

Bloomsbury Advances in Semiotics

# COMPUTATIONAL SEMIOTICS

JEAN-GUY MEUNIER



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*Bloomsbury Advances in Semiotics*

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*To Suzanne and Pierre-André:  
the dynamic signs of my life.*



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# Preface

We humans build proxies, surrogates or artefacts by which we situate ourselves in the world, communicate with others and even come to know ourselves. These processes and artefacts are often called representations, signs, signals or icons. Such notions are very general and open to all kinds of definitions. Still, they are omnipresent in all human sciences, including philosophy, anthropology, linguistics, mathematics, literary studies, aesthetics, economics and studies in architecture, religion, communication and media. And now, we increasingly see them making their way into natural sciences. They are found in biology, artificial intelligence and even in neuroscience.

One particular feature of these 'representational artefacts' is that they are carriers of meaning. It is this feature which confers them their intriguing complexity. And whoever wishes to study them immediately becomes entangled in the relational nature of meaning, which is one that makes these artefacts 'stand for' something else to somebody. Any expert who embarks upon this type of study is immediately thrown out of his or her comfort zone. How indeed does one explain the meaning of the Notre-Dame de Paris cathedral, of the Stonehenge monument or of the pyramids of Egypt, of the Easter Island Moai statues, of the presidential faces on Mount Rushmore? These artefacts are not just huge piles of rocks or bricks that have atomic structures and which hold together by gravity or cement. They are there because they are first and foremost carriers of meaning built by humans.

The meaning of certain simple artefacts may be evident to everyone. For instance, the meaning of a wedding ring on one finger may be quite simple to explain. But things become less so when contemplating some of the complex artefacts listed above. Some are even more complex: What is it about Beethoven's *Symphony No. 9*, Shakespeare's *Romeo and Juliet*, the pilgrimage to Mecca, a benediction by the pope or a visit from the Dalai Lama? What makes an artefact an important carrier of meaning? Can there be some scientific enquiry about such semiotic artefacts?

It so happens today that there are two opposite academic disciplines which have overtly put these artefacts at the core of their enquiries: artificial intelligence and semiotics.

For the founding fathers of artificial intelligence, signals are what computers process, but what these machines 'manipulate' are symbols (Newell 1983). And both signals and symbols are artefacts that 'stand for' something else and ultimately do so for somebody. This is why many semioticians have seen the computer as a semiotic machine (Nadin 2007, 2011).

And for the founding fathers of semiotics, from Plato to Augustine and from Peirce to Saussure and for so many other semioticians today, it is also this 'stand for' relation of signs that is so intriguing and complex. And recently, some semioticians have come to believe that because it manipulates symbols, a semiotic machine such as a computer

may participate in the study of these semiotic artefacts and processes. So, maybe an encounter between computation and semiotics is possible – that is, there may indeed be a place for computational semiotics. Some semioticians explored this through the study of the semiotics of computation. Others took the opposite path: they explored the possible usage of computers in the realm of semiotics. Both are heuristic.

It is the second direction that was taken in this book. How may computer technology and the formal structure of mathematical computation encounter semiotics as an epistemic endeavour for analysing and explaining meaning-carrying artefacts and the processes that build this meaning? Can computation help us understand this meaning-making process? Such is the encounter which is explored in this book.

For me, exploring possible answers to these questions has been the focus of some fifty years of research. It is a matter which rests upon the dynamics of conceptual conflicts and paradoxical explanation. It was an adventure into two independent and divergent territories that were said to never share interests. It forced experts in electronic signal-processing technology to dialogue with experts in the interpretation of meaning-carrying artefacts. It forced semiotic artefacts and semiosis to enter the world of computation. Could such a paradoxical project become computational semiotics?

This book has two types of readers in mind. It is mainly written for semioticians who are comfortable with using computers in research but who are very resistant to accept computation within the interpretative practice of semiotics, as it would bring them into the naturalist and formalist world. I just hope to show that, on the contrary, computers can enhance the interpretative endeavour of semioticians, as computation may provide great assistance to their irreplaceable insight. On the other hand, the essay is also written with computer scientists in mind. They will not learn much on the definition of computation in this essay. But they surely will become more sensitive to the complexity of semiotic artefacts and processes. This will be especially relevant when they encounter the barrier of meaning or use oracles in their own computations applied to semiotic artefacts.

When I started this slow-paced research in the late 1960s, I had asked computer scientists if one day I could use a computer to manipulate texts or other semiotic artefacts. The answer was: *No, you can't*. Later, when AI developed, the answer to the same question increasingly became: *Yes, you can*. And the research became: *How can I?* But now my preoccupation is more: *Why can I?*

Today, such encounters of computers with semiotic artefacts and processes are everywhere: from e-texts to e-games and from e-music to e-films, computers are so extensively devoted to semiotic artefacts that they have become processors of e-artefacts. Nevertheless, for me, the same question remains. It is still a quest for a better answer and understanding. How is it that we can use computers in the encounter of semiotic artefacts? Are we at a dead-end or on the path towards rational enrichment?

For me, this endeavour has been more than a theoretical question and a technological project. It has also been a wonderful collective experience with colleagues and friends who have shared the darkness and light of research. This path was shared by Ismail Biskri, Jean-Pierre Desclés, François Rastier, Dominic Forest, Francis Rousseau, Serge Robert, Pierre Poirier, Ghyslain Lévesque, Stevan Harnad, Vincent Rialle, Christophe

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The intuition for this book came from Paul Bouissac who, for many years, has discreetly seen the pertinence of my research for semiotics and who invited me to write this book. Throughout the years, this research has been greatly supported by the Social Sciences and Humanities Research Council of Canada and the Université du Québec à Montréal. The book itself received meticulous, patient and unwavering attention from Lila Roussel and Ludovic Chevalier. But the greatest source of energy has been my wife Suzanne, my son Pierre-André and my grandson Cedric, who are the best carriers of meaning that life can give you.

