, P., *Topos theory*, London, New York, Academic Press, 1977.

LAMBEK, J. & SCOTT P.J., *Introduction to higher order categorical logic*, Cambridge, Cambridge University Press, 1986.

LAWVERE, F.W., *The category of categories as a foundation for mathematics, in* Eilenberg *et al* 1966, 1-20.

MAC LANE, S., *Kategorien,* Berlin, Springer, 1972.

MAKKAI, M. & REYES, G.E., *First order categorical logic,* Berlin, Springer, 1977.

MATURANA, H., "Biology of language", *in* MILLER, G.A. & LENNEBERG, E. (Eds.), *Psychology and biology of language and thought.*, New York, Academic Press, 1978.

MATURANA, H. & VARELA, F., *Autopoiesis and cognition*, Dordrecht, D. Reidel, 1980.

MERLEAU-PONTY, M., *Die Struktur des Verhaltens*, Berlin , De Gruyter, 1976, first print : 1942.

MERLEAU-PONTY, M., *Phaenomenologie der Wahrnehmung*, Berlin, De Gruyter, 1974, first print : 1945.

NORMAN, D. A. & RUMELHART, D. E., *Explorations in cognition,* San Francisco, Freeman, 1975.

RIEGER, B., *Unscharfe Semantik,* Frankfurt am Main, Peter Lang, 1989.

RIEGER, B., "Unscharfe Semantik : zur numerischen Modellierung vager Bedeutungen von Wörtern als fuzzy Mengen", *in* H.J. Friemel & G. Müller-Schönberger & A. Schütt (Hrsg.) *Forum 90 Wissenschaft und Technik*, Berlin, Springer, 1990.

RIEGER, B.& THIOPOULOS, C., "A self-organizing system in hypertext", to appear *in Proceedings of the first conference on quantitative linguistics*, Trier, 1991.

RIJSBERGEN van, C.J., "Towards an information logic", *in* N.J Belkin & C.J. van Rijsbergen (eds.), *Proccedings of the twelfth annual international ACMSIGIR conference on research and development in information retrieval*, Cambridge, Massachusetts, special issue of the *SIGIR Forum*, 1989.

TARSKI, A., *Logic, semantics, metamathematics*, Oxford, Clarendon Press, 1956.

THIOPOULOS, C., "Meaning metamorphosis in the semiotic topos", *Theoretical Linguistics*, 16(21), 1990.

VARELA, F., *Principles of biological autonomy*, New York, North-Holland, 1979.

WINOGRAD, T. & FLORES, F., *Understanding computers and cognition*, Norwood, NJ., Ablex, 1986.