

Mechanical Bodies, Computational Minds

Artificial Intelligence from Automata to Cyborgs

Edited by
Stefano Franchi and Güven Güzeldere

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Phenomenology and Cognitive Science

Serge Sharoff

As classical philosophy fades away, said Heidegger, cybernetics becomes a philosophy for the twentieth century.¹ However, this thesis can be reversed; that is, philosophical systems can be interpreted from the viewpoint of computer science. Different schools of cognitive science, then, represent the interpretations or realizations of corresponding schools of philosophy.

The history of artificial intelligence began with efforts to create thinking machines designed to cover the widest possible domain of human intellectual activity, and the declared objective of such program development was to exceed usual human reasoning, at least in certain fields. Programming served as a basis for these investigations. In practical terms, the relative failure of these early attempts—the discrepancy between their announced intentions and their real successes—has led to the creation of effective programs operating successfully in carefully constrained problem domains. Conceptually, the goal now of theoretical research in AI is to investigate the human mind, an end to which both psychological research and pure programming tricks have been put. But many AI problems also have a direct relationship to old philosophical problems: mental category determination, hermeneutic circle problems, the balance between empirical and a priori knowledge, the interrelations between abstract and specific knowledge, and so on. If we look at theoretical investigations in AI, we discover that they are always based on some philosophical background; this framework helps in large part to determine the structure of AI models as they are elaborated.

Dreyfus and Dreyfus offer one attempt to trace the links between classical philosophy and cognitive science, and to interpret the former from the standpoint of the latter. As they describe the history of European philosophy, they identify a sequence of AI predecessors: Plato, Galileo, Descartes, Leibniz, Kant, and Husserl. For example, they write,

Kant had a new idea as to how the mind worked. He held that all concepts were really rules. For example, the concept for dog is something like the rule: If it has four legs, barks, and wags its tail, then it's a dog.... Husserl, who can be regarded as the father of the information-processing model of the mind, [extended Kant's ideas and] argued that concepts were hierarchies of rules, rules which

contained other rules under them. For example, the rule for recognizing dogs contained a subrule for recognizing tails. Husserl also saw that such rules would have to tell us not about any particular dog, or dogs in general, but about the typical dog. All the basic ideas used by Minsky and his students of artificial intelligence were in place.²

But even though many of the basic ideas of AI may be in place in classical philosophy, AI researchers must actively *develop* the particular philosophical systems they use: they must clarify obscure propositions and develop many lines of inquiry left out of the frame of the original philosophical systems. For example, in "On the Art of Combinations" (1666), Leibniz proposed that all reasoning can be reduced to an ordered combination of elements. If we could define such an algebra of thought, it would become possible for a machine to reason like clockwork. Such a machine would be capable of resolving every philosophical controversy as well as making discoveries by itself. Leibniz's thesis amounts to a theory of artificial intelligence for the seventeenth century. However, Leibniz did not have to develop many concrete questions about the correlation between his elements, about the problems of their sufficiency, or about ensuring right outcomes from right premises; that is, he never had to debug his program. The "General Problem Solver" (GPS), developed mainly by Allen Newell and Herbert Simon, is one of the earliest and most general approaches in cognitive science. The GPS-style description of reasoning (in terms of simple algebraic symbols and operations that combine these symbols into expressions) directly follows from Leibniz's thoughts and "debugs" them. As far as I know, developers of AI systems have never emphasized just how much their work relies upon and develops related philosophical theories. So, for example, the discussion about interrelations between GPS representations and Leibniz's "combinations" is rather suggestive—and unusual.

A Realization of Philosophy

Another example from classical philosophy can serve as a metaphor for the interpretation of AI investigations as philosophy. Drawing on the distinction between the thing-in-itself and the phenomenon it presents to us, Kant wrote in his *Critique of Pure Reason*:

I cannot explore my soul as a thing-in-itself by means of theoretical reasoning (still less by means of empirical observation); hence, I cannot explore free will as a feature of a being.... Nevertheless, I can *think* about freedom, that is, the *representation* of it is at least without contradictions.³

To shift this Kantian example into the domain of AI: researchers, as conscious beings, probably cannot *create* artificial consciousness, but they can think about their own consciousness and express their thoughts in some language—in the language of philosophical concepts (in Kant's case) or in a programming language (in the case of AI researchers).

