

Introduction to Cognitive Robotics

Module 6: Artificial Cognitive Systems

Lecture 1: The paradigms of cognitive science; cognitivism

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www.vernon.eu

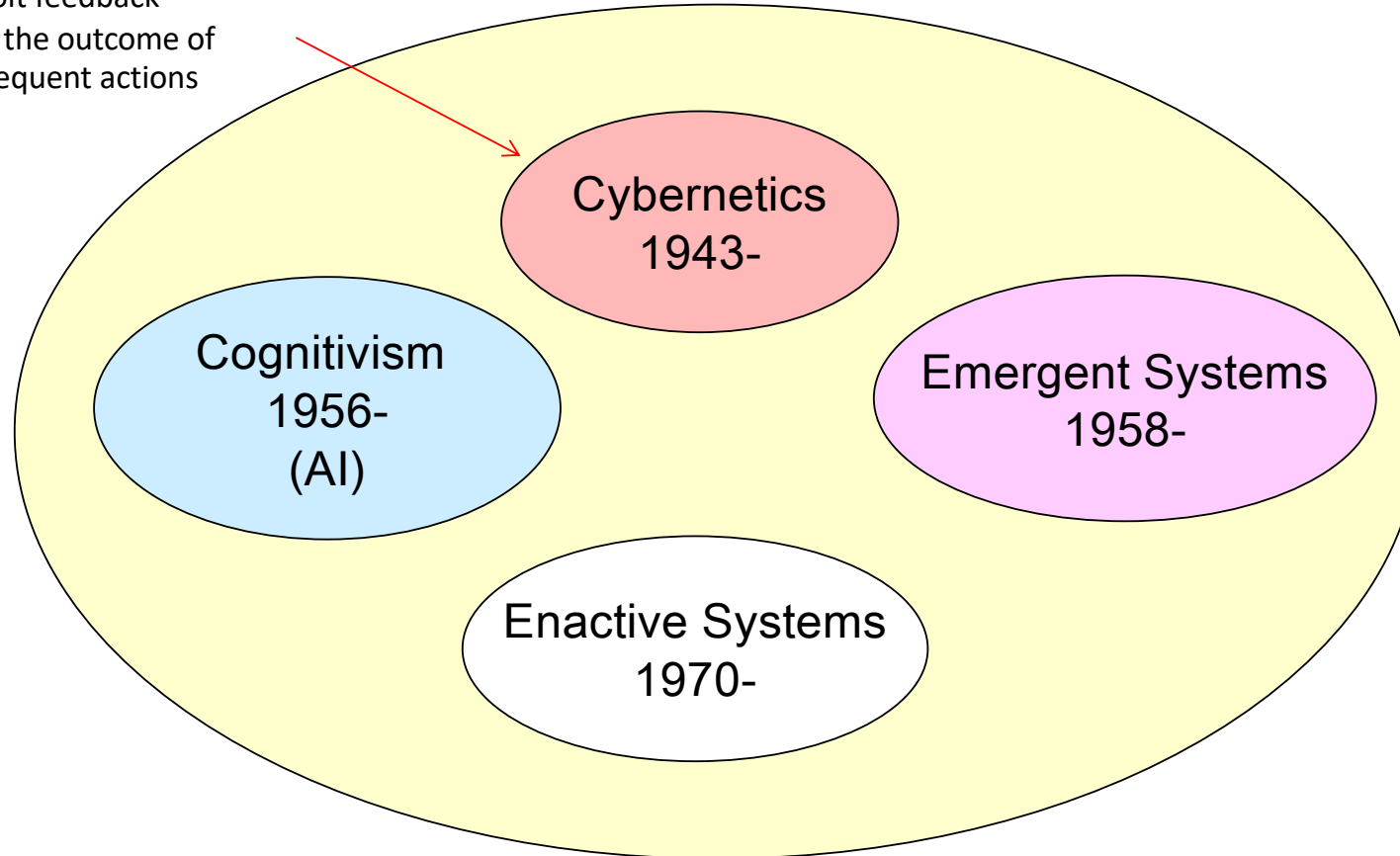
Cognitivism & Artificial Intelligence

- Module 6 addresses a sample of topics in the field of **artificial cognitive systems**
 - Lecture 1. The paradigms of cognitive science; cognitivist (symbolic) paradigm
 - Lecture 2: The paradigms of cognitive science: emergent and hybrid paradigms
 - Lecture 3. Learning and development
 - Lecture 4. Memory and prospection
 - Lecture 5. Internal simulation; the symbol grounding problem
 - Lecture 6. Interaction, social cognition; theory of mind; instrumental helping; collaboration
- Module 7 goes a deeper when dealing with the topic of **cognitive architectures**
- For a more thorough treatment of these topics
 - Refer to a complete course on artificial cognitive systems here: <http://www.vernon.eu/ACS.htm>
 - Refer to (Vernon 2014)

D. Vernon, *Artificial Cognitive Systems – A Primer*, MIT Press, 2014

Cognitive Science

The study of adaptive, regulatory, goal-directed (purposeful) systems that exploit feedback – or circular causality – where the outcome of actions provide input for subsequent actions

