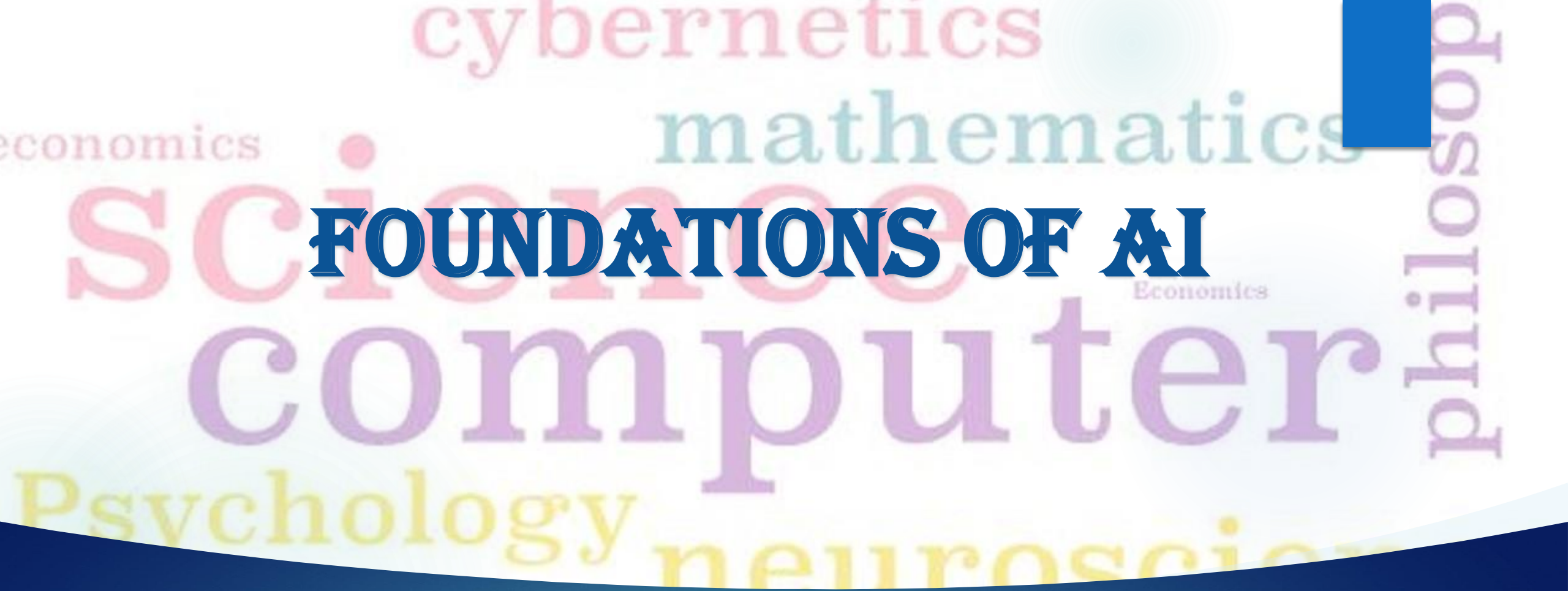

FOUNDATIONS OF AI

ARTIFICIAL INTELLIGENCE

The Foundation Of AI

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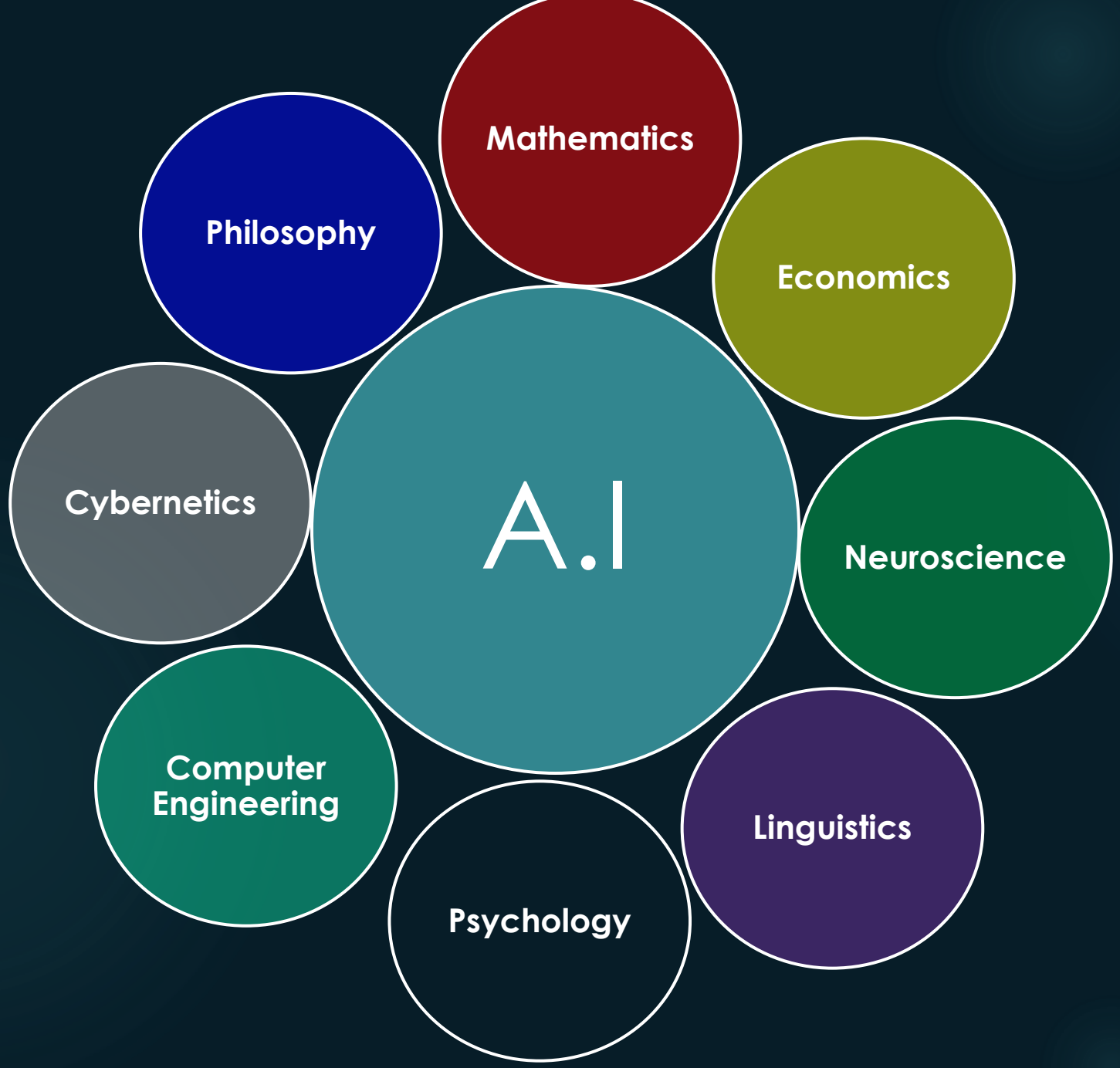


Philosophy

- Where does knowledge come from?
- How does knowledge lead to action?

- Aristotle (384–322 B.C.): was the first to formulate a precise set of laws governing the rational part of the mind.
- Thomas Hobbes (1588–1679) proposed that reasoning was like numerical computation, that “we add and subtract in our silent thoughts.”
- Rene Descartes(1596-1650): Developed dualistic theory of mind and matter. Descartes attempted to demonstrate the existence of god and the distinction between the human soul and body.

Philosophy

- The empiricism movement, starting with Francis Bacon's (1561– 1626).
- The confirmation theory of Carnap and Carl Hempel (1905–1997) attempted to analyze the acquisition of knowedge from experience.
- Carnap's book The Logical Structure of the World (1928) defined an explicit computational procedure for extracting knowledge from elementary experiences. It was probably the first theory of mind as a computational process.
- The final element in the philosophical picture of the mind is the connection between knowledge and action. This question is vital to AI because intelligence requires action as well as reasoning.

Mathematics

- What are the formal rules to draw valid conclusions?
- What can be computed?

- George Boole (1815–1864), who worked out the details of propositional, or Boolean, logic (Boole, 1847).
- In 1879, Gottlob Frege (1848–1925) extended Boole's logic to include objects and relations, creating the first order logic that is used today.
- The first nontrivial algorithm is thought to be Euclid's algorithm for computing greatest common divisors.
- Besides logic and computation, the third great contribution of mathematics to AI is the PROBABILITY theory of probability. The Italian Gerolamo Cardano (1501–1576) first framed the idea of probability, describing it in terms of the possible outcomes of gambling events.
- Thomas Bayes (1702–1761) proposed a rule for updating probabilities in the light of new evidence. Bayes' rule underlies most modern approaches to uncertain reasoning in AI systems.