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In order to develop cognitive science as rigorous philosophy, it is necessary to adopt the premise that a description of states of consciousness as representational states can be consistent.⁴ States of consciousness themselves, along with skills, emotions, and so forth, are not representations in themselves and do not belong to the realm of language; however, the fact that these states may find expression in verbal forms demonstrates that some kind of symbolic representation is possible. Moreover, states of consciousness have an inherent need for some kind of expression in order to be grasped, and language is the medium for symbolizing internal states. Schütz refers to this process as explication.⁵ Admittedly, explication is possible only for some part of consciousness, and it cannot be done to "absolute zero," to the *n*th degree. But interpreting situations is one of the main activities of consciousness, and explaining them through language is a necessary way of socializing and expanding the conscious "stock of knowledge." Schütz uses the phrase "taken for granted" to describe the seemingly natural attitude one adopts in everyday life toward phenomena such as the characteristics of the world and of other conscious beings. In fact, what this "natural" attitude takes for granted is precisely the possibility of describing consciousness. We may recall a quotation from Pascal that Dreyfus and Dreyfus use as the title for their book's prologue: "The heart has its reasons that reason does not know." Undoubtedly, there is a reason why the European philosophical tradition has for so long attempted to elucidate the processes of consciousness. There is no reason to declare this attempt no longer valid.

Basic Concepts for Computer Phenomenology

Many of the primary phenomenological ideas of Husserl and the early Heidegger lend themselves to interpretation from the viewpoint of cognitive science: notions of the phenomenon, the constitution of meaning, readiness-to-hand (*Zuhandheit*), intentionality, horizon, and internal time consciousness.

For the purposes of this chapter, phenomenology may be described as the philosophy of dynamic representations. In *Truth and Method*, Hans-Georg Gadamer cites Schleiermacher's words as a slogan for this philosophy: "Blooming is the real maturity. A ripe fruit is only a chaotic surface that does not belong to the organic plant." The purpose of phenomenological description is to probe the thinking life hidden within us: "In contrast to an analytic philosophy that substitutes simplified constructions for the immediately given in all of its complexity and applies 'Ockham's razor,' phenomenology resists all transforming reinterpretations of the given, analyzing it for what it is in itself and on its own terms."⁶

Phenomenology's key concept is the notion of constitution, a description of the creative dynamics of the phenomena of consciousness. As Husserl wrote, "It is necessary to show in each concrete constituting act how the sense of the phenomenon is being

created."⁷ Phenomenology uses a complex description of the phenomenon as "that which shows its selfness through itself." For our purpose—that of describing a computer phenomenology—it is sufficient to consider a phenomenon as a mental construct that is placed in consciousness, complies with other phenomena, and has the ability to reveal itself.

Husserl's methodological solipsism corresponds closely to the nature of computer representations. His descriptions deal exclusively with subjective phenomena. The external world is taken out of brackets; as Husserl says, *epoché* is committed. A mental act, as phenomenology describes it, is concerned not with material things but with itself. Husserl uses the notion of intentionality, the direction of consciousness toward a perceived object, to describe the interaction between consciousness and objects in the external world. Through intentionality, consciousness comes to represent the object as a phenomenon.