# The complexity of semiotics

*Man has, as it were, discovered a new method of adapting himself to his environment. Between the receptor system and the effector system, which are to be found in all animal species, we find in man a third link which we may describe as the symbolic system. This new acquisition transforms the whole of human life. As compared with the other animals man lives not merely in a broader reality; he lives, so to speak, in a new dimension of reality.*

(Cassirer 1944: 92)

## Introduction

In classical semiotics, one of the main human cognitive abilities is the use of signals and symbols to deal with one's environment, one's peers and oneself. And in contemporary semiotics, manipulating signals or symbols is a capability inherent to all living organisms.

In humans, this ability manifests through the production of complex meaning-carrying artefacts. The most sophisticated type of such artefacts is natural language. But it is not the only one. Indeed, in their self-cognition, as well as in their interaction with others and with the environment, humans are made to constantly negotiate with a diversity of signals and symbolic artefacts. Some are simple – jewellery, make-up, dress codes and so on. Others are slightly more complex – salutations, codes of seduction, table manners, birth ceremonies, funeral processions, marriage contracts, royal coronations, parliament opening ceremonies and so on. Some are highly sophisticated and take various forms: aesthetic (e.g. the arts), cultural (e.g. ceremonies), religious (e.g. churches), technical (e.g. electrical blueprints), scientific (e.g. chemistry symbols), economic (e.g. money), etc. And all living organisms present similar capabilities, but often these will be less complex. From the use of signals to basic symbols, they allow communication among members of a community.

Practically no domain of human activity is devoid of the use of signals and of symbolic artefacts. Most have a specific signature, structure and usage. In fact, they may form one of the most complex systems that humans have to learn, master, share and, above all, interpret.

All semiotic theories aim to offer some description, explanation and understanding of the nature and usage of the artefacts whose main feature is to carry meaning of one sort or another, but also to study the active process involved in their semiosis or interpretation.

Semiotics . . . [is] . . . concerned with ordinary objects in so far (and only in so far) as they participate in semiosis. (Morris 1938: 3)

Semiotics is the study of signs. It thus investigates the structure and function of all events which involve signs: the processing of information in machines, the metabolism in organisms, the stimulus-response processes in plants and animals, the activities of perception and orientation in higher creatures, the interactions of primates, communication between humans, the dealings between social institutions, and the delicate processes of interpretation which take place in the comprehension of the complex sign structures in legal matters, in literature, music, and art. (Posner et al. 1997: 1)

Thus, all semiotic theories share a set of theses regarding signs: (a) they are artefacts of some sort; (b) they carry some meaningful content; and (c) they must be interpreted by some sort of inner capacity. 'A sign is an object which stands for another to some mind' (Peirce, MS 214, 1873).

Semiotics is hence a sort of epistemic endeavour that constructs theories about or applies them to objects, facts or events that carry meaning for living beings. To put it simply, semiotics explores and defines the conditions of signs being signs. 'It is general semeiotic, treating not merely of truth, but also of the general conditions of signs being signs' (Peirce 1958: CP 1.444).

Non-semioticians may criticize such a definition as being too general. But one must be very careful, for this definition is not about the meaning of a lexical item. It is just an introductory definition for a research programme. Semiotics is a field which studies 'signs' in the same general manner as psychology is said to study 'cognition' and 'emotions', or as neuroscience studies the 'brain', for instance. The important point of this definition is that semiotic phenomena are not taken as objects of study because of their physical properties or features, but because of the intriguing property by which they have meaning.

## The semiotic paradigms

Naturally, this general definition of semiotics has been refined and deepened in various ways. Both the nature of semiotic artefacts and the process of semiosis have been the object of many theories which have become the main paradigms of semiotics. In our research in view of linking semiotics with computation, we may distinguish three main types of such paradigms: *philosophical*, *linguistic* and *naturalist*. These paradigms or types of semiotic theories are not inherently contradictory to one another. They form different points of view for explaining, describing and understanding semiotic artefacts and the process of semiosis. And as they are well known, we shall briefly present them here.

The first and probably the best-known set of semiotic theories are the philosophical ones. They come in three different shades and tonalities: *mentalist*, *pragmatic* and *hermeneutic* theories. Each one has its own concepts, arguments, discourses and methodology. And they are not theoretically independent from one another. They have strong interwoven relations.

The first type of philosophical semiotic theories is the mentalist ones, which are also the most famous. They are grounded in the long-standing tradition of Greek and Medieval philosophy (Abelard, Aquinas, Occam). Their formulation was coined by Augustine as 'aliquid stat pro aliquo' (Augustine) and reformulated by Peirce, who insisted that this 'stat pro' or, in English, to 'stand for' was to be conceptually understood as to 'represent'. This approach was integrated into most of the modern and contemporary semiotic philosophical trends (from Port-Royal to Kant, Frege and Fodor). This relation has become one of the prototypical features of semiotic artefacts: a symbol or a signal (natural sign) is something that *stands for* or *represents* something else. The explanation of the process by which something effectively stands for something else is mainly explored through a philosophy of mind where perception, conceptualization and language will be understood as the dominant components of the processes of semiosis. In other words, according to this mentalist paradigm, semiotic artefacts have the main relational feature of *standing for something else*. Meaning is the result of a semiotic process where a *mind* creates a *representation* that stands for *something else*.

