Power of the Mass

Yiyang Xu
Robota Psyche w/ Prof. Shiloh

The ants

Animals = Humans?

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	Ant colony	Human neural network
By element	A weak, blind, unintelligent ant	(Mostly) a differentiated single-functioning cell
In mass	A coherent swarm that kills, devours, and builds nests	A system with higher cognitive functions
In isolation	Immune and stress genes downregulated	Less frequently activated neurons die off

Animals = Humans = Machines?

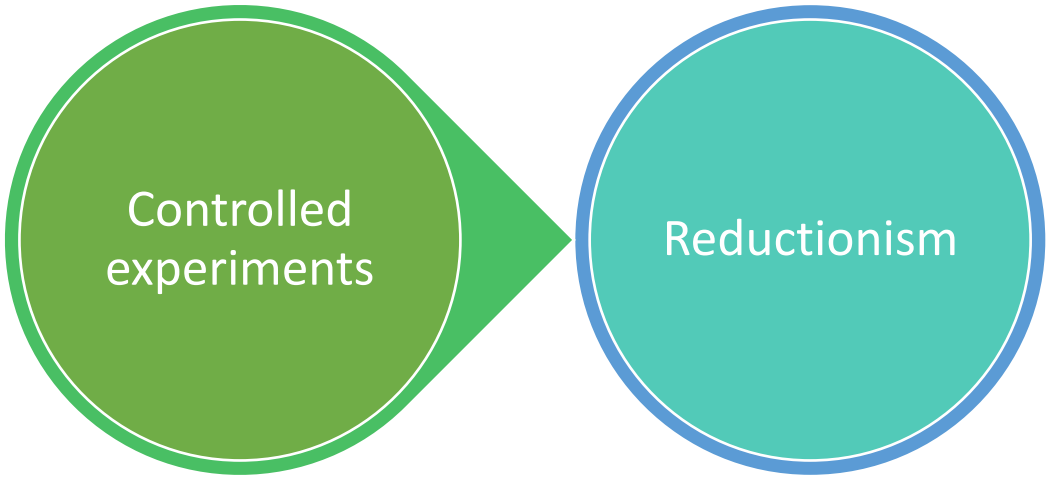
	Ant colony	Human neural network	World Wide Web
By element	A weak, blind, unintelligent ant	(Mostly) a differentiated single-functioning cell	An incommunicable point of no use
In mass	A coherent swarm that kills, devours, and builds nests	A system with higher cognitive functions	A massive and complicated system of millions of devices
In isolation	Immune and stress genes downregulated	Less frequently activated neurons die off	Inability to access information around the globe

The complex system

Large networks of components, each functioning at a relatively minimal capacity

No commander, thus individuals can both produce and use signals from internal and external environments

Interactions give rise to complex collective behavior


Controlled experiments
Reductionism

Reductionism & scientific inquiries

- “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”
- “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.”

Machine applications of the complex system

Braitenberg vehicles – complex behavior perfectly mimicking insects

Markov chain – ignores grammatical principles, but only analyzes the frequency of one word beside another word statistically

Artificial neural networks – produces results based on trials

Further discussion: Gunkel's agent-patient question on machine morality

- Whether and to what extent machines of various designs and functions might be considered a legitimate **moral agent** that could be held responsible and accountable for decisions and actions?

- Whether machines are capable of occupying the position of a **moral patient** “who” has a legitimate claim to certain rights that would need to be respected and taken into account?

Further discussion: unpredictable situations in dynamic systems theory

- There can be **internal changing behavior** at the macroscopic level, producing chaos, e.g., relativity and quantum mechanics
- 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

Thanks

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. - Melanie Mitchell

References listed in the script.