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Nesse texto, Paul Pangaro nos dá uma clara noção da diferença entre Cibernética e Inteligência Artificial, caracterizando especificamente e revelando a relação existente essas duas ciências.

What is the derivation of the word "cyberspace"?

"Cyber" is from the Greek word for navigator. Norbert Wiener coined "cybernetics" around 1948 to denote the study of "teleological mechanisms" [systems that embody goals].

—William Gibson, who coined the term "cyberspace" in 1982, as quoted in New York Times Sunday Magazine, 19 August 2007

CYBERNETICS — A Definition

Artificial Intelligence and cybernetics: Aren't they the same thing? Or, isn't one about computers and the other about robots? The answer to these questions is emphatically, No.

Researchers in Artificial Intelligence (AI) use computer technology to build intelligent machines; they consider implementation (that is, working examples) as the most important result. Practitioners of cybernetics use models of organizations, feedback, goals, and conversation to understand the capacity and limits of any system (technological, biological, or social); they consider powerful descriptions as the most important result.

The field of AI first flourished in the 1960s as the concept of universal computation [Minsky 1967], the cultural view of the brain as a computer, and the availability of digital computing machines came together to paint a future where computers were at least as smart as humans. The field of cybernetics came into being in the late 1940s when concepts of information, feedback, and regulation [Wiener 1948] were generalized from specific applications in engineering to systems in general, including systems of living organisms, abstract intelligent processes, and language.

O autor faz uma clara distinção entre as noções de Inteligência Artificial e Cibernética. Enquanto a primeira surge na década de sessenta a partir de uma universalização das possibilidades da computação e busca uma aproximação entre o cérebro humano e o computador e o desenvolvimento de máquinas inteligentes, o campo da Cibernética tem início na década de quarenta e foi generalizada enquanto aplicações no

entendimento de sistemas em geral, de organismos vivos, processamento de dados e linguagem.

### Origins of "cybernetics"

The term itself began its rise to popularity in 1947 when Norbert Wiener used it to name a discipline apart from, but touching upon, such established disciplines as electrical engineering, mathematics, biology, neurophysiology, anthropology, and psychology. Wiener, Arturo Rosenblueth, and Julian Bigelow needed a name for their new discipline, and they adapted a Greek word meaning "the art of steering" to evoke the rich interaction of goals, predictions, actions, feedback, and response in systems of all kinds (the term "governor" derives from the same root) [Wiener 1948]. Early applications in the control of physical systems (aiming artillery, designing electrical circuits, and maneuvering simple robots) clarified the fundamental roles of these concepts in engineering; but the relevance to social systems and the softer sciences was also clear from the start. Many researchers from the 1940s through 1960 worked solidly within the tradition of cybernetics without necessarily using the term, some likely (R. Buckminster Fuller) but many less obviously (Gregory Bateson, Margaret Mead).

Adaptado do grego, o significado "the art of steering" foi usado para evocar a rica interação entre objetivos, feedback, ações, em sistemas de todos os tipos.

### Limits to knowing

In working to derive functional models common to all systems, early cybernetic researchers quickly realized that their "science of observed systems" cannot be divorced from "a science of observing systems" — because it is we who observe [von Foerster 1974]. The cybernetic approach is centrally concerned with this unavoidable limitation of what we can know: our own subjectivity. In this way cybernetics is aptly called "applied epistemology". At minimum, its utility is the production of useful descriptions, and, specifically, descriptions that include the observer in the description. The shift of interest in cybernetics from "observed systems" — physical systems such as thermostats or complex auto-pilots — to "observing systems" — language-oriented systems such as science or social systems — explicitly incorporates the observer into the description, while maintaining a foundation in feedback, goals, and information. It applies the cybernetic frame to the process of cybernetics itself. This shift is often characterized as a transition from 'first-order cybernetics' to 'second-order cybernetics'. Cybernetic descriptions of psychology, language, arts, performance, or intelligence (to name a few) may be quite different from more conventional, hard "scientific" views — although cybernetics can be rigorous too. Implementation may

then follow in software and/or hardware, or in the design of social, managerial, and other classes of interpersonal systems.

Nesse trecho o autor fala sobre a tensão entre a separação do conceito de cibernética de primeira e segunda ordem e das noções de estudo da observação de sistemas e estudo dos sistemas observados. Essa diferença se dá pela compreensão de que um estudo descritivo contém intenções subjetivas daquele que observa o sistema, sendo ele, então, considerado parte constitutiva desse sistema.

### Origins of AI in cybernetics

Ironically but logically, AI and cybernetics have each gone in and out of fashion and influence in the search for machine intelligence. Cybernetics started in advance of AI, but AI dominated between 1960 and 1985, when repeated failures to achieve its claim of building "intelligent machines" finally caught up with it. These difficulties in AI led to renewed search for solutions that mirror prior approaches of cybernetics. Warren McCulloch and Walter Pitts were the first to propose a synthesis of neurophysiology and logic that tied the capabilities of brains to the limits of Turing computability [McCulloch & Pitts 1965]. The euphoria that followed spawned the field of AI [Lettvin 1989] along with early work on computation in neural nets, or, as then called, perceptrons. However the fashion of symbolic computing rose to squelch perceptron research in the 1960s, followed by its resurgence in the late 1980s. However this is not to say that current fashion in neural nets is a return to where cybernetics has been. Much of the modern work in neural nets rests in the philosophical tradition of AI and not that of cybernetics.