Economics

- How should we make decisions to maximize payoff?
- How should we do this when the payoff may be far in the future?

- The science of economics got its start in 1776, Smith was the first to treat it as a science, using the idea that economies can be thought of as consisting of individual agents maximizing their own economic well-being.
- Decision theory, which combines probability theory with utility theory, provides a formal and complete framework for decisions (economic or otherwise) made under uncertainty.
- Von Neumann and Morgenstern's development of game theory included the surprising result that, for some games, a rational agent should adopt policies that are (or least appear to be) randomized. Unlike decision theory, game theory does not offer an unambiguous prescription for selecting actions.

Neuroscience

- How do brains process information?

- Neuroscience is the study of the nervous system, particularly the brain.
- 335 B.C. Aristotle wrote, “Of all the animals, man has the largest brain in proportion to his size.”
- Nicolas Rashevsky (1936, 1938) was the first to apply mathematical models to the study of the nervous system.
- The measurement of intact brain activity began in 1929 with the invention by Hans Berger of the electroencephalograph (EEG).
- The recent development of functional magnetic resonance imaging (fMRI) (Ogawa et al., 1990; Cabeza and Nyberg, 2001) is giving neuroscientists unprecedentedly detailed images of brain activity, enabling measurements that correspond in interesting ways to ongoing cognitive processes.

Psychology

- How do humans and animals think and act?

- Behaviorism movement, led by John Watson(1878-1958). Behaviorists insisted on studying only objective measures of the percepts(stimulus) given to an animal and its resulting actions(or response). Behaviorism discovered a lot about rats and pigeons but had less success at understanding human.
- Cognitive psychology , views the brain as an information processing device.
- Common view among psychologist that a cognitive theory should be like a computer program.(Anderson 1980) i.e. It should describe a detailed information processing mechanism whereby some cognitive function might be implemented.

Computer Engineering

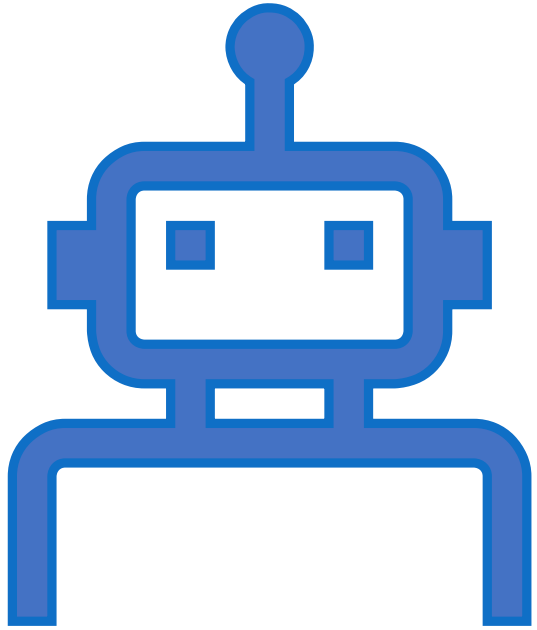
- How can we build an efficient computer?

- The first operational computer was the electromechanical Heath Robinson,8 built in 1940 by Alan Turing's team for a single purpose: deciphering German messages.
- The first operational programmable computer was the Z-3, the invention of Konrad Zuse in Germany in 1941.
- The first electronic computer, the ABC, was assembled by John Atanasoff and his student Clifford Berry between 1940 and 1942 at Iowa State University.
- The first programmable machine was a loom, devised in 1805 by Joseph Marie Jacquard (1752–1834), that used punched cards to store instructions for the pattern to be woven.

Control theory and cybernetics

- How can artifacts operate under their own control?

- Ktesibios of Alexandria (c. 250 B.C.) built the first self-controlling machine: a water clock with a regulator that maintained a constant flow rate. This invention changed the definition of what an artifact could do.
- Modern control theory, especially the branch known as stochastic optimal control, has as its goal the design of systems that maximize an objective function over time. This roughly matches our view of AI: designing systems that behave optimally.



Linguistic

- How does language relate to thought?

- In 1957, B. F. Skinner published Verbal Behavior. This was a comprehensive, detailed account of the behaviorist approach to language learning, written by the foremost expert in the field.
- Noam Chomsky, who had just published a book on his own theory, Syntactic Structures. Chomsky pointed out that the behaviorist theory did not address the notion of creativity in language.
- Modern linguistics and AI, then, were “born” at about the same time, and grew up together, intersecting in a hybrid field called computational linguistics or natural language processing.