Interdisciplinary Description of Complex Systems 3(2), 77-83, 2005

PARTICIPATORY POSITION

Urban Kordeš

Faculty of education – University of Ljubljana
Ljubljana, Slovenia

Conference paper *Received:* 16 May, 2005. *Accepted:* 10 July, 2005.

SUMMARY

The paper deals with the problems encountered in exploring/describing cognising systems. It is argued that these are mostly an issue of epistemology and that some of the aspects of the above mentioned systems cannot be described without taking into account the researcher's participation in the process of researching (and describing).

KEY WORDS

living systems, non-trivial machines

CLASSIFICATION

APA: 2340

PACS: 89.65.-s

*Corresponding author, η: urban.kordes@guest.arnes.si; +386 1 5892200;
Faculty of education, Kardeljeva ploščad 16, SI – 1000, Ljubljana, Slovenia

THE PROBLEM OF COGNITIVE SCIENCE(S)

In the eighties, due to the explosion of computer technology, the area of artificial intelligence underwent rapid development. The capability of computers to solve tasks virtually insoluble even to the smartest of man caused general optimism and belief that the invention of computers as intelligent as their human creators or even more is only a question of time. Typical of this period was the search for (computer) algorithms to simulate intelligent behaviour. Only when it was proved in time that the intelligence of computers does not grow proportionally to the Central Processing Unit speed (does not grow at all, in fact), the researches started to consider the question of what intelligence actually is more seriously[1].

By the end of the decade, a satisfactory answer had not been found and computers which could be deemed »intelligent« had not been developed. It turned out that it is indeed relatively easy to produce the algorithms for certain tasks considered to be the indicators of high intelligence or supposed to be soluble only by "experts", like e.g. making a diagnosis on the basis of known symptoms, calculating complex differential equations or playing chess. But at the same time, certain operations so routine that we hardly even notice them in everyday life turned out to be utterly incomprehensible: e.g. the processes of cognising, language acquisition and some others. This proved that the issue of intelligence cannot be solved through a shortcut, but must be addressed by first exploring cognition and consciousness in order to solve them. To this effect, the nineties saw the growth of a new scientific discipline – that of cognitive science.

Indeed, it is more appropriate to use the term in the plural form – cognitive sciences – for it consists of differing scientific disciplines originating in various sciences. Each of them approaches the problem of consciousness and cognition in its own way. These include primarily neurophysiology, computer modelling of cognitive phenomena, philosophy of cognitive science, cognitive psychology and some other disciplines. Since than, incredible progress has been made in the cognitive sciences, providing new insights concerning cognitive phenomena in all areas. Nevertheless, there has been increasing talk of "a crisis of the cognitive sciences" in the last few years. It would appear that detailed analysis of individual elements of the cognitive system does not add significantly to the understanding of the entire phenomenon of cognition, nor render the solution of the so-called "hard problem", the pivotal question of the cognitive sciences.

Most cognitive scientists share a tacit assumption that a way out of the standstill lies in the further specialisation of the research of cognitive phenomena that will one day bring to a unified theory which will be able to satisfactory explain the phenomenon of consciousness. But the voices, warning that the crisis at hand is no mere standstill but a real crisis, are becoming louder and louder (e.g. [1] – where the authors have anticipated the problem long before it became the subject of general discussion [2, 3]). Some of the questions they are asking are: How is it possible to address the phenomenon of consciousness before we explore (or at least satisfactorily define) the phenomenon of life and the living? Can the mind and other cognitive phenomena be dealt with independently of the living system? Furlong and Vernon, for example, say: "Actually, when you ponder on it, it is indeed strange, and telling, that artificial intelligence should have been a subject of serious, detailed study before artificial life, for, actually we never assign intelligence to anything other than living systems. Did the artificial intelligencers simply but quietly assume that when their job was done their artificial intelligence systems would in fact be living systems?" [3]. The idealised concepts of intelligent talking machines are becoming less and less plausible and the intertwinement among the processes of life and cognition more and more obvious [4]. Thus, a new level of research has been formed that can be characterised with the question: ‘What is the living?’ or ‘What is life?’