The second set of philosophical theories are the pragmatist ones. They find their original synthetic expression in Peirce. His theory sees a semiotic phenomenon not mainly as a state, but as a complex epistemic activity called 'semiosis'. This activity is a process by which certain artefacts become *carriers of meaning* or, more simply, *signs*. It is a dynamic process that rests upon complex epistemic categorizing operations realized by human agents such as sensing, perceiving and conceptualization.

Peirce also complexifies the *stand for* relation. It links together: (1) something that is the carrier of meaning (i.e. the *representamen*); (2) something that the sign conveys for somebody (i.e. the *interpretant*); and (3) that what it stands for (i.e. the *object*). And semiotic phenomena can come in many forms such as symbols, icons, signals or indices, which all inhabit a dynamic process, semiosis, itself carried out by interpreters.

Variants and nuances of this Peircean pragmatist semiotic theory are numerous: in Frege, the *stand for* relation becomes 'term', 'sense' (*Sinn*) and 'referent' (*Bedeutung*); in Morris (1938), it is 'signal/symbol', 'interpretant' and 'designatum'. And other variants may add epistemic modalities (Hintikka 1997), contexts and situations (Morris 1938; Barwise and Perry 1983), culture (Luhmann 1995), embodiment (Brier 2008) or cognition (Brandt 2013).

A well-known variant of this triadic model has been the behaviourist formulation by Ogden and Richard (1923: 140). Here, the triadicity of the sign is translated in terms where a 'stimulus' is the representamen, the 'reaction' is the reference or object, while the 'engram' is sometimes identified with the 'thought'. According to this perspective, the study of a semiotic artefact must reveal what, in it, makes it a stimulus, what it stands for or represents and what is the engram it produces in the interpreter.

Compared to the mentalist paradigm, this pragmatist view complexifies the *stand for* relation with respect to three components: representamen, interpretant and object. Meaning emerges in a process of semiosis where (a) some agent, (b) creates interpretation, on (c) an artefact so that it signifies something else. An interesting point here is that these 'artefacts' may themselves be other signs.

The third philosophical semiotic paradigm is a hermeneutic one. It has its source in the theory of language and textual interpretation initiated by Herder and Hermann and developed by Schleiermacher, Humboldt and Dilthey. And more recently, Gadamer, Habermas, Adorno and Ricoeur enhanced it and applied it to different types of semiotic artefacts. Although not always expressed in classical semiotic terms, these theories emphasize that meaning is given to semiotic artefacts through the epistemic process of understanding the world. In revealing the meaning of semiotic artefacts, hermeneutic semiosis may call upon not only the inner experience of the interpreter but also the culture in which he or she lives. Hence, interpretation is a dynamic process that is circular or, in better terms, spirally enhanced.

Some researchers such as von Uexküll explicitly integrated this hermeneutic point of view into semiotics. Semiotic artefacts are mediators in building our own world (*Umwelt*). And for some others (Jakobson, Martinet, Vygotsky, Halliday, Eco, Apel, etc.), this mediation also had to take into account the important role of language or, more generally, of various means of communication such as dialogue (Ricoeur) or intentionality (Austin, Searle, Grice). For their part, Lotman, Luhmann, Brier, Brandt and many others complexified these relations pertaining to meaning by including contexts, situations, and social and cultural environments.

Hence, in this hermeneutic paradigm, both the semiotic artefacts and the process of semiosis have become more complex. They comprise an interpreter whose process of interpretation creates different states or an inner world that stands for the word itself. And various complex intervening factors such as the context, situation, culture or intentions may come into play.

Some contemporary semiotic theories associate hermeneutic positions through modern cognitive theories. They may call upon such things as phenomenological experience, perception, memory, conceptualization, categorization, reasoning and information processing. Here, meaning is intrinsically rooted in the human cognitive tendency to explain and understand. For Brandt, a theory of meaning so understood is the project of cognitive semiotics. Thom and Petitot have proposed that semiotics should focus on the phenomenological experience of the world.

Finally, some other semioticians will add a communicational dimension to this cognitive framework. In so doing, they build a bridge towards the Morrisian semiotic theory. Signs are not built just for individual cognitive purposes; they also are a means of sharing meaning. Signs participate in the interaction and social negotiation we have with others in our relation to the world (Habermas 1984; Apel 2000). Thus, meaning is the result of an interpretation that emerges through cognition and communication. Communication is a form of interactive meaning creation, for it relies on coordination and cooperation, among other things.

The second very important paradigm comes from structuralist and formal linguistic theories. In these theories, attention is directed towards the structure of semiotic

artefacts and the effect it has on the process of semiosis itself. Three main points of view regarding this structure are proposed. One sees it as being similar to a linguistic structure, the second one sees it as a logical form, while the third views it more as a dynamic mathematical form.

The first one has its origin in Saussure but developed within the structuralist movement often called the 'semiological school' – its leaders include Hjelmslev, Trubetzkoy, Jakobson, Greimas, Lévi-Strauss, Barthes, Rastier, Todorov and Fontanille. But there are important variants in terms of understanding the nature of what this semiotic structure is. The dominant understanding of the structuralist thesis is purely Saussurean. Semiotic artefacts are rarely atomic or isolated entities. They are most often embedded within complex structures of meaning. In other words, they live and operate within some context.