Intentionality expresses the fundamental feature of consciousness: it is always *consciousness about something*. Consciousness is not an abstract mechanism that processes raw data; its *core structure* correlates with and therefore depends on grasped phenomena. This ensures the impossibility of a description of consciousness that is separate from perceived objects. Husserl wrote,

In all pure psychic experiences (in perceiving something, judging about something, willing something, enjoying something, hoping for something, etc.) there is found inherently a being-directed-toward.... Experiences are intentional. This being-directed-toward is not just joined to the experience by way of a mere addition, and occasionally as an accidental reaction, as if experiences could be what they are without the intentional relation. With the intentionality of the experiences there announces itself, rather, the essential structure of purely psychical.⁸

The notion of intentionality was popularized in the AI world by John Searle, who described it as "a feature of many mental states and events, by means of which they are directed to objects and states of affairs of the external world."⁹ Searle claimed that he wanted to remove some of the peculiarities of certain old philosophical traditions. Yet Husserl's and Searle's definitions of intentionality are quite similar. As Searle himself admitted, the main difference lies in their ways of using these notions. The idea of intentionality can be interpreted from two different standpoints: it is both the direction of conscious acts toward objects in the external world, and the way in which phenomena exist within consciousness. But regarding the first interpretation, Husserl wrote, "The invention of intentionality realized by Brentano did not yet overcome naturalism, which, so to speak, captured intentional experiences and closed the way to the real tasks of the investigation of intentionality."¹⁰

It is precisely the second interpretation, and the consequent work of describing conscious phenomena, which Husserl regarded as the real task of investigations of intentionality. Husserl's method of analyzing consciousness is purely descriptive. The

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fact that the external world is taken out of brackets, that *epoché* is committed, does not deny this world; the external world maintains its existence. A philosopher committing *epoché* refuses to deal with the external world prior to its entry into consciousness. The difference between the "imagined" or nonsensical (e.g., a centaur smoking a pipe) and "real" or sensible objects is only in the mode of the phenomena; both objects are intentionally represented or actualized within consciousness. The direction of consciousness toward an object results in the act of endowing something with sense. In Husserl's words, when we speak about sense, "we speak about some ideal entity that can be something that is implied (*vermeintes*) in the open infinity of real and possible sense-giving (*meinende*) experiences."¹¹

Husserl uses the notion of an act (say, an act of giving sense or an act of perceiving time) only to indicate the passive synthesis in consciousness of what something means. The notion of act does not mean a conscious action, just as intentionality does not mean desire, for we are always already situated within consciousness even as we analyze it. Otherwise, if we assign an act to some hypothetical action maker, we have to describe the functions of an internal consciousness, a consciousness within consciousness: in programming terms, we become hopelessly trapped in an endless loop.

Intentionality concerns the phenomena at the center of consciousness, at its focus. At the periphery of consciousness is what Husserl termed the "horizon," the background that provides the conditions for comprehending phenomena. In other words, what the horizon provides is pre-understanding (*Vorverständnis*). For instance, we understand the meaning of words in the context of a horizon constituted from our understanding of other words and their relations. Describing the relationships between horizon and intentionality, Husserl points out, "Consciousness—where the given object is led to its realization—is not like a box with data inside. A current state of consciousness is constituted so that every object shows its selfness."¹²

Heidegger uses a notion similar to Husserl's horizon: readiness-to-hand (*Zuhandensein*). The word *Zuhanden*—at hand—emphasizes that relevant objects are held near the focus of consciousness. Both horizon and intentional states are constantly changing, and a phenomenon placed at the horizon, in the background, can be readily moved to the center by consciousness. Conversely, the phenomena constituted in the field of intentionality form a part of the horizon for the next intentionality field. As they move from center to periphery, they move from present to just-past; they submerge into the horizon, sink in time.

Internal Time Consciousness

In order to describe the constitution of mental phenomena, we need some possibility for representing time in consciousness. The original source for the phenomenology of time may perhaps be found in the writings of Augustine. In his lectures on the

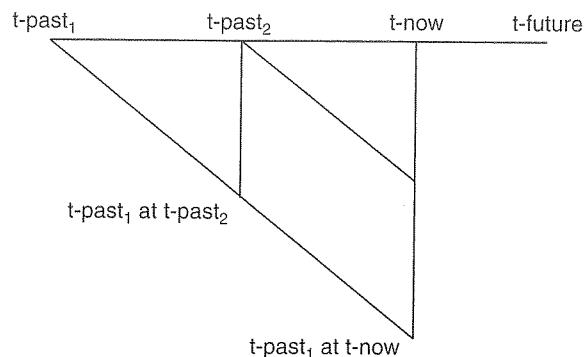


Figure 1

phenomenology of time, Husserl cited a description of time experience from the eleventh volume of the *Confessions*: "I measure time in my soul." Like Augustine, Husserl dismisses any objective notion of time. All phenomena are represented in consciousness, and consciousness operates with meanings created through intentionality. Therefore, temporal phenomena are constituted by consciousness, but they refer to a state of affairs in the external world.