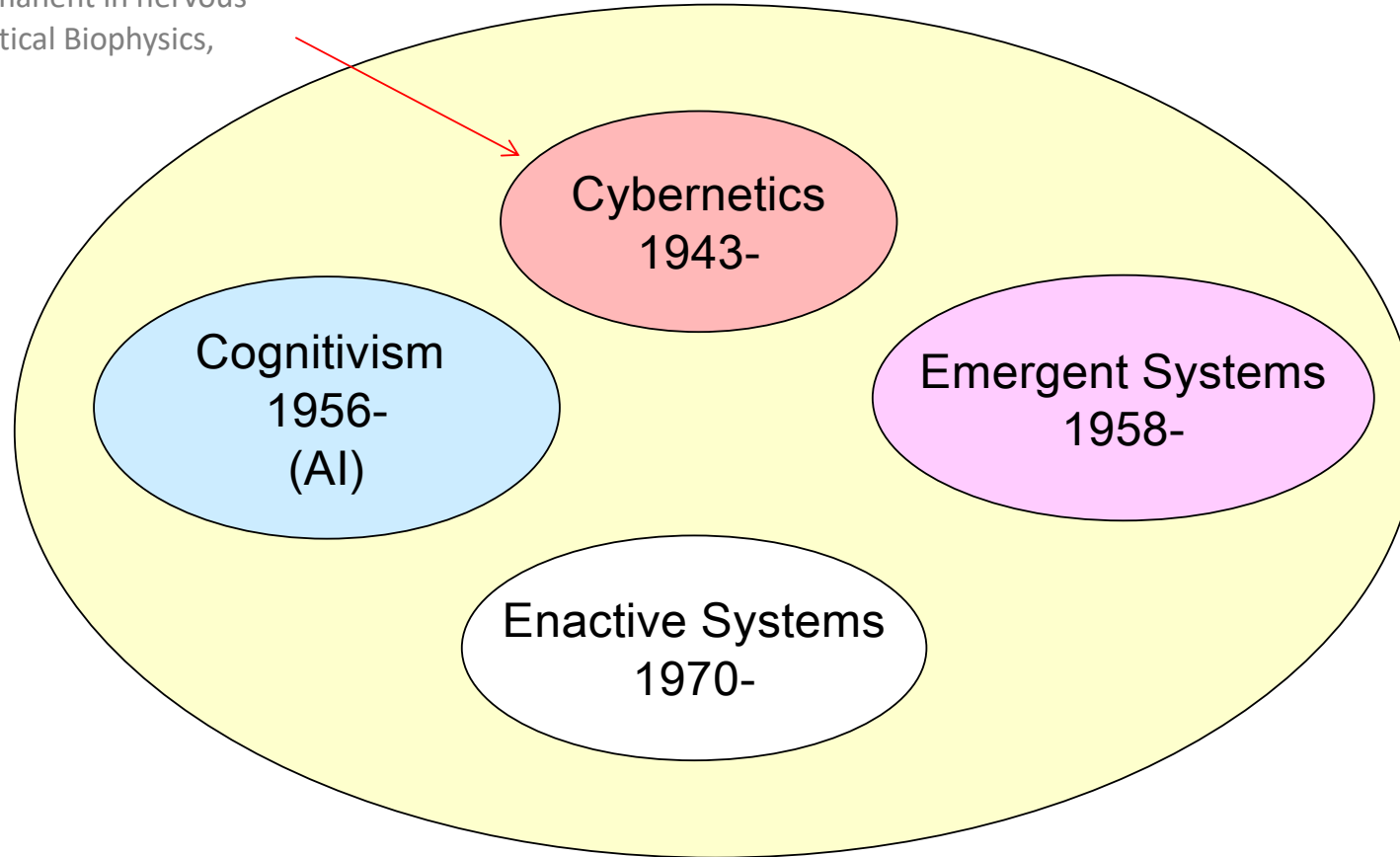


F. J. Varela. Whence perceptual meaning? A cartography of current ideas. In F. J. Varela and J.-P. Dupuy, editors, *Understanding Origins – Contemporary Views on the Origin of Life, Mind and Society*, Boston Studies in the Philosophy of Science, pages 235–263, Dordrecht, 1992. Kluwer Academic Publishers.

Cognitive Science

W. S. McCulloch and W. Pitts.

"A logical calculus of ideas immanent in nervous activity", *Bulletin of Mathematical Biophysics*, 5:115–133, 1943.