The prototypical example of such meaningful systems will be a language (*la langue*). For Saussure, a language is essentially a set of relational structures. It is a 'system of interdependent terms in which the value of each term results solely from the simultaneous presence of the others' (Saussure 1959: 114). It is governed by a multiplicity of structural relationships (syntagmatic, associative, paradigmatic, oppositional, differential, etc.) and can even be seen as a formal system: 'language, in a manner of speaking, is a type of algebra consisting solely of complex terms' (Saussure 1959: 122). According to Saussurean structuralism, meaning is a relation between a 'signifier' (*signifiant*) and a 'signified' (*signifié*). And this relation is created in the act of speaking (*la parole*). Saussure extended the structural thesis to all types of sign structures, and these form the research object of semiology. He defined the latter as 'a science that studies the life of signs within society' (Saussure 1959: 16, emphasis removed). This new science, he said, would show us 'what constitutes signs, what laws govern them' (ibid.). Hjelmslev (1968) added some complexities to this concept of linguistic structure. Both the *signifier* and the *signified* form a *structure*: a level of *expression* that is functionally related to a level of meaningful *content*. For this structuralist school, meaning is deeply *embedded* within the various structures of semiotic artefacts, for the structure of the signified is functionally dependent upon the structure of the signifiers.

An important variant of this structuralist view of language will be offered by Harris (1982) and Chomsky (1956) and their followers. Here, the structure is described by some in algebraic or 'generative' terms. For Harrisians, meaning will be *distributed* in the context of the linguistic structure, while for Chomskyans, it lies in the deep structures underlying the surface and will even take a logical form. Chomsky will refuse to extend his generative view to all other meaningful artefacts. Semiological theories, however, will not retain this view except maybe for the Harrisian contextual distributionality thesis.

The second paradigm for understanding the organizational structure of signs, though it is not always seen as a semiotic theory, takes its source in Frege and his followers: Russell, Church, Carnap, Montague, Shaumyan and many others. It also takes language as a prototype for other semiotic artefacts. But here, it is not a matter of natural language but of formal language. Such language is defined as a set of atomic or discrete symbols in which the structure is given by a set of rules called 'formation' or 'transformation rules'. These rules define the syntax of the language and underlie

the formation and transformation of sentences or formula. The prototypical examples of this paradigm will often be called logical symbolic languages, such as found for instance in the *propositional*, *predicate*, *modal*, *categorical* or *logical* languages. These languages can be seen as complex structural variants for describing other types of semiotic systems.

In a sub-paradigm of this logicist view, meaning is not embedded in the logical structure itself. It is given to these structures by a *functional association* to the syntactic rules and the lexicon of the language. Carnap and Tarski, among others, have offered a formal definition of the relation between meaning and the structure of a language. It will be seen as a function of mapping from its syntactic structure to its semantic structure. And this semantic structure will be mainly defined in referential terms. Carnap and Morris will generalize this formal view of the formation of a logical symbolic system to all types of other signs. In this view, semiotics will become a general formal theory of symbolic systems.

The third structuralist trend deepens the concept of structure itself by exploring its mathematical properties. It was mainly developed by Thom (1988), Petitot (1985a, 2009, 2018), Wildgen (1982), Wildgen and Brandt (2010), Piotrowski (2017), Piotrowski and Visetti (2014). According to this paradigm, structure is not mainly understood as being differential or combinatorial; it is a mereological and gestaltic structure and also a dynamical system. In this perspective, a structure is a dynamic process, one with stable and unstable phases in which there are fusions, ruptures and catastrophes, if not chaotic attractors. And the meaning of artefacts is the result of the complex process of integrating multiple interactive (internal or external) formants of a morphodynamic semiosis.

In short, semiotic theories influenced by structuralism – be it linguistic, logicist or dynamical – claim that an adequate and rich theory of semiotic artefacts and semiosis must focus on the inner and outer structures of these artefacts. And it is within these complex structures that meaning is embedded or to which it is associated, with semiosis being the process by which meaningful structures are interpreted. Thus, according to these three structuralist semiotic paradigms, there is always (a) an agent that is an interpreter; and (b) a semiosis that is an interpretive process, though this interpretative process is applied to highly complex structured artefacts (sentences, texts, formulas, proofs, etc.). Context is recognized by Saussure as participating in the semiosis, but it is not given the focus. According to more logicist approaches, the context of the interpretation may include the world if not some possible worlds. For dynamicists, the context is an external constituent of the overall structures of a dynamic semiosis.

The third type of paradigm is a naturalist one. This naturalism is to be understood at two epistemic levels: that of the object under study and that of the methodology.

The first understanding of naturalism focuses on semiotic artefacts or objects: these are entities in nature which humans, animals or some kinds of living beings construct or manipulate and which are seen as carriers of meaning. Such objects can be symbols (language, icons, etc.) or signals. The second understanding sees semiotics as following or as being inspired, at least in part, by the methodologies of the natural sciences: observation, experimentation, formalization and so on. Both approaches will be highly

entangled. Despite strong variances from a theoretical standpoint, they have opened new and important semiotic territories.