Husserl describes time through a tripartite structure consisting of protention, the now-point, and retention. Protention is an anticipation of the future, the various expectations constituting and conditioning "that which is coming." At Husserl's now-point are the current horizon and the intentionality constituted within this horizon. Retention is the chain formed of the past, the reflections (*Abschattungen*) of previous phenomena kept in consciousness. Figure 1 represents Husserl's scheme.

The horizontal line corresponds to the flow of conscious phenomena, and the vertical lines to the mobile temporal horizon, in which the shadows of previous phenomena are still present in consciousness. Each phenomenon has a retention chain, represented as a diagonal line. These lines express the way in which the now-point has changed the representation of previous moments. Just as the moment *t-now* was constituted at the moment *t-past₂*, so expectations at the moment *t-now* constitute *t-future*. Specifically, the moment *t-future* is already represented in consciousness at *t-now* as an intentional state.

For Husserl, consciousness is a flow of phenomena along a common line or with a common pivot: the revealing or unfolding of experiences in time. The process of revealing determines the structure of these experiences. In other words, time consciousness provides the organizing basis for all other activities of consciousness. Like other phenomena, time is constituted in consciousness, but time also provides a basis for constituting other phenomena, because each phenomenon starts, modulates, and concludes along the connected life of consciousness.

It is possible to distinguish between two kinds of intentionality: longitudinal and transversal (represented in figure 1 as vertical and horizontal lines). Transversal intentionality means grasping an object at various points in time: how it begins, varies, finishes; it provides the possibility of grasping a temporal object. Longitudinal intentionality, on the other hand, allows us to grasp the flow of consciousness itself. Consciousness can thus become the object of analysis because of retention, the chain formed of the past.¹³ Logically and practically, the introduction of time allows us to escape another endless loop: the infinite regress of reflective consciousness, of a consciousness analyzing its own consciousness. The question for AI is, however, can we analyze our own consciousness?

Obstacles for Computer Phenomenology

A cornerstone of Heidegger's philosophy is his refusal to isolate research into language and mind from social environment and body. According to him, New Age metaphysics replaces the world with a representation and a person with a subject. Modeling phenomenological concepts and analyzing consciousness and language without embodying the whole system means that we lose any real engagement with a situation; Husserl's answer to the problem of embodied consciousness, the phenomenology of consciousness, thus had some problems. An attempt to shelter in pure subjectivity might easily fail. When describing a situation it seems difficult to deny the direct, rather than the internalized, influence of external forces. The source of time—the fact that being lasts—is also difficult to place exclusively within ourselves. As a result, a thesis concerning the link of consciousness and body, being-in-the-world, became a key subject for Heidegger's and Merleau-Ponty's versions of phenomenology.

Heidegger changed Husserl's emphasis and shifted from the analysis of consciousness to the analysis of being (*Dasein-analytik*); for this reason, his problems differ from those of cognitive science. Although Dreyfus's exploration of the philosophical background of AI, based on Heidegger's ontology,¹⁴ leads one to an appropriate conclusion about the impossibility of such a project, its impossibility arises from Heidegger's phenomenology of *being*¹⁵ rather than from Husserl's analysis of *consciousness*. In contrast, Husserl's descriptive analysis of consciousness by means of reflection corresponds quite closely with the goals of cognitive science. Regarding the question of a method for phenomenological psychology, Husserl wrote, "Reflection should be made so that the variable, fluctuating life of the ego, the life of consciousness, is not viewed at its surface but instead explicated in contemplation according to its own essential constituent parts."¹⁶