From the standpoint of traditional science, the research of the phenomenon of life should be approached in the same way as the research of cognitive processes. It calls for an interdisciplinary approach, each scientific discipline tackling one aspect of the problem and trying to work on it in the same manner as on the rest of its repertory of research. The phenomenon of life can be approached from the standpoint of chemistry, biology, philosophy, anthropology or computer modelling. A chemist, for example, can deal with the chemical processes taking place inside a living organism. Naturally, he will be unable to describe the entire (chemical) conundrum at once, so he will focus on one specific chemical process in one specific kind of organisms. This breaking down of the problem into simpler components is the chief trick of the analytical-reductionist approach: if a system is too complex to be understood, it is to be divided into smaller and simpler parts. If these parts turn out to be still too complex, divide them again … and so forth, until we reach the parts simple enough for us to understand and describe.

The advantage of the analytical-reductionist approach lies in the fact that it *always* comes up with a result. If we start breaking a system down into parts, sooner or later we get a system that we can handle or describe. Unfortunately, it can happen that the results reached have virtually no connection to the initial problem any more. Thus we can gain immense quantities of data about individual parts and profoundly broaden our knowledge of them. Each detail conceals an infinity of new possibilities for further, even more specialized research and soon we get a feeling that the initial problem cannot be grasped at all, without knowing the single last detail. More often than not this makes the initial problem seem rather distant, turning it into a sort of legend bearing no connection to everyday research.

In 1971 Heinz von Foerster published his so-called “first theorem”: “The more profound the problem that is ignored, the greater are the chances for fame and succes.” [5].

However mockingly cynical this claim might appear, it is a fact that the incredible progress in, say, biology was reached exclusively by denouncing any questions concerning its foundations, the questions about the basic difference between the living and the non-living, between Jung’s *creatura* and *pleroma*.

Life is not a property, which could be satisfactorily determined by empirical parameters (which has been proved by numerous unsuccessful attempts in this direction). Rather, it manifests itself as a complex, (self-)contained and self-producing and therefore irreducible phenomenon. Life is *gestalt*, the consequence of a sensitive balance composed of numerous parts, more than just a simple sum of all of its components. Besides, it is a dynamical *gestalt* that we cannot simply “freeze” in a moment of time, as living beings can only be told apart from the non-living inside the context of time. Thus Furlong and Vernon [3, p.96] write: “And what is wrong with our conception of science in its application to Life and Mind is that the analytic reductionism which characterises the spectator consciousness stance can never capture the organisational distinctions which characterise living or cognizing beings.” No matter how detailed our description of the components be, it cannot describe the essential distinction between the living and the non-living, as this distinction appears not at the level of structure, but at the level of organisation, that is, the relation between the components [4]. In relation to this, Bateson quotes the biologist McCulloh (in [6]): “If you ask me concerning a particular cell what its function is, you've asked a question like what is the function of the second letter of every word in the English language.”

In the words of Furlong and Vernon [3, p.96]: "Scalpels and microscopes may be useful, but not for the discovery of Life and Mind, for when the analysis is done, that which is essential is gone." We cannot simply cut a living organism (literally or metaphorically) and continue treating it as a living being: *the method of research (analysis) essentially changes the properties of the living organism.*

TRIVIAL AND NON-TRIVIAL MACHINES

I believe that thinking about the puzzles of cognition necessarily takes us beyond the limits of "soft" problems that allow for the use of an analytical-reductionist approach, exact descriptions and predictability.

In the remaining part of this article, I try to prove the existence of systems, which cannot be exactly described nor predicted, even if we had at our disposal all the time and all the conceivable computational capabilities in the universe. I will use the machine metaphor and, proceeding from the work of Gell, Ashby and von Foerster (cf. [7]), explore its two categories: *trivial* and *non-trivial* machines.