The first of such variants may be found in the cognitive and informational view of semiotics. Its origin may be traced back to Peirce for whom signs are, before anything else, *means to acquire knowledge*: 'a sign is something by knowing which we know something more' (Peirce 1958: 332). But it was also heavily marked by the functionalist theories of language of Jakobson, Martinet and Halliday, by the pragmatic and intentional philosophy of language of Austin, Searle and Grice, by the social psychology of Vygotsky and by the pragmatic philosophy of communicative action of Habermas and Apel. But in semiotics, it seems to have been Eco (1965) who has been among the first to open the door to the cognitive dimension of semiotics. Through his reflection on symbols and icons, he understood the *stand for* relation to be grounded in an important cognitive activity: perception. This supposes that semiotics has to take account of some cognitive operations in making a semiosis meaningful. Sebeok<sup>1</sup> was more radical. By exploring various types of semiotic artefacts, he insisted on seeing semiosis as linking meaning with communication among cognitive agents.

Deely and his colleagues (1986) were among the first semioticians to *explicitly* ask for a cognitive revolution in semiotics. Faithful to their medieval theoretical background, semiosis was to be seen as an act of 'cognitio'. And this entailed the need for a semiotic revolution: one that would ground semiotics in our human cognitive experience. 'The semiotic revolution concerns, first of all, our understanding of human experience itself, and therewith all of human knowledge and belief. What semiotics at this point has shown is that the whole of human experience – the whole of it – is mediated by signs' (Deely et al. 1986: xii).<sup>2</sup>

Serson saw that Peirce's semiotic model 'goes immeasurably further (and deeper) than the semiotic currently employed implicitly or explicitly by the semiotic scientists' (Serson 1994).

The naturalist twist really came with researchers such as Bouissac (2010, 2012), Rieger (1999a, b), Varela, Petitot et al. (1999), Sonesson (2012), Zlatev (2012), Brandt (2004, 2013), Brier (2008) and many others. For them, semiosis is a natural process. And a cognitive semiotics focuses mainly on the process of semiosis itself: that is how humans deal with symbols, icons and signals. But it also retains the cognitively processed semiotic artefacts such as languages but also gestures, music, film, texts, dance, painting, theatre, electronic media, clown performances, child development, sexuality.

In this view, humans are *meaning-making agents*, meaning which they communicate. As Brandt summarizes well: 'meaning is based on two distinct capacities of the human mind, cognition and communication' (Brandt 2019: 2).

From a methodological point of view, this cognitive semiosis will be studied through various types of theoretical and formal models, highly inspired by the cognitive sciences and by sciences such as psychology, ethnology, anthropology, cultural studies and to a quite lesser degree linguistics and logic. But this 'naturalism' will not be a reductive one. 'Natural' does not mean mechanical or merely informational. As Brier says, in semiotics, 'information is not enough'. Interpretation is a highly complex natural semiosis. So, an adequate cognitive semiotic theory must also take account of

the situation, of bodily embedment, ecology, culture and, most of all, of language and communication.

Two other sub-disciplines will be distinguished, but they have increasingly been seen as overlapping. Zoosemiotics (Sebeok 1968; Martinelli 2010) will be interested in how animals deal with signals. Biosemiotics, for its part, will focus on signal processing in dynamic biological structures pertaining to life, survival, emotions and even social communication.

According to the naturalist paradigm, the process of semiosis will include (a) an interpreter; and (b) a complex set of interpretive cognitive operations such as sensing, perceiving, categorizing, reasoning, memorizing and feeling. Many determinants and factors will intervene: the situation, context, culture, the body, evolution, communication, etc. And it will be applied to many types of artefacts – from symbols (language, music, art, etc.) to signals (behaviours, stimuli, feedback, etc.).

Our brief presentation of these three main paradigms did not delve into the details of each conceptual framework – we rather took a bird’s-eye view. This allows us to distinguish two main components of semiotic phenomena:

- (1) Artefacts of which one of the main features is to be a carrier of meaning; and
- (2) Processes of semiosis by which living beings identify in these semiotic artefacts the meaning they carry.

Each of the paradigms presents some specific *conceptual framework* containing concepts and propositions for describing, explaining and understanding the semiotic artefacts and the processes of semiosis.

The *philosophical* paradigms focus mainly on the process of semiosis. The *mentalist* view claims that semiosis builds a *mental representation* through which semiotic artefacts are interpreted. The *pragmatist* paradigm insists on distinguishing in a semiotic artefact the representation itself from various means (interpreter, producer, situation, etc.) that determine the representation. Finally, the *hermeneutic* paradigm insists on subjective and external factors that determine the representation, such as culture and environment.

The *linguistic structuralist* paradigm focuses on the inner and outer combinational or dynamic structures of semiotic artefacts and on the embedment of meaning in these structures. Natural language is taken as the prototype of semiotic artefacts. The *logicist structuralists* are also sensitive to the structure of semiotic artefacts. But, here, structure is seen through their chosen prototype: logical language. Meaning is seen as being somewhat *external to the language* – it is associated (by an external decision, convention, etc.).

Finally, in the *naturalist* paradigms, living beings are seen as manipulating semiotic artefacts which are symbols or signals. In humans and in some animals, these manipulations will be understood mainly in terms of cognitive information processing. And it takes the form of sensing, perceiving, categorizing, memorizing, feeling and ultimately communicating with other members of a social and cultural community.

Through the presentation of these three paradigms, we see that semiotics, like any other science, builds theories about its own specific type of reality: (1) there are

artefacts in the world that have a particular property – they are carriers of something that is called *meaning*; and (2) there is a specific type of cognitive process that identifies such meaning in these artefacts.