Husserl's attempts to explore the constitution of phenomena in consciousness—his call for models of its production—agree with the basic essence of cognitive science. However, Husserl also imposed some limitations on the scope of this analysis when

he wrote about the preintentional field, the field of pure possibility of intention, which constitutes the primary flow and which limits the possibility of analysis by means of language. The primary flow thus becomes the crucial problem when we consider the possibility of continuing the European philosophical tradition by means of cognitive science. There are two possibilities. If cognitive science can be used to interpret the structure of the primary flow, then it transcends traditional philosophy because it goes beyond the linguistic-based approaches of a human thinker; that is, its modeling is on a level below traditional description. The second possibility is that the primary flow is as impenetrable to analyses based on cognitive science as it was to previous descriptions based on traditional philosophy.

Nothing remains but to admit the restrictions placed by phenomenology on computer realization. How significant would this realization be under such restrictions? Of course, I use the term *realization* only metaphorically. But phenomenology nonetheless proposes interesting concepts for the development of the classical AI paradigm. AI can no longer attempt to create thinking machines; the only possible computer project is a development of some version of philosophy. We can elaborate our concepts, but we cannot elaborate ourselves. Yet even this weak assumption is unjustifiable if we do not consider how we are to realize our position, if we do not clarify our concepts by using the computer. The following section attempts to apply phenomenological concepts to traditional fields of AI.

An Interpretation of Phenomenological Concepts for Cognitive Science

Husserl's horizon and internal time consciousness can provide the key ideas for a computer version of phenomenology, a version that uses continually changing representations of information to ensure the readiness-to-hand of relevant facts. The situation thus constitutes itself on the basis of the history of previous steps.

The main distinction between phenomenological and classical approaches to cognitive science is the use each makes of saved information, for instance, vocabulary items, scripts, and frames. In essence, the distinction is between dynamic remembering and constant memory. Dynamic representations suppose that scripts or word meanings are not simply selected from a vocabulary of possibilities; instead, they are created and constituted during the process of analysis. The problem of polysemy does not even arise during real understanding, for the situation constitutes itself so that a "word meaning" *must* be integrated in its context; the meaning of a word is its meaning in the current situation. It is the situation that attaches meaning to a word, like the king's seal, which, as Mark Twain's pauper demonstrates, may also be used to crack nuts.

It is also possible to apply Husserl's scheme of intentionality to the field of natural language understanding. A word or sentence can serve as an object of intentionality; the flow of interpreting words and sentences produces the flow of acts of intentional-

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ity. The act of giving sense to a word takes place in the context of other words and of a general understanding of the situation. The horizon is formed at the current moment, combining the flow of intentional acts with the assumptions that create the background for understanding. In some ways, the notion of the horizon corresponds to a traditional notion of the context. Husserl's description, however, resists the traditional separation of focus and context, for intentionality presupposes that the structure of an intentional object corresponds to the structure of the horizon.

Two examples of the situational analysis of meanings can be given from Winograd's works. For instance, there are many situations where the standard legal definition of the word *bachelor* is evidently incorrect, for instance, with regard to a Roman Catholic priest or in the case of metaphoric usage: "Has your dog ever sired puppies? No, he is a bachelor."¹⁷ The possibility of applying this definition varies not only with regard to different men but also regarding the same man in different situations, for example, in a country that permits polygamy. Even if we were to construct more and more precise definitions of *bachelor*, new situations might arise where this definition would be violated. Moreover, if we constructed a long list of situations with a precise definition for each situation, this list would be unusable because we would have to extract precise information to confirm that the current situation satisfied a precise definition. Distinctions between each situation, however, would not be rigid. As a result, definitions would be duplicated and we would not know which definition was more appropriate. We need definitions that are not more, but rather less, precise.

The second example I select from Winograd is, "Is there water in eggplants?"¹⁸ Water can have many different definitions, but if it is a hot day and somebody asks whether there is water in the refrigerator, then it is evident that he or she is thinking of water as a means to quench thirst. If there is a soft drink in the refrigerator, we could answer in the affirmative. Answers about water in the chemical content of eggplants, or water condensed on the refrigerator shelves, might be relevant to an analytically oriented logician but not to a real person in such a situation. The second answer, however, might be relevant to the technician who repairs refrigerators.