Trivial machines are:

- independent of time and their history of interactions
- analytically determinable

and therefore *predictable*.

If we wish to understand the functioning of a concrete trivial machine (to determine its preceding function), we generally need as many trials as there are distinct inputs.

Non-trivial machines have internal states. The relation between the inputs and outputs of a non-trivial machine is anything but invariant. Instead, it is determined by the machine's previous operation. Thus the history of the machine's operations affects its preceding function. Ashby and von Foerster [8] prove that some of them are in principle, and others in practice, analytically indeterminable and therefore unpredictable.

Let n be the number of inputs to the machine. Let us suppose that the number of outputs is equal to the number of inputs. The number N of all trivial machines that can be synthesized is therefore $N_T(n) = n^n$, and the number of non-trivial machines is as much as $N_{NT}(n) = n^{nz}$, where z represents the number of internal states. In this case, z cannot be greater than the number of possible trivial machines ($z \leq n^n$). Thus, for trivial machines with four possible inputs, $N_T(4) = 256$ and for non-trivial machines, $N_{NT}(4) = 4^{1024}$, which means approximately 10^{620} elements. And we are still dealing with a simple machine operating only with four variable values, having only 256 internal states at its disposal. Nevertheless, even the complexity of this system is unthinkable to the point that it is absolutely impossible to analytically explore its functioning. The problem is transcomputational. According to the machine metaphor, what is to be thought of the attempts of brain modelling, a system with at least 10^{10} elements?

In sight of such complexity, the analythic-reductionist scientist would undoubtedly reach for his scalpel and try to reduce the observed system as much as possible. But some non-trivial systems have the annoying property that their parts change their characteristics completely when separated from the system. Besides, even the detailed knowledge of the functioning of all of its components does not guarantee the understanding of the entire system's operation.

Von Foerster says: "When asked, all my friends consider themselvs to be like non-trivial machines, and some of them think likewise of others. These friends and all the others who populate the world create the most fundamental epistemological problem, because the world, seen as a large non-trivial machine, is thus history dependent, analytically indeterminable, and unpredictable. How shall we go about it?" [9].

The same author can see three strategies that could be applyed: 1. ignore the problem, 2. trivialize the world, 3. develop an epistemology of non-triviality.

The most popular version is of course to ignore the problem, closely followed by the method of universal trivialisation. In the words of von Foerster: "One may call it the "Laplacian solution", for it was Laplace who eliminated from his considerations all elements that could cause trouble for his theory: himself, his contemporaries, and other non-trivial annoyances, and than pronounced the universe to be a trivial machine …

The tremendous attraction of having to deal with something analysable, reliable and predictable, persuades one to pay for guarantees that our watches, lawnmowers, airplanes, etc., maintain their no-choice quality. The danger begins, when we extend this demand to others, to our children, our families and other larger social bodies by trying to trivialize them, that is, by reducing their number of choices, instead of enlarging it" [7].

The situation in science is similar. The danger begins, when we stubbornly stick to the analytical-reductionist paradigm, even dealing with problems, which it cannot cope with. Triviality is just an approximation. Even in the case that there exist trivial systems "out there" (and that there exists some "out there"), our cognitive system is most certainly non-trivial and so is everything that we experience. Like Newton's mechanics in physics, trivialisation is a very successful idealisation, functional in the larger part of the known world. It promises predictability and therefore safety and stability. But there is an immense expanse of indescribable forms lurking just behind the limits of triviality, elusive and intangible exactly because of their indescribability. And the moment we try to fixate some part of the non-trivial vastness, its essence has already been lost.