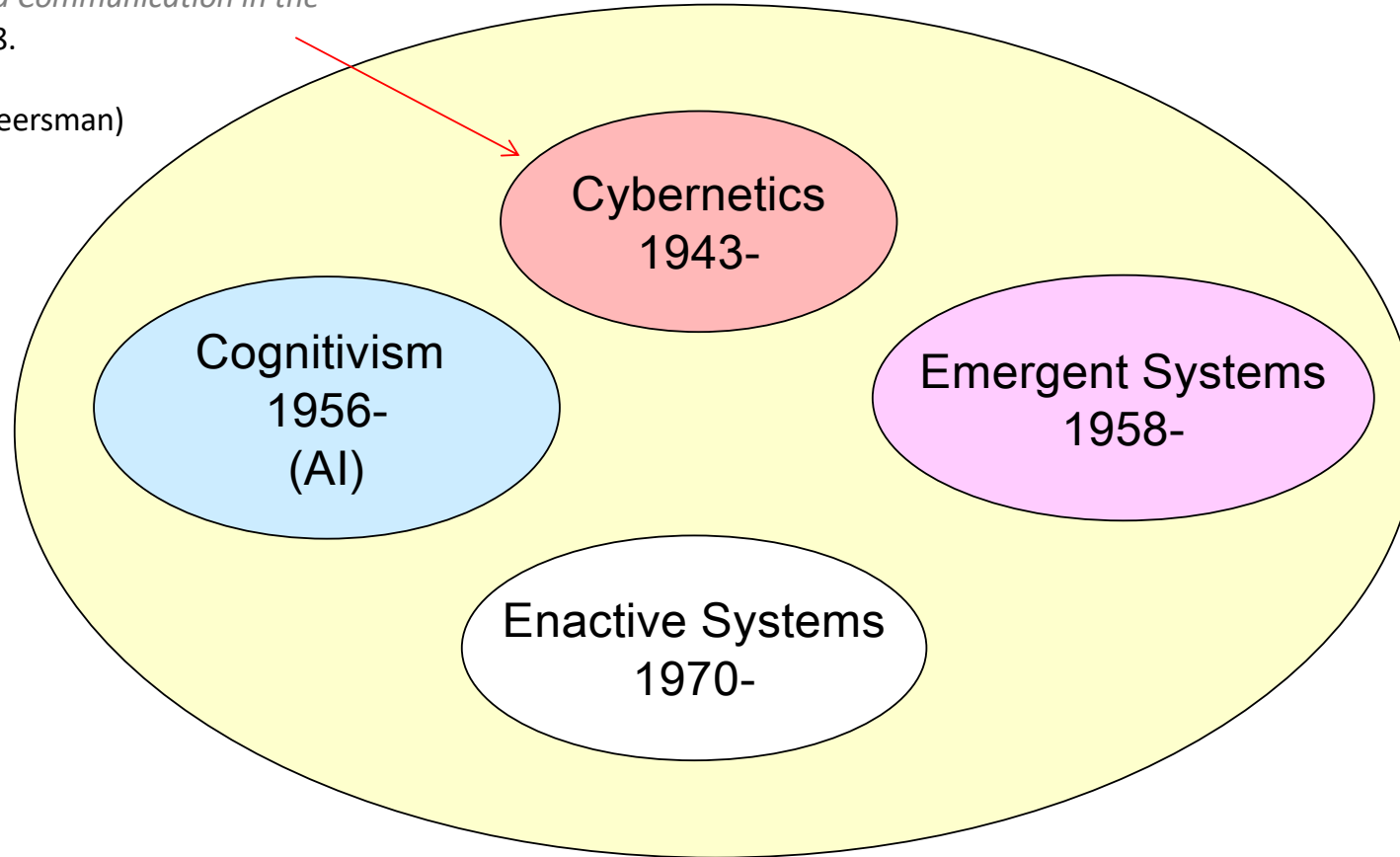
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Cognitive Science

N. Wiener

Cybernetics: or the Control and Communication in the Animal and the Machine, 1948.

(κυβερνητης or kybernetes: steersman)



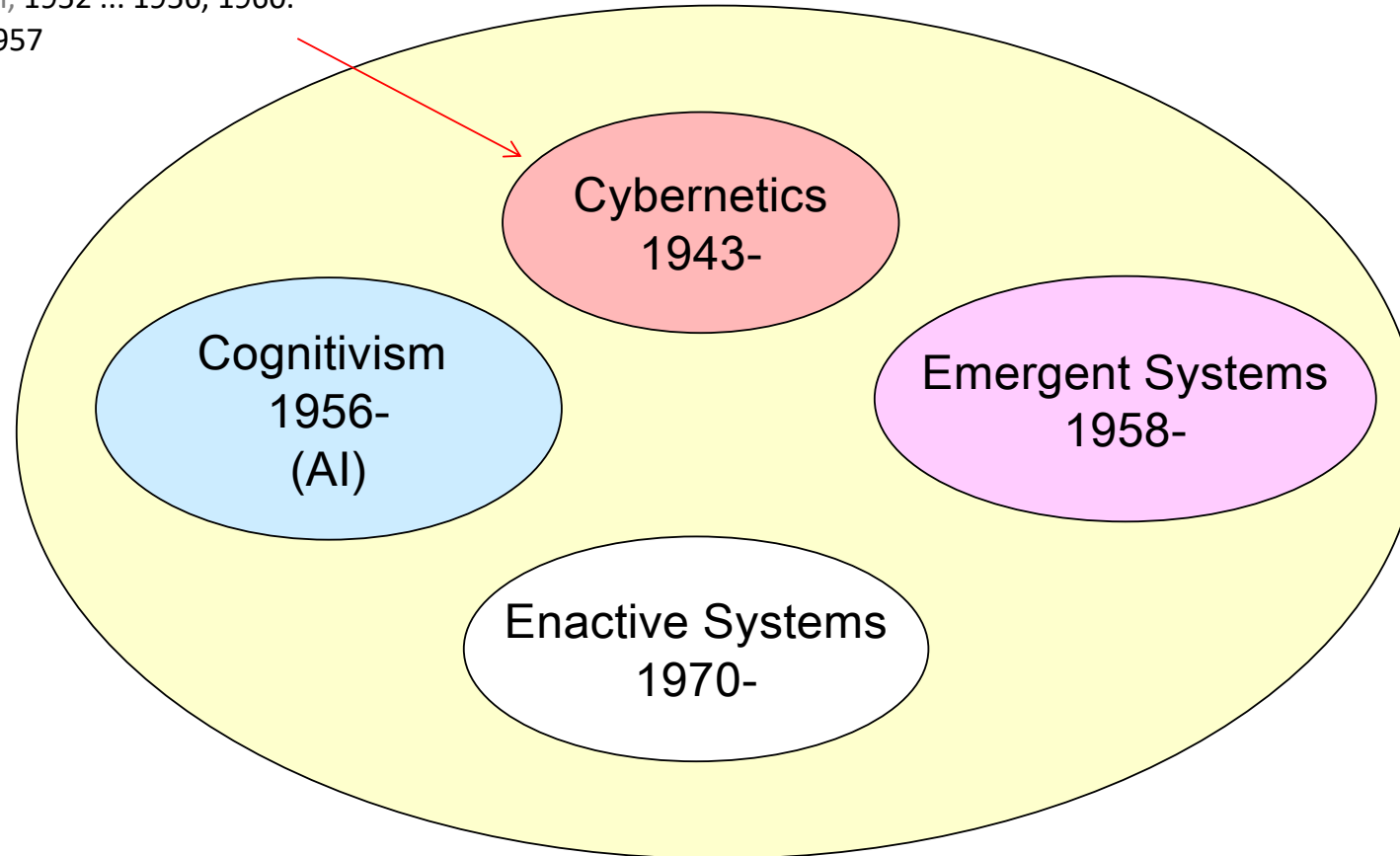
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Cognitive Science