How can we use phenomenological description in this case? Speaking in Husserl's terms, the meaning of a query is constituted in the current flow of consciousness. The meaning of the word *water* represents the focal object of the question and is integrated into consciousness on the basis of the current horizon. Preunderstanding is already given, so the relevant features of meaning are actualized. The word *water*, however, still belongs to the usual vocabulary of anyone considering this question. There is an apt term: "the internal form of the word," which means a combination of an external form as it is represented in the speech or in consciousness of a speaker, and a fluid internal content actualized by a situation.

So meaning is represented as a phenomenon of revealing. On the one hand, there is a misleading determination of the word, a seeming unity of the meaning: the external

form of the phenomenon. On the other hand, a word has its internal content. The internal content does not include all the meanings of the word *water* (*water₁*, *water₂*) or the sequence of situations in which the meanings can occur. It is rather some structure with all these meanings in a "packed" form, which is meaningless outside the way it is actualized. This actualization takes place in the frame of the current horizon, which provides a basis for preunderstanding and develops the aspects of meaning that correspond to the current situation. In phenomenological terms, the result is an intention of meaning, an act of giving a certain sense. The essential features of the meaning thus become ready-to-hand when the internal form is realized in a concrete situation.

Describing meaning in the analytic tradition is radically different. The analytic tradition emphasizes the result of meaning as objectification; the meaning is cut off from the intentionality that constituted it, so that the meaning becomes an independently analyzable object. In his later work, Wittgenstein criticized this idea: "We are drawn to a wrong idea that a meaning of a sentence entails it, follows it persistently."¹⁹ A very different citation reveals the thoughts of the early Wittgenstein: "A sentence is understood if its constituent parts are understood."²⁰ Here is one more example of situational analysis: Wittgenstein, Moore, and Malcolm have all analyzed the expression "I know." The meaning of this expression in real life depends on the situation: assurance, conviction, evidence, assertion. Someone who has become blind says "I know that this is a tree" instead of "I see." Malcolm's summary presents a list of 12 situations where the expression "I know" has different meanings.²¹ Of course, the list could be extended.

We can apply the distinction between objectified and interpreted descriptions to differentiate between plans of action (say, the scripts used in cognitive science) and situation-driven activities. While the description of a restaurant visit as entering, calling for a waiter, ordering, and so on, is based on our real restaurant visits, it is nonetheless the result of meaning objectification. The inadequacy of such a description becomes evident if we remember the necessity of dividing these scenes into subsценen, the possible disturbance of script elements, and the importance of learning the proper behavior in the situation. For example, we might divide the first scene into opening the restaurant doors, leaving one's coat in the cloakroom, finding a vacant seat. But this scenario could go wrong in many ways: a doorkeeper might open the door for us; there might be no need for a visit to the cloakroom (during the summer or when there is no cloakroom at all); there might be no vacant seats. The situation constitutes itself. When using scripts we need to specify many explicit restrictions that develop from our understanding of the situation. As with the definition of the word *bachelor*, the number of restrictions increases until they end up obscuring our understanding.

The principle of evidence forms the core of Husserl's methodology. Simple situations are evident to us. When we are engaged in a situation, some events seem to be evident; these events are ready-to-hand. Each next step is submerged in a number of previous

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steps, in a particular context of the situation; each step is determined by this context. Using Husserl's notion of the horizon, which has the property of readiness-to-hand, it is possible to refer to a "space for problem solving." This space offers essential data and appropriate methods in order to solve a current problem. But certainly, in the case of a complex problem or of a misunderstanding, we would need to make an effort to restore any missing evidence.