I believe *that the phenomenon of life cannot be treated as a trivial affair, neither can living beings be considered as mere trivial systems.* In exploring many phenomena, the observed system can undergo trivialisation, allowing for all of the benefits of the analytical-reductionist methodological paradigm. But there are also other phenomena that cannot be addressed in this paradigm and for which the non-trivial nature of the observed system ought to be taken into consideration. I think that the necessity for taking into account non-triviality does not end with the research of the phenomenon of life, but emerges at all levels of the exploration of living systems (therefore in the exploration of psychical, cognitive and, on the other hand, social systems as well).

As stated above, many phenomena can be divided into trivial and non-trivial parts. I wish to argue that the dividing line runs along the border *between the part we can satisfactorily describe as separated from the observer and the part, for which such idealisation is no longer functional*.

Including the observer into the observed system represents the basis for a *participatory epistemological position* (constructivism). The emphasis of research ensuing from this position is no longer on looking for the properties of the system, but on finding the properties of interactions between the (non-trivial) system and the (equally non-trivial) environment.

A more in-depth presentation and argumentation of the above mentioned epistemology, and the research possibilities deriving from it, is of beyond the scope of the present paper, but can be a good introduction for a debate. Let me conclude with summarizing the major differences between the classical scientific method and the described alternative in Table 1.

Table 1. Major differences between the trivial and non/trivial systems.

	Trivial systems ("classical" scientific method)	**Non-trivial systems**
Method	observer/researcher must not participate in the object of research	participation of the observer/researcher
	repeatability	non-repeatability
	reductionism and disregard of the "non-essential" parameters	cherishing complexity
	(linear) causality	circular (intertwined) causality
Epistemology	metaphysical realism	participatory position, constructivism
	the quest for truth	the quest for viable solutions
Ethics	objectivity	responsibility (for one's world)

REMARK

[1]This division of the development into decades is, of course, a simplification. My aim is to emphasise the general direction of the developement and not its temporal dynamics.

REFERENCES

[1] Winograd, T. and Flores, F.: *Understanding Computers and Cognition*.
Ablex Publishing Co., Norwood, 1986.

[2] Varela, F.; Thompson, E. and Rosch, E.: *The Embodied Mind (Cognitive Science and Human Experience).*
The MIT Press, Cambridge, London, 1991,

[3] Furlong, D. and Vernon, D.: *Reality Paradigms, Perception, and Natural Science The Relevance of Autopoiesis*.
In: McMullin, B. and Murphy, N., ed.: *Autopoiesis and Perception*. Proceedings of a workshop held at Dublin City University on August 25th and 26th, 1992,

[4] Maturana, H.R. and Varela, F.J.: *The Tree of Knowledge*. In Slovenian.
Studia Humanitatis, Ljubljana, p. 3, 1998. Translation from: Shambhala, Boston & London, 1998.

[5] von Foerster, H.: *Responsibilities of Competence*.
Journal of Cybernetics **2**(2), 1-6, 1972,

[6] Keeney, B.: *The Aesthetics of Change*.
The Guilford Press, New York, London, 1972,

[7] von Foerster, H.: *Through the Eyes of the Other*.
In: Steiner, F., ed.: Research and Reflexivity, Sage Publications, London, pp. 63-75, 1990,

[8] von Foerster, H.: *'Uncle Ludwig' and other Wittgensteiniana*.
Lecture, symposium Wittgensteinseminara held 24. 5. 1992, Skjoldnu, unpublished, 1992,

[9] von Foerster, H.: *For Niklas Luhmann: How recursive is communication.*
unpublished, 1993.

POZICIJA SUDJELOVANJA

U. Kordeš

Pedagoški fakultet – Sveučilište u Ljubljani
Ljubljana, Slovenija

SAŽETAK

Članak razmatra problem koji se javlja pri istraživanju/opisivanju kognitivnih sustava. Zastupa se kako je to prvenstveno pitanje epistemologije te da neki vidovi kognitivnih sustava ne mogu biti opisani bez uzimanja u obzir učestvovanja istraživača u procesu istraživanja (i opisivanja).

KLJUČNE RIJEČI

živi sustavi, netrivijalni uređaji