W. R. Ashby.

Design for a Brain, first edition, 1952 ... 1956, 1960.

Introduction to Cybernetics, 1957

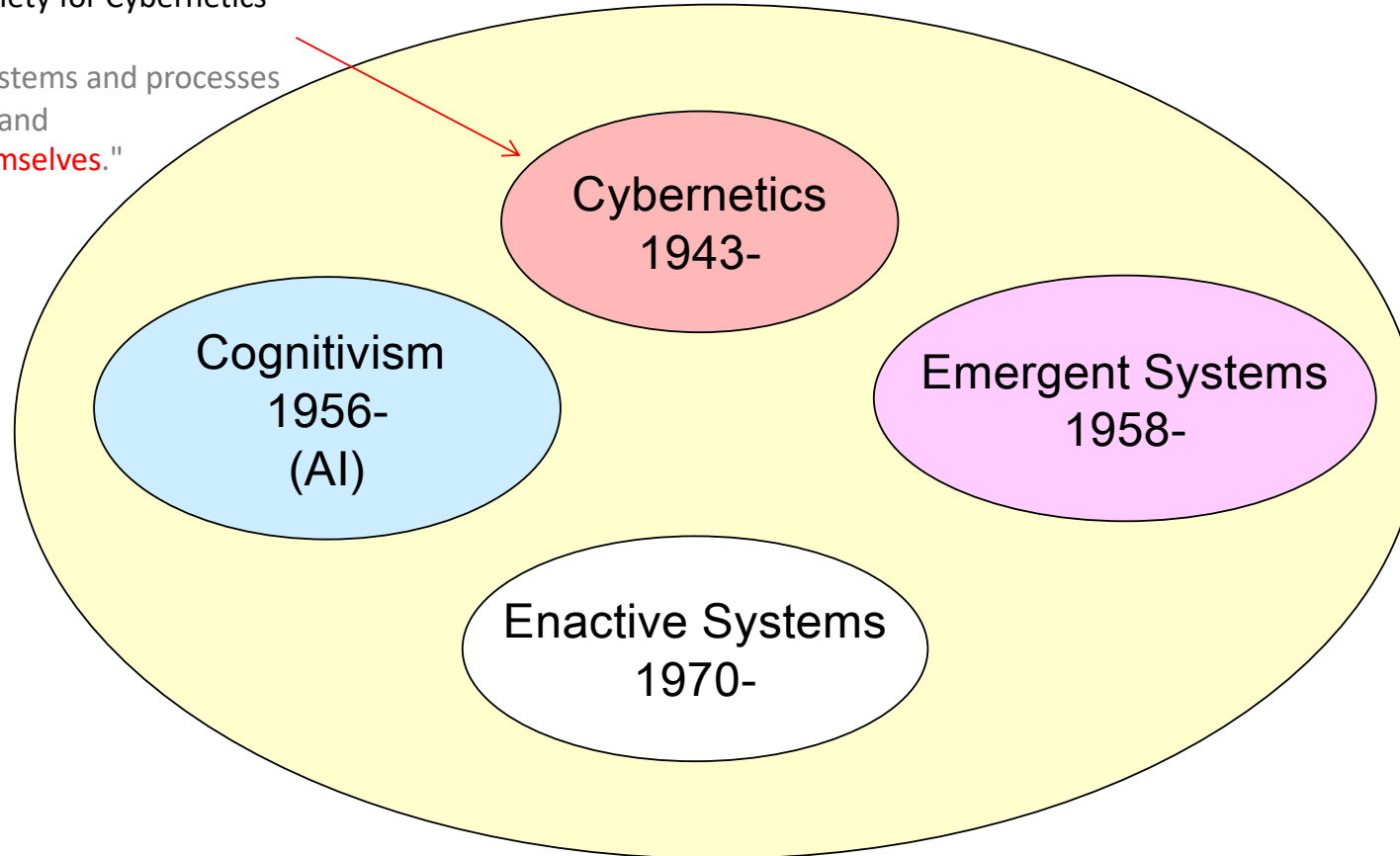


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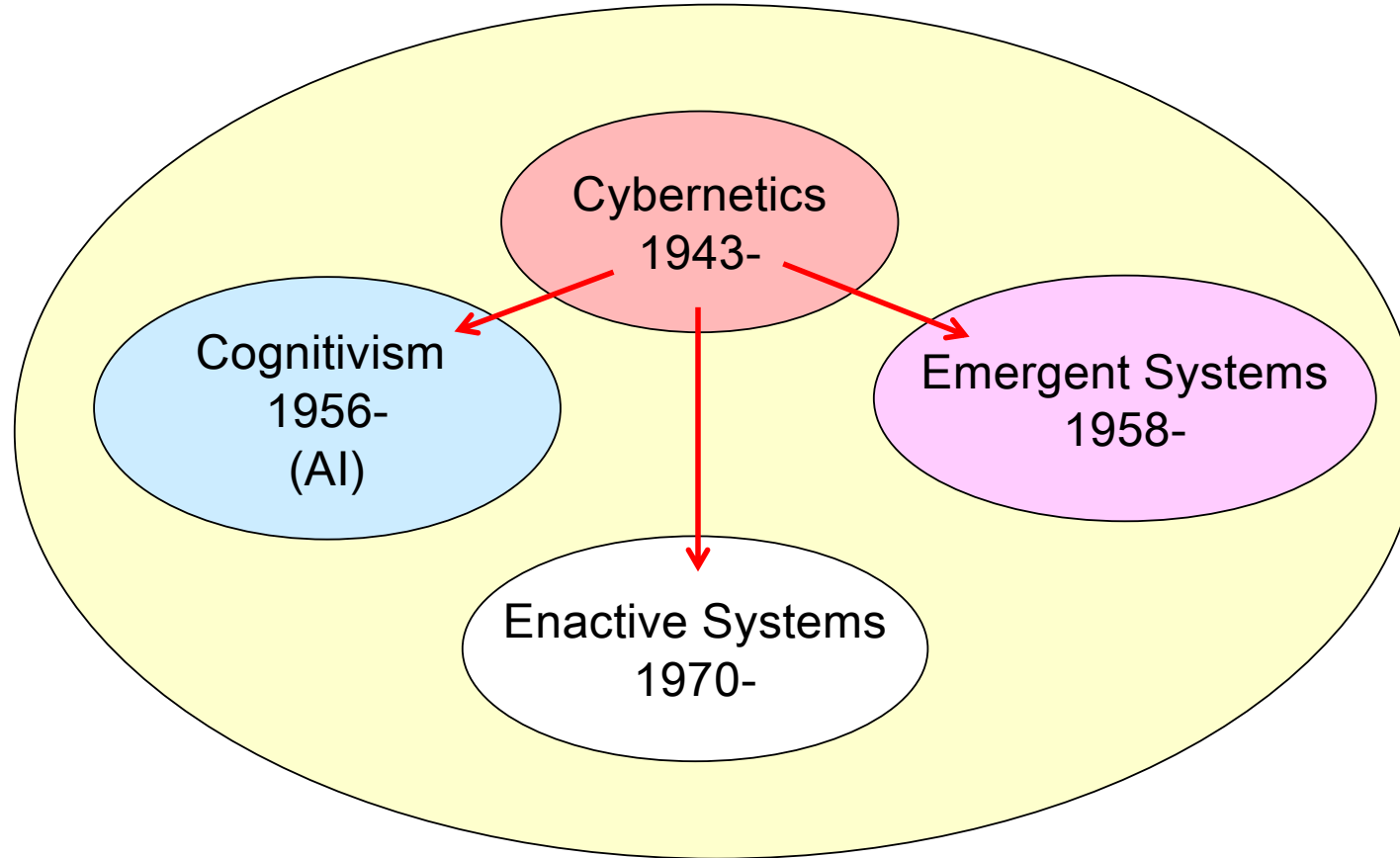
Louis Kauffman
President of the American Society for Cybernetics

"Cybernetics is the study of systems and processes that interact with themselves and **produce themselves from themselves.**"