But what then appears from this bird's-eye view upon the paradigms is that an adequate semiotic theory cannot be limited to just one viewpoint. A serious, if not scientific semiotic theory cannot describe, explain or understand semiotic phenomena by taking just a single point of view upon a semiotic phenomenon. Each of the paradigms' points of view are not necessarily false or true in themselves – just incomplete in regard to the nature of semiotic artefacts and of the processes of semiosis. To reformulate this in general Peircean terms: the aim of semiotics is to find 'the general conditions of signs being signs'.

## Semiotics and complexity

If one point of view is not enough for explaining, describing and understanding semiotic phenomena, then how can an all-inclusive integrated semiotics be built? Even if such all-inclusive theory were available, we would eventually discover that the theory would have to deal with a myriad of properties and structures for each semiotic artefact and semiotic process. Indeed, we may imagine that it could be easy to somehow identify a few properties for simple semiotic artefacts such as *an American dollar, a candle, a wedding ring or a handshake*. But the number of properties grows exponentially for less simple semiotic artefacts such as *an Hindu funeral ceremony, clowns in a circus, animal drawings in Neolithic caverns, the Beethoven symphonies, the Easter Island Moai statues, the Stonehenge circle or the Notre Dame Cathedral*.

There have been many critiques of these various semiotic paradigms. A typical and general one is the critique by Harman: after showing that semiotics uses the word *means* in a variety of ways, he concludes that 'there is no reason to think that these theories must contain common principles' (Harman 1977: 23).

Many of these critiques do not always rest upon strong epistemological principles. They are often made by illustrating the semiotic research methods and objects using simple examples of the 'x means y' form, such as *a smile means this, smoke means that*, and so on.

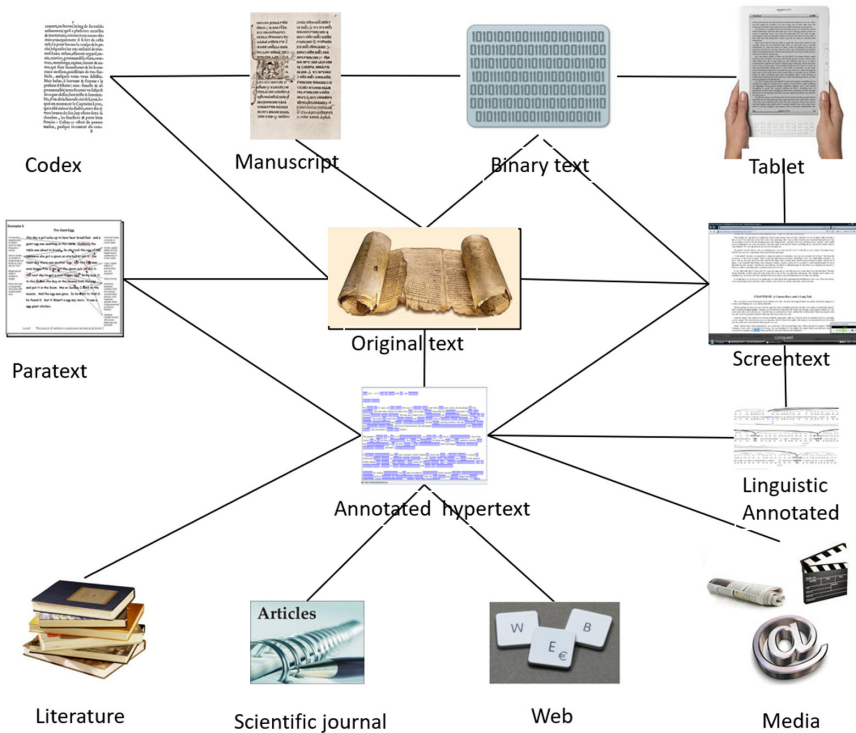
Such critiques may indirectly claim that there cannot exist a theory, and even less a scientific theory, that can offer an adequate explanation and understanding of semiotic artefacts or of semiosis precisely because of the multiplicity and complexity of the properties, structures and processes these involve. In their view, a semiotic theory can only offer subjective, heuristic descriptions – nothing more than a wonderful and brilliant epistemic spectacle or representation. The underlying postulate of such criticisms rests upon an implicit epistemological thesis that the objects being characterized by a multiplicity and variety of properties and structures renders their scientific investigation practically impossible. This is a radical claim against semiotics. And it justifies interpretative semiotics.

Let's reformulate the core of this critique. The underlying implicit postulate seems to be, at least in part, the following: *because a semiotic phenomenon is complex and contains a multiplicity of features, it cannot be studied scientifically*. If this thesis is valid, it should also be applied to most scientific research objects and methods. Would it

not also challenge the possibility of scientific enquiry on physical, biological or social artefacts and processes? Aren't such research objects also plagued with a variety of complex properties, structures and processes and aren't they also entrenched in some point of view or perspective that is, at least partly, highly subjective?

For our part, we prefer to argue that it is precisely because semiotics must be seen as dealing with a complex type of properties and processes that it is interesting and that it may be subject to scientific enquiry. For instance, if semiotic phenomena were very rare, unique and irregular, it would probably be impossible to find out what they are and how they may be explained by some principles or rules.

But because they are numerous, it becomes possible to discover in them some type of regularity or another. Take, for example, the semiotic artefact that is a 'text'.<sup>3</sup> Linguists (Weinrich 1976; Halliday and Webster 2014), philosophers (Ricoeur 1970), literary theorists (Genette 1979; Rastier 2009) and editors (Sahle 2013) have distinguished among this class of semiotic artefacts a galaxy of texts: material texts, narrative texts, intentional texts, etc. In the world of computers, the various types of text components and manipulation have to be well distinguished because they all carry many different shades of meaning and interpretations. In Figure 1.1, we illustrate a variety of texts, including those distinguished on the basis of their physical medium.



