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How AI may successfully impact society through innovation? A Revisitation of Systems Theory.

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This developmental paper presents a theoretical review of systems theory, focused on aspects regarding innovation in society through the lens of cybernetics, second-order cybernetics, autopoiesis and social systems. The research suggests the comprehensiveness of social systems theory could help to develop a better understanding of artificial intelligence and improve its impact in modern societies.

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Understanding the complexity of Artificial Intelligence Ethics, this paper proposes an analysis of how AI impacts society through the lens of systems theory. It will outline the concepts and developments of those theories, revisiting the major theorists, such as Norbert Wiener, Heinz von Foerster, Humberto Maturana, Francisco Valera, Niklas Luhmann. A critical analysis of the impact of those approaches could have to AI and society will be made, identifying possible areas of study to explore the nature of this relationship in order to develop better practices in the innovation field.

Artificial Intelligence has many and complex definitions, from different disciplines, including law and computer science (Heikkinen, 2019; Sarmah, 2019). Dreyfus et al (1986) argue machines are not in this world - they do not have body, childhood or culture practice - so they cannot acquire intelligence as a human being does. Other authors say machines cannot be intelligent as human beings since human intelligence is not algorithmic (Penrose, 1994), but organic; and as organic it is not measurable (Lebow et al, 2016). More recently, Tadeo and Floridis (2018) said AI is

*a growing resource of interactive, autonomous, self-learning agency, which enables computational artifacts to perform tasks that otherwise would require human intelligence to be executed successfully.* (p. 751)

Nevertheless the perspectives suggested by AI co-creators and ethics specialists, the impact of this technology in postmodern societies has been boosted by marketing into a wave of cyber-enthusiasm (Trend, 2001; Linden and Feen, 2003; Shead, 2020), provoking an accelerated digital life, hesitant about the future (Kitchin and Fraser, 2020), and impacted by the rise of social inequality (Hughes, 2016) and volatile sustainability (Dauvergne, 2020).

The notion of system was not born with questions of technology, but it is a perennial philosophical problem addressed by a large variety of thinkers over the centuries. In the presocratics, it was defined as an order or *kosmos* in a hostile world governed by chaotic and incomprehensible forces. For Aristoteles, the system problem regards “The whole is more than the sum of its parts” (p. 407) - a problem still relevant (von Bertalanffy, 1972). The glossary provided by Maturana and Varela (1980) conceptualises a system as “*any definable set of components*” (p. 138). For Mingers (2002), the traditional idea of system theory involves open systems processing inputs into outputs. However, when we refer to societies, it is necessary to have a more dynamic view, where their complex systems can adapt internally to survive unforeseen turbulences.

Cybernetics’s first publication as scientific discourse dates to 1948, when Norbert Wiener (2019) published the first edition of the book Cybernetics or Control and Communication in the Animal and the Machine. In this book, Wiener states Cybernetic approaches the role of information in communication science, control and statistical mechanics, conceptually and mathematically. In other words, cybernetics is a philosophical approach of mathematical theory of communication (Seising, 2010). Ashby (1961) defined cybernetics as the “science of control and communications” (p. 1), focusing on concepts such as change, stability and regulation in complex systems (Scott, 2004). Control is understood by Wiener as a negative feedback to maintain the essential parameters of a dynamic system while permitting its evolution despite perturbations. Regarding communications, Wiener was interested to understand the role the noise plays in interfering in the transmission of signals and how it could be prevented to preserve the quality of the information (Parra-Luna, 2009; Seising, 2010; Wiener, 2019;).
Second-order Cybernetics was coined by Heinz Von Foerster (1992) from his interest to discuss the cybernetics of cybernetics, calling SOC the study of observing systems (Scott, 2004). This new approach contravened the principle of objectivism, that demands the observer be separated from observed, to consider - from a constructivist perspective - the observer

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\text{a person who considers oneself to be a participant actor in the drama of mutual interaction of the give and take in the circularity of human relations.}
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(Foerster, 1992, p. 42)

Furthermore, Foerster argued the participation of the observer in constructing reality is a responsibility to the world that has been constructed (Scott, 2004); the choice on undecidable questions is, hence, the origin of ethics (Foerster, 1992).

The radical constructivism presented in the Foerster’s SOC work is followed by Maturana and Varela, who developed a different system called autopoiesis to explain the nature of the living and non-living entities (Maturana and Varela, 1980; Mingers, 2002). Autopoiesis system is an independent and closed unity based on a network of recursive processes that produces all components necessary for its own production, defining its own boundaries (Maturana and Varela, 1980; Radosavljevic, 2008) and transforming “itself in itself” (Mingers, 2002, p. 280). The environment does not determine the autopoietic unity, but autopoietic systems can interact with the environment and with each other through hetero-referential interactions with its components (Maturana and Varela, 1980).

The autopoiesis system theory has been expanded to social system theory (Figure 1) by Luhmann (1995), who offered major development in ecological problems and mass media fields. Properly reviewing Luhmann’s theory could take more than a few papers, for what this analysis will be limited to a few relevant characteristics for the scope of this research. The first consideration to be made about the autopoietic social system is the exclusion of physical dimension in its process of production, which means the exclusion of people. Not because people are not relevant but entirely the opposite. People are too complex to be reduced in one dimension, for what we are composed by three systems - organism system (body), psychic system (mind) and socials systems (communication). Another important characteristic is the refutation of unilateral control - the system cannot be controlled by one part, without this part being controlled by the whole. And finally, the communications are the elements used by autopoietic social systems to reproduce themselves. Ultimately, the physical world cannot affect society until it does not become the subject of communication (Luhmann, 1995; Mingers, 2002).
Aguado (2009) revisited Luhmann’s work, focusing on the paradox of Mass Media System, as a subsystem of a highly complex social system that “produce the reality it observes and observe the reality they produce.” (p. 67). It implies it is impossible to separate the actor from the observer. The self-observation of social systems requires a distinction between actor and observer, which is not possible in the mass media system. The implication is the production of a differentiated social sub-system, condemned to hetero-referential implementation. In this concern, and following Luhmann’s own words (2000),

How is possible to accept information about the world and about society as information about reality when one knows how it is produced? (p.122)

Luhmann (2000) also suggests second-order cybernetics can only be understood as a therapy system to observe the pain and questioning why the observer made some specific choice and not another.

Systems theory demonstrates to be an interesting field to understand the impact of Artificial Intelligence in complex modern societies from a constructivist perspective. Luhmann’s Social Systems theory could be specialty relevant as a sociological approach to understand the complexity of human-oriented AI, which should abandon the rationalist view of body and mind separation and consider the interconnection between all systems.

Reference List