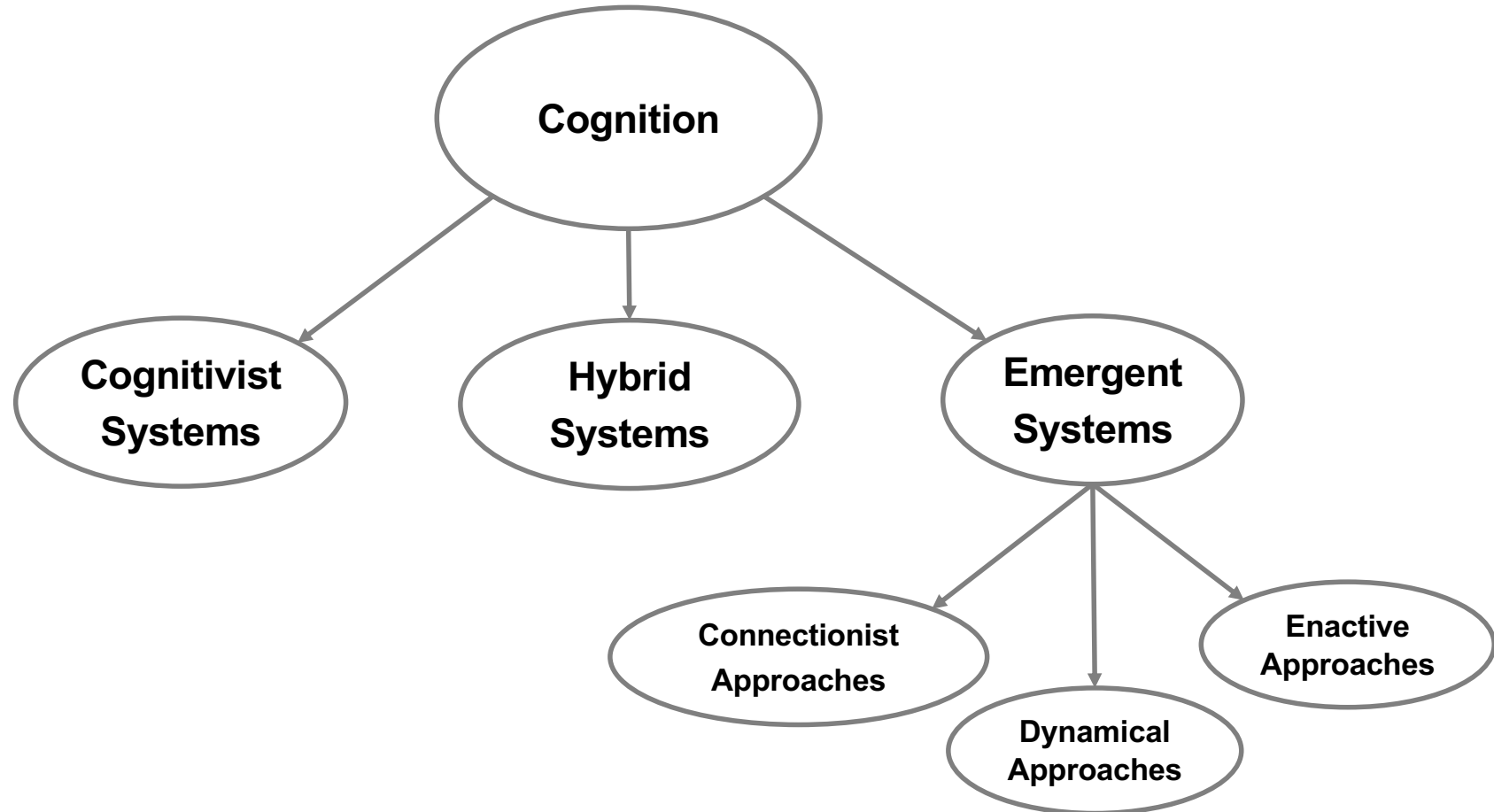


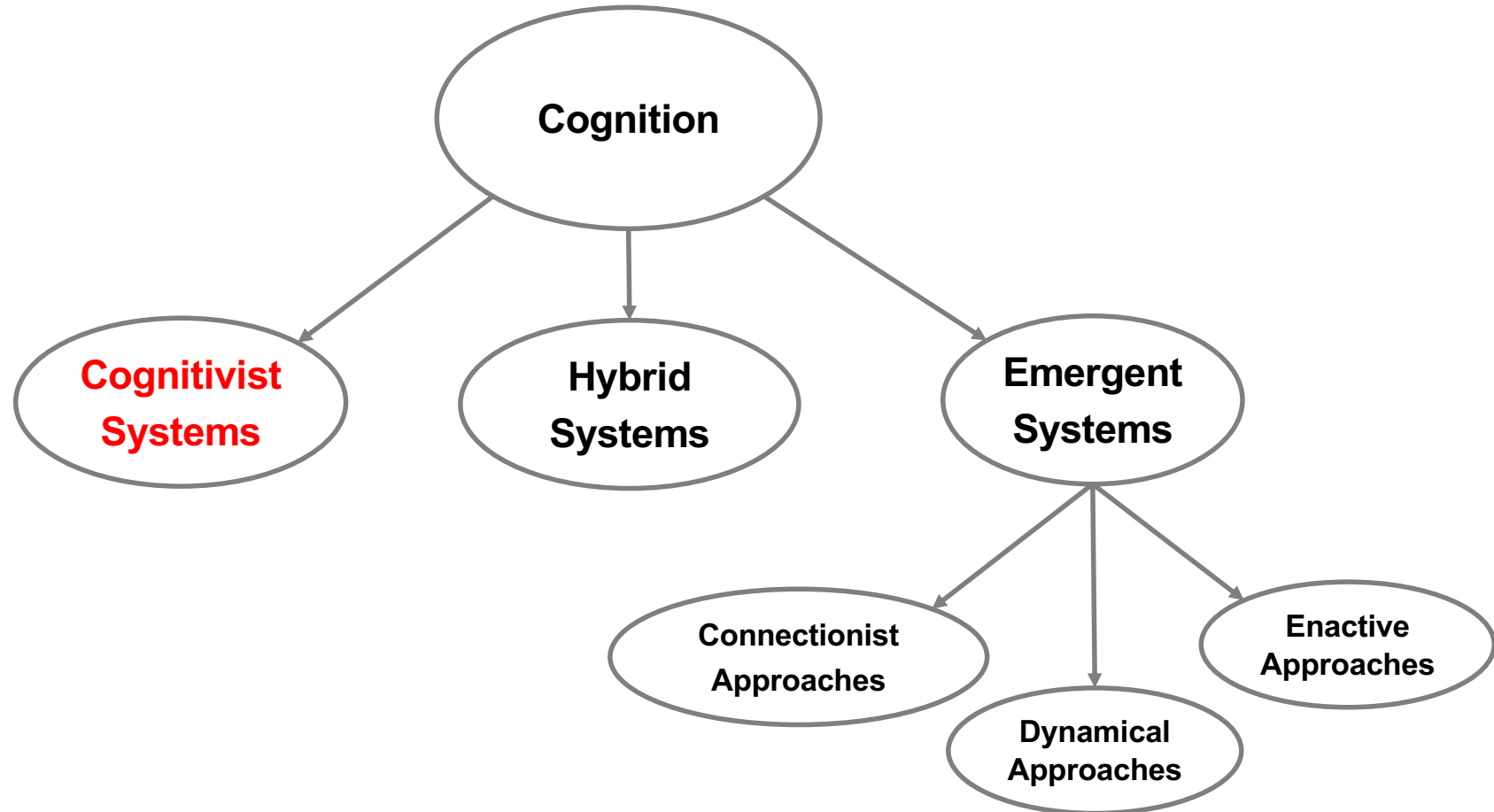