**Figure 1.1** A variety of 'texts' in a computer environment, distinguished by their physical medium.

So even if semiotic phenomena are complex, the question remains whether semiotic artefacts can be studied scientifically. To answer this question, we must clarify what it is to claim that a scientific inquiry can deal with objects or artefacts that present complexity in their properties, structure and processes. For our purpose here, we will recall that the notion of complexity<sup>4</sup> in science has many meanings. Two of these meanings are relevant for our purpose. The first one is basic epistemic complexity; the second is epistemological complexity.

The first meaning of complexity is easy to understand. It pertains to the mode of observation one has about some reality. Here, *complexity* is often synonymous with *complication*. It is an epistemic position: something may appear complicated because one may not proceed with the correct means for observing its features. In such a case, the ensuing understanding will be limited. And things look *complicated*. For instance, for some person, a thermostat may be a complicated gadget because he or she cannot explain how it works. For the same reason, a computer scientist may find that connecting his or her cellular telephone to a new Wi-Fi router may be a complicated procedure. The same situation may occur when explaining what is going on in a funeral ceremony. For a celebrant who masters all of its rituals, the ceremony is not complicated either in its organization or in its meaningful content. But it may be complicated for the family or for a guest who is taking part in such a ceremony for the first time and who does not understand what is going on or what the ceremony means.

And in our daily personal and social life, we encounter many such semiotic artefacts. Consider such examples as *a fine table setting*, *a birthday party*, *a veil worn by a Muslim woman*, and so on. For some people, these artefacts may be simple, but for others, they may be complicated and their meaning is not always easy to discover or to understand. Such types of objects, events or processes may appear complex in the sense of *complicated* because there are many different features and properties to be observed and many explanations to be given, while they are not easily accessible, observable or mastered by the observer. As Ashby formulates in a slightly Shakespearian manner: organization is partly in the eye of the observer (Ashby 1962: 258–9). It is not because such semiotic artefacts are complicated that they are to be excluded from serious and legitimate semiotic enquiries. Some of them may have a simple organization, but in most cases they are not just complicated: they are complex artefacts. It may require much work to unwrap their structure and meaning.

The second meaning of *complexity* is more sophisticated. It is the one that has become important in contemporary science. One main reason for this importance has been the slow obsolescence of the deterministic, positivist and logicist epistemological models of scientific practices. These models appeared inadequate for describing and explaining many types of phenomena that could not integrate easily and clearly certain types of properties such as *continuity*, *dynamicity*, *evolution*, *adaptiveness*, *emergence*, *multi-factoriality*, *parallelism* or *modality*. Although these concepts may have an intuitive, vague and ambiguous meaning, they came to characterize the notion of *complexity*. They allowed us to study some natural phenomena by focusing on them in a holistic and dynamic manner – that is, to see them as a whole rather than as a collection of local, isolated and static components. In other words, complexity is a particular epistemic point of view by virtue of which properties or attributes are not

strictly explained solely by their local, atomic and static components, but also by their global, holistic and dynamic structure.

Still, this difference between the local and the global is not sufficient to characterize complexity. The deep problem is in explaining the inner relations between the local and global components through some integrative formal model. A nice synthetic definition of this complexity problem is the following:

We call complexity the fact that higher levels of organization display features not predictable from the lower ones. (Arecchi 2002: 132)

By complex [we mean that] . . . knowledge stored in well established models is not sufficient to predict reliably the emergence, and must integrate the deductive chains with extra information which introduces a historical flavour into the scientific procedure. (Arecchi 2002: 113)

In other words, complexity is both an epistemic and an epistemological problem. It is epistemic because one must *observe and describe* that certain phenomena present a multiplicity of local, low-level properties, structures and processes from which a distinct set of global properties will emerge, supervene and become observable. It is also an epistemological problem because one must *explain by means of formal models* how such a dynamic phenomenon is realized.

Take, for example, a typhoon. A localist and static explanation might emphasize the presence of molecules of air and of water, the amount of pressure and the local temperature. At the global level, one may stress the occurrence of a big, strong and directional movement of wind and low air pressure forming a vortex involving various forces (wind, pressure) over the ocean. Many formal and computational models have been created by climatology and by meteorological science in order to explain not just the constituents of a typhoon, but the various dimensions of the dynamics, formation, development and emergence of a typhoon. These models are applied to the interactions between components such as the temperature on the land and in the ocean, the changes in air pressure, the circular movement, the energy potential and so forth. Such formal models of typhoons aim at explaining their genesis, emergence, development, periodicity and so on.

Semiotics encounters similar complex phenomena. Take the following example: the religious procession for Easter in Spain. Every year, on the week before Easter, most Spanish towns and villages have a highly organized religious procession which is very important for the community. A localist explanation will rest upon presenting the basic elements or components of such a social semiotic artefact. It could present, for instance, the local actors, objects and their local meaning (persons, costumes, procession cars, music, religious representations, chants, candles, etc.). A localist view that focuses only on the features of individual participants or artefacts will never approach the meaning of this ritual. Conversely, a holistic explanation would aim at identifying the interrelations between the multiplicity of the participants and components so as to discover integrated structures that traverse the whole of the procession itself and that embed the meaning it may carry. If such an explanation is to be offered, the complexity must be dealt with by offering a formal model, not just by adding new components.