In "A Framework for Representing Knowledge," Minsky discussed the process of building this space for problem solving during problem analysis.²² In the wake of this article, frames became a popular structure for the representation of knowledge. Most of these realizations and concrete applications of frame systems have, however, emphasized a hierarchy of concepts, default slot assigning, and so on. Many object-oriented languages were created soon after or around the same time; some of these languages employed the frame terminology directly (for instance, Smalltalk and CLOS). It could be said that the concept of frames had stimulated the object paradigm.

Yet, in contrast to the popular acceptance of the frame structure, Minsky's analysis of perception dynamics—the dynamics of frame development during the process of situation understanding—was generally ignored or simply misunderstood. In the introduction, Minsky describes the basics of using a frame system:

The different frames of a system describe the scene from different viewpoints, and the transformations between one frame and another represent the effects of moving from place to place.... Different frames correspond to different views, and the names of pointers between frames correspond to the motions or actions that change the viewpoint.²³

Later in the article, Minsky applies this idea about transformations to analyze a fable about a wolf and a lamb. He also uses transformations in his discussion of the widely used notion of the "problem-solving space." He writes,

The primary purpose in problem solving should be better to understand the problem space, to find representations within which the problems are easier to solve. The purpose of search [sic] is to get information for this reformulation, not—as is usually assumed—to find solutions.²⁴

Minsky offers a description of perceiving a cube that directly corresponds to a phenomenological scheme; Husserl likewise uses cube perceiving as the simplest model: Perceiving a cube is a set of various acts of intentionality; the cube is represented from different points of view and from different angles. Visible parts of the cube are related to invisible but anticipated parts. So the perceiving of the stream of aspects and the way they are synthesized reveals the presence of a single and whole consciousness directed towards something.²⁵

I should devote a few words here to a phenomenology-based analysis of the processes of memorizing and remembering, that is, the actualization of memorized information. These processes can be related to internal time consciousness and the feature of readiness-to-hand. When we try to understand any description, the representations

we build during the process of understanding are arranged in layers. Each representation is laid on the previous one and modifies it. Husserl uses the following metaphor to describe the way in which we retain an object image: we can see its previous image as if through a transparent layer of water. The process of layering and modifying representations results in the "packing" of this representation under the pressure of and together with the representations following it. At last these representations reach the long-term memory; we could say that "Husserl's water" hides them. When we read a text and unknown words or unexpected combinations of known words appear, these words and the contexts in which they are being used are overlaid, or sedimented. When we face a situation or a description of a situation, the set of phenomena corresponding to the situation's representation is sedimented, too. Only the core of representations remains. It can be developed later, developed in ways that will differ according to different situations.

These processes of developing, "unpacking" the core according to both the current horizon and the current state of consciousness, constitute the essence of remembering. This unpacking will be different when the horizon or the intentionality state—the mode of consciousness—is different; consciousness will reveal another aspect of a word, the aspect that is ready-to-hand. The structure of consciousness corresponds to the comprehended object because of intentionality. What is remembered as a part of the consciousness structure corresponds to the comprehended object and to other parts of the consciousness structure. Remembering does not work as though we are cutting a representation out of memory, which is structured (according to this view) as a linear array or list of data accessible according to their position. Such an array would be an insensitive medium that would not depend on the data structures stored in it. Instead, remembering is the *process* of constituting the representation necessary for the situation. The metaphor of a river can help clarify the process of remembering. Water in a river does not itself remember the direction of the stream. Moving in its bed, the stream provides the necessary direction of movement. The river corresponds here to an intentional act of remembering, and its bed corresponds to a horizon. Once a core of some remembered object is developed, it can be sedimented again when it is enriched by situational contexts. Subsequent sedimentation is not, however, always necessary, for well-known words or familiar situations, for example. In this case, the development of the prototypical meaning does not change the whole structure of consciousness and protentional field very much. These words or situations become phenomena with a correspondence to their type and to the current consciousness structure. They should sink in time, too, but without much new sedimentation on their prototypical features.

From the cognitive science viewpoint, the representation of the structure of time consciousness provides the possibility that an application may use its own history—*history* here meaning only a sequence of its previous states. If an AI system understands its history, this understanding allows the possibility that it may then reflect on its own