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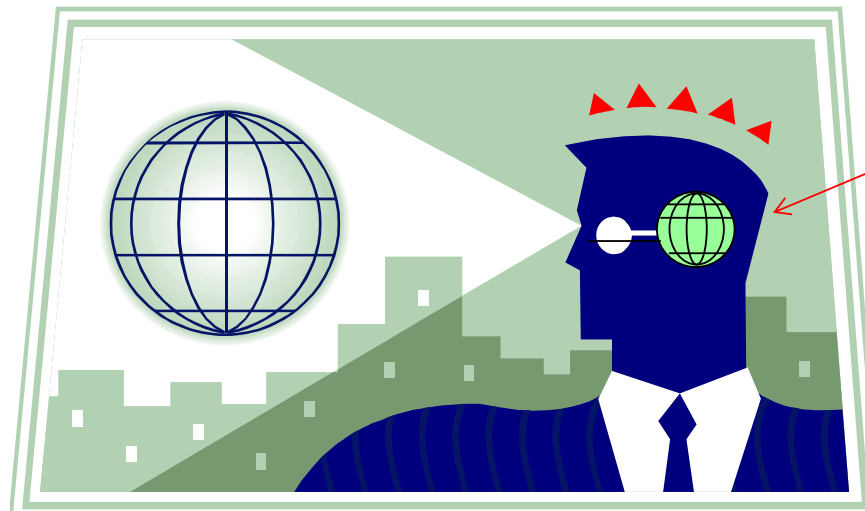
Cognitive Science