Complexity is one of the most important scientific challenges semiotics must deal with. As we can see, the real epistemological problem of complexity is not mainly one of increasing the number of components or of the features of a phenomenon, but of building formal models of the complexity itself. And this has been done in many scientific domains. Some will use simple formal models, while others will require more sophisticated ones. They call upon various mathematical structures such as classical linear, non-linear, homological, geometric, vector and matrix algebra, dynamic analytic systems, descriptive and inferential statistics, Bayesian probabilities and topology. And not all of these mathematical models are about 'quantities'. Many are about purely geometrical, topological, generative, graphical, combinatorial and even chaotic structures. In this view, the classical logical or linguistic model is no longer seen as the prototype of formal models for complex phenomena.

Thus, the natural language expression *complexity* is used for naming, in a synthetic but often opaque manner, formal models that, in the study of phenomena, take into account both the multiplicity of their components and their global structural forms, as well as eventual dynamic changes in their states or phases.

The existence of these formal models, however, still does not exhaust the problem of complexity. That is, it is not because a sophisticated and refined formal equation is produced for modelling a particular dimension of a complex phenomenon that it can be effectively calculated. Take the following example. It is quite easy to calculate the equation:

$$y = \sqrt{x}$$

If  $x$  is not too big, most mathematically educated persons will effectively be able to calculate this in an acceptable time lapse. But how about the equation:

$$y = \sqrt[13]{x}$$

This equation is conceptually quite similar to the simple square root equation. But the effective calculus necessary for finding the value of  $y$  is quite a burden for a human, even one heavily educated in mathematics.<sup>5</sup>

What this example shows is that complexity does not only apply to the multiplicity of static or dynamic relations, but also to the calculability of the formal models used in studying them. If a simple formal model such as the second equation presented above was already a burden to calculate, one can imagine how sophisticated formal models for complex phenomena may be even more burdensome.

In fact, there existed many formal models which were created to explain and to describe complex objects and processes but which could not be calculated because of a lack of effective calculating power or, to put it more simply, because of the lack of 'manual computing power'. The power of computing machines changed this situation. They do not change the calculability of mathematical functions. They just allow faster *effective* calculation. Such computing power is quite recent in the development of scientific practices. It allows complex calculable formal models to become effectively calculable with the assistance of a computer. But by the same token, this introduced a lot of change in the practice of science. As sciences integrated such computational power into their

enquiries, an increasing number of known sophisticated formal models that could deal efficiently with complex problems could thenceforth be effectively calculated. And this physical computing power was not without effect upon the methodology of science itself. These computing machines could then calculate complex functions containing a myriad of variables and factors. In other words, effectively computable complex formal models could be built. Hence, the term 'complexity' is applicable to phenomena that may contain a myriad of sets of complex relations which can, today, not only be modelled formally, but which can also be effectively calculated by computer.

And today, there are a multitude of algorithms that can effectively compute the formal models that would not have been effectively computable some time ago. Such algorithms often bear rather metaphoric names: 'experts', 'problem-solvers', 'natural language processors', 'inferential machines', 'artificial intelligence', 'autonomous intelligent agents', 'neural nets', 'deep learning', 'distributed memories' and even sometimes 'robots' and 'androids'. But what is really going on in these computers is effective computing power implementing a variety of algorithms that translate formal computable mathematical functions which map onto complex problems.

So, if computational semiotics is to exist and has to deal with complex semiotic phenomena, it must justify how it can enhance its enquiry of such phenomena by calling upon computers which, by nature, themselves call upon algorithms and which, in turn, rest upon calculable functional relations. Computational semiotics cannot be simply defined as computer-assisted classical semiotics – this just hides the real innovation underlying its research programmes: the integration of computation into semiotic theories.

## Semiotic complexity and computational semiotics

The research object of semiotics is typically presented as being about artefacts that carry meaning and about the processes that must be activated to build or access this meaning. Such a definition is very general. The real problem of semiotics arises when one opens up this definition: it turns into a Pandora's Box.

As we have seen, there are different points of view from which to approach semiotic phenomena – there appears to be a variety of them. But we believe that, in their core theses, they do not contradict one another. Rather, they may be complementary. But, in accepting this complementarity of points of view, the object of semiotics suddenly becomes highly complex.

As long as the complexity problem is pushed under the carpet by understanding it as nothing but a small epistemic complication in the observation process, semiotics will dwell in its own paradigm. Each semiotic project will be satisfied with the set of entities and operations that the framework offers. And in most cases, the use of a computer or of a computational approach or point of view will not appear to be heuristic. According to such a perspective, a computational semiotics would be useless and would be no more than the resurrection of an old positivist dream.

But if one accepts or at least recognizes the complexity of semiotic artefacts and processes, then one has to find the means to deal with what underlies such complexity: the multiplicity of types of artefacts, the varieties of their structures, the intricacies of their interpretation, the divergences among meaning-makers and interpreters, the host of interpretations, the myriad of situations, the wealth of social and cultural contexts, the sophistication of communication means and so forth.

And in many sciences, as we have shown, when such complexity emerges and is accepted as part of the problem, then formal and computational models become an essential partner for scientific enquiry.

This book is an *essay* on the types of complexities borne by semiotic artefacts. It endeavours to respect the multiplicity of points of view that the various paradigms of semiotics have unveiled. We hope to understand how a semiotic enquiry can deal with the *barrier* of meaning and of how semiosis manages to pass through this barrier so as to create and identify the meaning. It will not claim that the classical procedures of semiotic enquiry must be replaced by computation or that semioticians should be replaced by computers. What it will do is rather explore this complexity against the horizon of computation.

