

## CS 356 - Artificial Intelligence

### Philosophical Notes

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## Aristotle

Work in logic by the Greek philosopher was driven by the idea that the study of thought was the basis of all knowledge.

His *Logic* described how to relate true statements, or *assertions*, using logical inference. He was able to prove syllogisms such as:

- All men are mortal
- Socrates is a man
- Therefore, Socrates is mortal

## The Copernican Revolution

Implicit in the change in worldviews driven by the work of Copernicus and Galileo (in overthrowing Ptolemy's cosmology) is the notion that *ideas about the world are distinct from the world's appearance*.

Descartes later fully separates the mind from the physical world to the point where the only reality is thought.

## Cartesian Duality

We now have the mind/body or mind/world problem: what are the interactions between mental states and physical actions? If mental processes arise from a physical system, could they not come from a mechanical system as well?

From the other direction, Pascal and Leibniz built calculating machines, thereby automating thought processes considered to be uniquely human.

## Automating Deductive Thought

If mental processes such as arithmetic can be automated, why not formalize and mechanize thinking itself?

- Leibniz and Euler used graph theory to capture the structure of relationships in knowledge and in computational steps.
- Boole created a symbolic language of logic that we now call *Boolean Algebra*
- Frege formalized Aristotle's *Logic* using a mathematical specification language called *predicate calculus*

## Rationalism and Empiricism

From Descartes, we have the idea that knowledge can be obtained purely from thought (rationalism). From Hobbes, Locke, and Hume, we have the importance of repeated experience building up knowledge through *association* (empiricism).

AI systems influenced by rationalism tend toward making assertions about the problem domain along with rules for interacting with the domain.

AI systems influenced by empiricism tend to be oriented toward building associations through a process of machine learning.

## From David Hilbert to Alan Turing

At the turn of the century, the German mathematician Hilbert laid out a set of mathematical grand challenges for the 20th Century. As a continuation, in 1928 he posed three more, one of which - called the *Entscheidungsproblem* - asked if an algorithm existed which could automate mathematical proofs.

Hilbert's challenge produced many important results:

- Kurt Godel's Incompleteness Theorem
- Alonzo Church's Lambda Calculus (one basis of Lisp/Scheme)
- Alan Turing's Turing Machine and proofs of computability

## Turing and AI

Alan Turing is most famous in AI for devising the Turing Test for machine intelligence. Chiefly a test for determining if a machine can mimic human intelligence, the test works like this:

- Place an interrogator in contact (but not in view) of a person and a machine.
- The interrogator asks each 'contestant' anything question at all in order to determine which is human and which is machine.
- Communication is through what we would call a terminal.

## Critiquing the Turing Test

Turing's test is useful in several respects: it provides an objective rather than subjective notion of intelligence, eliminates any bias toward living organisms, and doesn't require that the machine be conscious of its actions.

But consider this question: *are you a computer?* Can machines lie? Is craftiness an aspect of human intelligence to be modeled?

Further, imagine we asked both subjects to compute  $69283 \times 239348$ . If the machine responds in less than 1 second, it's nailed!

## Herbert Simon and Nature

I particularly like Herbert Simon's take. A living thing such as an ant or bee may have very simple internal processes. The originality and variability of their actions may be due more to the complexity of their environment. Their goals are quite simple.

This idea leads to systems which model the structure of the biological structures (such as neural networks) and social structures (such as interacting agents) rather than the structure of thought.