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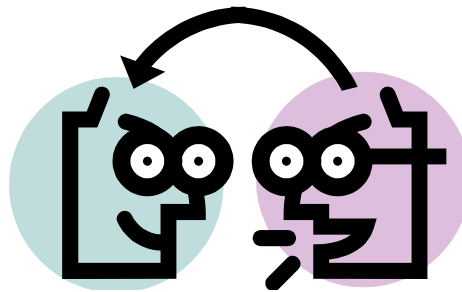
Explicit & symbolic

Representations denote external objects

Isomorphic with the world

Absolute and accessible ontology

That is consistent with human expression



Explicit & symbolic

Representations denote external objects

Isomorphic

Absolute and accessible ontology

That is consistent with human expression

Cognitivism & Artificial Intelligence

- Physical symbol system approach to AI
- Intelligence

- Principle of rationality

- ‘If an agent has knowledge that one of its actions will lead to one of its goals, then the agent will select that action’ (Newell 82)

- Rational analysis

- ‘The cognitive system optimizes the adaptation of the behaviour of the organism’ (Anderson 89)

Cognitivism & Artificial Intelligence

Physical Symbol Systems

[Newell and Simon 1976]

The Physical Symbol System Hypothesis

A physical symbol system has the necessary and sufficient means of general intelligence

Computer Science as Empirical Inquiry: Symbols and Search

Allen Newell and Herbert A. Simon



Computer science is the study of the phenomena surrounding computers. The founders of this society understood this very well when they called themselves the Association for Computing Machinery. The machine—not just the hardware, but the programmed, living machine—is the organism we study.

This is the tenth Turing Lecture. The nine persons who preceded us on this platform have presented nine different views of computer science. For our organism, the machine, can be studied at many levels and from many sides. We are deeply honored to appear here today and to present yet another view, the one that has permeated the scientific work for which we have been

Key Words and Phrases: symbols, search, science, computer science, empirical, Turing, artificial intelligence, intelligence, list processing, cognition, heuristics, problem solving.

CR Categories: 1.0, 2.1, 3.3, 3.6, 5.7.

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The authors' research over the years has been supported in part by the Advanced Research Projects Agency of the Department of Defense (monitored by the Air Force Office of Scientific Research) and in part by the National Institutes of Mental Health.

Authors' address: Carnegie-Mellon University, Pittsburgh.

