Script: Power of the Mass

Animals = Humans = Machines?

Comparison (Ant colony / Human neural network / WWW):

- By element
- In mass
- In isolation

The complex system

Observations from the comparison:

- differ in principles and mechanisms
- converge on their overall structure
- all these systems exhibit behavior that has been described as "adaptive," "life-like," "intelligent," and "emergent (self-organizing)"

Definition:

- large numbers of interacting components, in which the components are relatively simple compared with the system as a whole
- no central control or global communication among the components; thus all these systems produce and use information and signals from both their internal and external environments
- through interactions there appear higher capability/intelligence, including sophisticated information processing and adaptation via learning or evolution

Reductionism & scientific inquiries

Let's talk about a basic theory that utilizes the idea of complex system and helps us understand the world since a long time ago, an approach by which we find patterns and devise equations to analyze the world - Controlled experiments.

By applying the "all other things equal" principle, we introduce a doctrine of reductionism.

Reductionism has been the dominant approach to science since the 1600s. René Descartes, one of reductionism's earliest proponents, described his own scientific method thus: "to divide all the difficulties under examination into as many parts as possible, and as many as were required to solve them in the best way" and "to conduct my thoughts in a given order, beginning with the simplest and most easily understood objects, and gradually ascending, as it were step by step, to the knowledge of the most complex."

Physicist Albert Michelson, who proclaimed in 1894 that "it seems probable that most of the grand underlying principles have been firmly established and that further advances are to be sought chiefly in the rigorous application of these principles to all phenomena which come under our notice."

Examples that apply reductionism:

- components of a vector
- various economic models, e.g. Production Possibility Frontier, that generally assume "all other things equal"
- chemists who endeavored to decrease the scale of their research in order to focus on more basic particles
- biologists who divided organisms from kingdoms into species, and observe closely to different organ systems at the cellular level

By observing simple rules, we analyze the dynamics of larger systems, solve our problems, and make our predictions.

Machine applications of the complex system

There are also times that life and evolution can be mimicked in computers, and conversely the notion of computation itself is imported to explain the behavior of natural systems.

- Braitenberg vehicles – complex behavior perfectly mimicking insects
- Markov chain – ignores grammatical principles, but only analyzes the frequency of one word beside another word statistically; a language Braintenberg vehicle that only follows tendency but overthrow the entire reasoning part behind its strategy
- Artificial neural networks - produces results based on trials

Further discussion

Gunkel's agent-patient question on machine morality

Raised in his book The Machine Question.

Here agent is the entity that will be held responsible for decisions and actions, and patient is the victim of the agent's whatever decision or action.

This question arises when the man-made machines can, to some extent, exhibit animal or even human behaviors through the "complex", while they don't actually have consciousness.

Unpredictable situations in dynamic systems theory

Raised by Melanie Mitchell in the book Complexity.

- There can be uncertain and changing behavior at the macroscopic level, **producing chaos**, e.g., relativity and quantum mechanics
- Seemingly random behavior can emerge from deterministic systems with no external source of randomness
- The behavior of some simple, deterministic systems can be **impossible to predict** even in principle in the long term, due to sensitive dependence on initial conditions
- Although the detailed behavior of a chaotic system cannot be predicted, there is some **“order” in chaos** seen in universal properties

The antireductionist catch-phrase, “the whole is more than the sum of its parts,” takes on increasing significance as new sciences move beyond reductionism to explain how complex behavior can arise from large collections of simpler component.

References

Gunkel, David J. *The Machine Question: Critical Perspectives on AI, Robots, and Ethics*. MIT Press, 2012.

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Mitchell, Melanie. *Complexity: A Guided Tour*. Oxford University Press, 2009.