### Philosophy of cybernetics

AI is predicated on the presumption that knowledge is a commodity that can be stored inside of a machine, and that the application of such stored knowledge to the real world constitutes intelligence [Minsky 1968]. Only within such a "realist" view of the world can, for example, semantic networks and rule-based expert systems appear to be a route to intelligent machines. Cybernetics in contrast has evolved from a "constructivist" view of the world [von Glasersfeld 1987] where objectivity derives from shared agreement about meaning, and where information (or intelligence for that matter) is an attribute of an interaction rather than a commodity stored in a computer [Winograd & Flores 1986]. These differences are not merely semantic in character, but rather determine fundamentally the source and direction of research performed from a cybernetic, versus an AI, stance.

Pode-se entender que a filosofia que cerca a cibernética é a construtivista. Enquanto a noção de inteligência artificial trata o conhecimento como um objetivo passível de ser transferido, aplicado, a cibernética entende que o conhecimento é algo construído através do compartilhamento entre ambientes.

Underlying philosophical differences between AI and cybernetics are displayed by showing how they each construe the terms in the central column. For example, the concept of "representation" is understood quite differently in the two fields. Relations on the left are causal arrows and reflect the reductionist reasoning inherent in AI's "realist" perspective that via our nervous systems we discover the-world-as-it-is. Relations on the right are non-hierarchical and circular to reflect a "constructivist" perspective, where the world is invented (in contrast to being discovered) by an intelligence acting in a social tradition and creating shared meaning via hermeneutic (circular, self-defining) processes. The implications of these differences are very great and touch on recent efforts to reproduce the brain [Hawkins 2004, IBM/EPFL 2004] which maintain roots in the paradigm of "brain as computer". These approaches hold the same limitations of digital symbolic computing and are neither likely to explain, nor to reproduce, the functioning of the nervous system.

## Influences

Winograd and Flores credit the influence of Humberto Maturana, a biologist who recasts the concepts of "language" and "living system" with a cybernetic eye [Maturana & Varela 1988], in shifting their opinions away from the AI perspective. They quote Maturana: "Learning is not a process of accumulation of representations of the environment; it is a continuous process of transformation of behavior through continuous change in the capacity of the nervous system to synthesize it. Recall does not depend on the indefinite retention of a structural invariant that represents an entity (an idea, image or symbol), but on the functional ability of the system to create, when certain recurrent demands are given, a behavior that satisfies the recurrent demands or that the observer would class as a reenacting of a previous one." [Maturana 1980] Cybernetics has directly affected software for intelligent training, knowledge representation, cognitive modeling, computer-supported cooperative work, and neural modeling. Useful results have been demonstrated in all these areas. Like AI, however, cybernetics has not produced recognizable solutions to the machine intelligence problem, not at least for domains considered complex in the metrics of symbolic processing. Many beguiling artifacts have been produced with an appeal more familiar in an entertainment medium or to organic life than a piece of software [Pask 1971]. Meantime, in a repetition of history in the 1950s, the influence of cybernetics is felt throughout the hard and soft sciences, as well as in AI. This time however it is cybernetics' epistemological stance — that all human knowing is

constrained by our perceptions and our beliefs, and hence is subjective — that is its contribution to these fields. We must continue to wait to see if cybernetics leads to breakthroughs in the construction of intelligent artifacts of the complexity of a nervous system, or a brain.

## Cybernetics Today

The term "cybernetics" has been widely misunderstood, perhaps for two broad reasons. First, its identity and boundary are difficult to grasp. The nature of its concepts and the breadth of its applications, as described above, make it difficult for non-practitioners to form a clear concept of cybernetics. This holds even for professionals of all sorts, as cybernetics never became a popular discipline in its own right; rather, its concepts and viewpoints seeped into many other disciplines, from sociology and psychology to design methods and post-modern thought. Second, the advent of the prefix "cyb" or "cyber" as a referent to either robots ("cyborgs") or the Internet ("cyberspace") further diluted its meaning, to the point of serious confusion to everyone except the small number of cybernetic experts.

However, the concepts and origins of cybernetics have become of greater interest recently, especially since around the year 2000. Lack of success by AI to create intelligent machines has increased curiosity toward alternative views of what a brain does [Ashby 1960] and alternative views of the biology of cognition [Maturana 1970]. There is growing recognition of the value of a "science of subjectivity" that encompasses both objective and subjective interactions, including conversation [Pask 1976]. Designers are rediscovering the influence of cybernetics on the tradition of 20th-century design methods, and the need for rigorous models of goals, interaction, and system limitations for the successful development of complex products and services, such as those delivered via today's software networks. And, as in any social cycle, students of history reach back with minds more open than was possible at the inception of cybernetics, to reinterpret the meaning and contribution of a previous era.

Such a short summary as this cannot represent the range and depth of cybernetics, and the reader is encouraged to do further research on the topic. There is good material, though sometimes not authoritative, at [Wikipedia.org](http://Wikipedia.org).

Apesar das confusões geradas no emprego do prefixo cyber como referentes à internet ou robôs, os conceito e as origens desse conceito apresentam um grande interesse hoje. Designers estão redescobrando suas influencias em métodos de design e a necessidade do uso de métodos rigorosos para a elaboração e execução de produtos complexos.

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[Origin of this content: In 1990 Heinz von Foerster was approached by Macmillan to compose the entry on cybernetics for their 1991 Encyclopedia of Computers and von Foerster kindly referred them to me. The published text was (c) Macmillan Publishing while incorporating a figure created for an earlier purpose. Over time, updates, extensions, and clarifications have been incorporated into the text above. - Paul Pangaro, 3 August 2006]