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Cognitivism & Artificial Intelligence

Physical Symbol Systems

[Newell and Simon 1976]

The Heuristic Search Hypothesis

The task of intelligence is to avert the ever-present threat of the exponential explosion of search

Computer Science as Empirical Inquiry: Symbols and Search

Allen Newell and Herbert A. Simon



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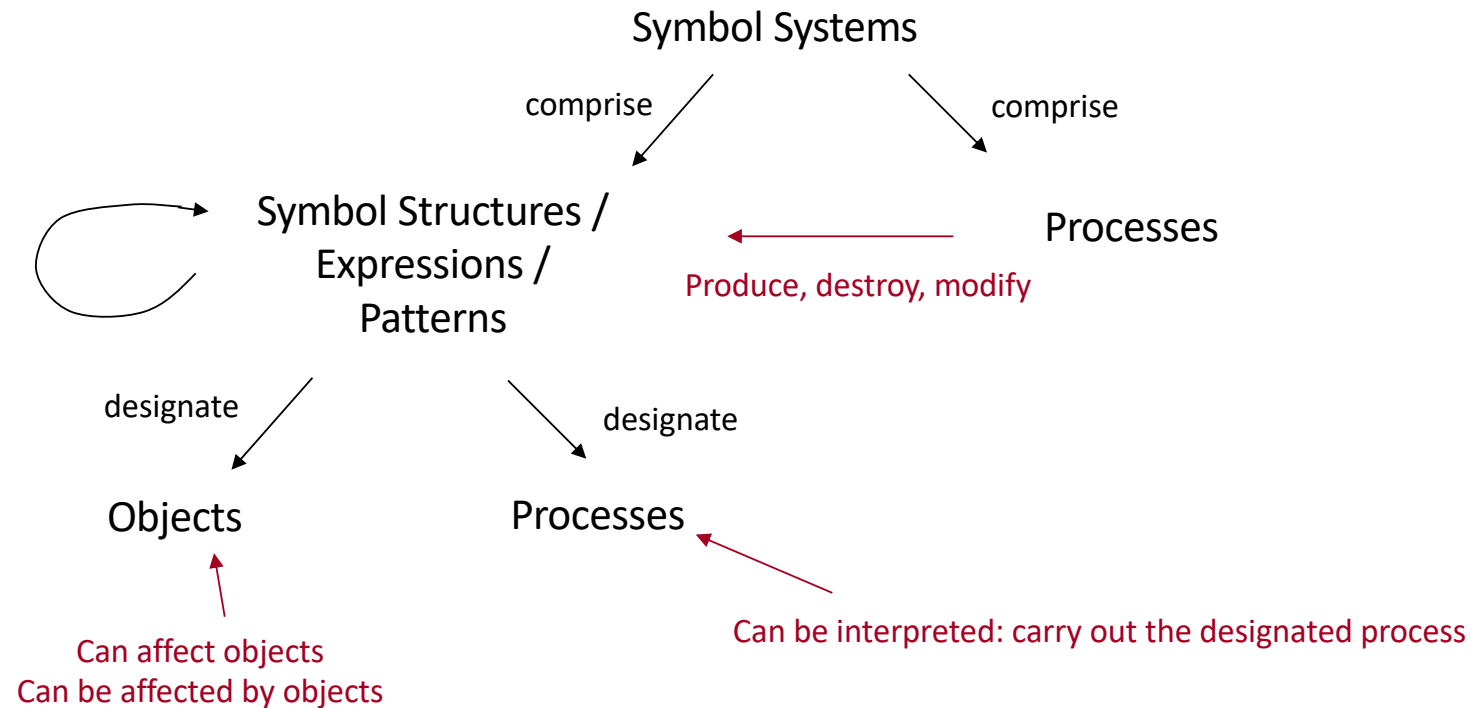
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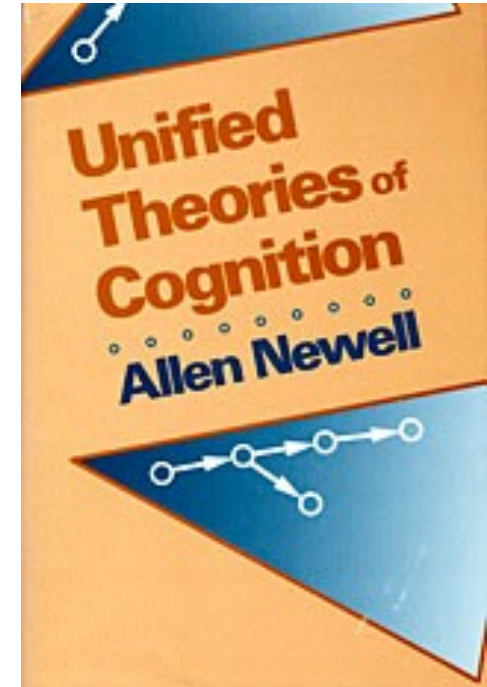
[Newell and Simon 1976]



Cognitivism & Artificial Intelligence

Unified Theories of Cognition

- Attempts to explain all the mechanisms of all problems in its domain
- Applies to both natural and artificial cognition



Recommended Reading

D. Vernon (2014). Artificial Cognitive Systems, MIT Press; Chapter 2.

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Langley, P. (2005). An adaptive architecture for physical agents. In *IEEE/WIC/ACM International Conference on Intelligent Agent Technology*, Compiegne, France, pp. 18–25. IEEE Computer Society Press.

Langley, P. (2006). Cognitive architectures and general intelligent systems. *AI Magazine* 27(2), 33–44.

Langley, P., J. E. Laird, and S. Rogers (2009). Cognitive architectures: Research issues and challenges. *Cognitive Systems Research* 10 (2), 141–160.

Lehman, J. F., J. E. Laird, and P. S. Rosenbloom (1998). A gentle introduction to soar, an architecture for human cognition. In S. Sternberg and D. Scarborough (Eds.), *Invitation to Cognitive Science, Volume 4: Methods, Models, and Conceptual Issues*. Cambridge, MA: MIT Press.

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