Taxonomy of AI

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Lecture objectives

- By the end of the lecture, students should be able to:
  - ✓Explain the basic taxonomy of AI
  - ✓Describe the concept of learning in relation to AI.
  - ✓Explain why machines need learning
  - ✓Discuss the various types of learning
  - ✓Explain the classification of AI learning techniques

Core components of AI

- The field of AI involves three core components:
  - ✓Learning – knowledge acquisition through experience, or through being taught.
  - ✓Discovery – finding through a search.
  - ✓Reasoning – causing, explaining or justifying.

What is learning

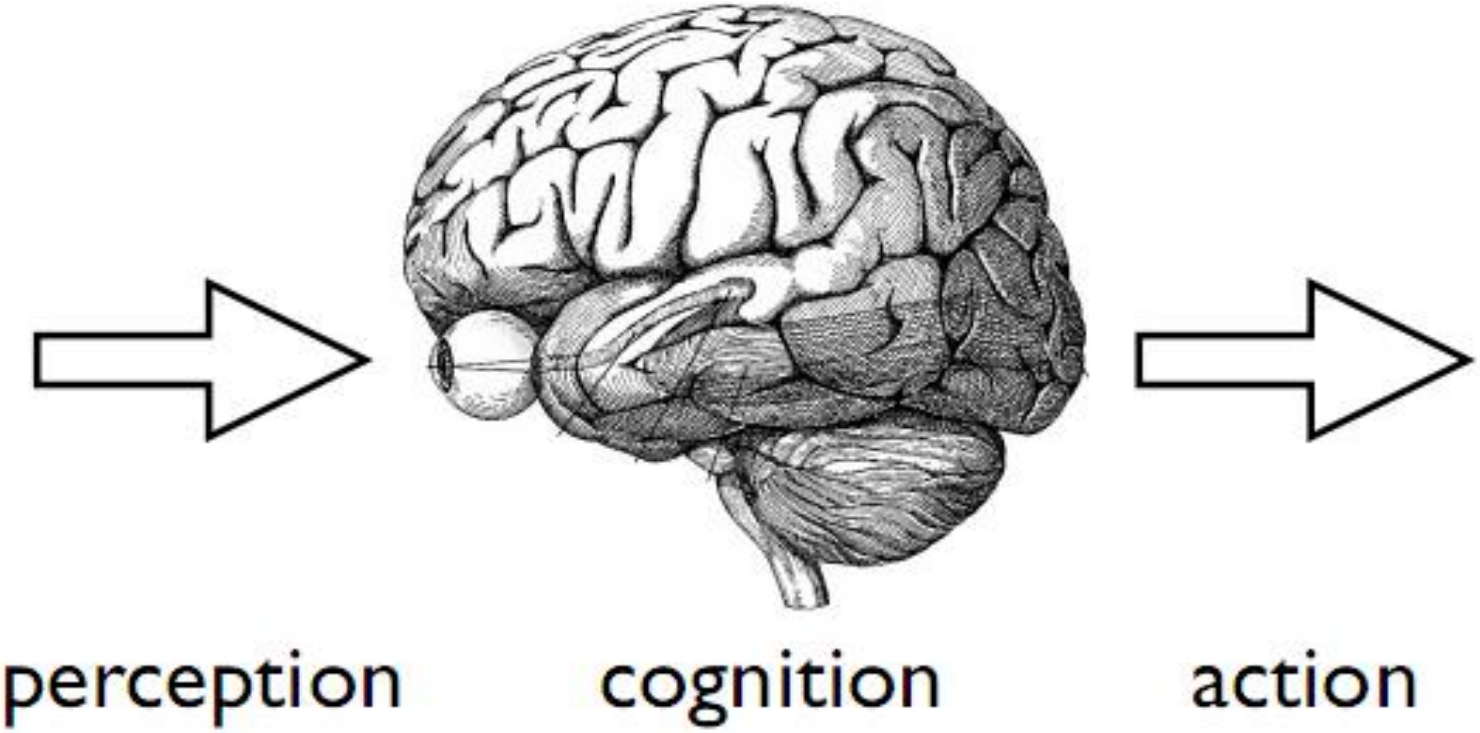
- Learning refers to the modification in a system in an adaptive sense that can enable the system to do the same task or tasks drawing from the same population more efficiently and more effectively the next time.
- Learning automatically generates strategies to classify future inputs based on the attained training.
  - ➢ It does not necessarily depend on complete information about the environment
- It is, thus, concerned with an environment

“A computer program is said to learn from experience E with respect to some class of tasks T and performance P if its performance at tasks in T, as measured by P, improves with experience E.”

Tom M. Mitchell, 1997
(Professor, Carnegie Mellon University)

AI learning

- AI learning uses sequences of percepts to estimate the missing details



Brains vs Computers

Brains (Adult cortex)

- Surface area: 2500cm^2
- It is squishy
- Neurons: 20billion
- Synapses: 240trillion
- Neuron size: 15µm
- Synapse size: 1µm
- Synaptic OPS: 30trillion

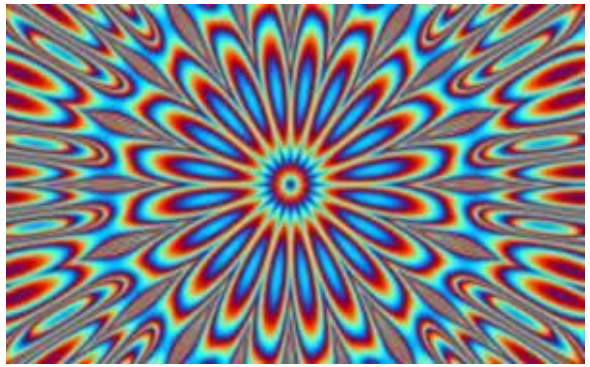
Computers (Intel Core 2)

- Surface area: 90mm^2
- It is crystalline
- Transistors: 291 million
- Transistor size: 65nm
- Flops: 25billion

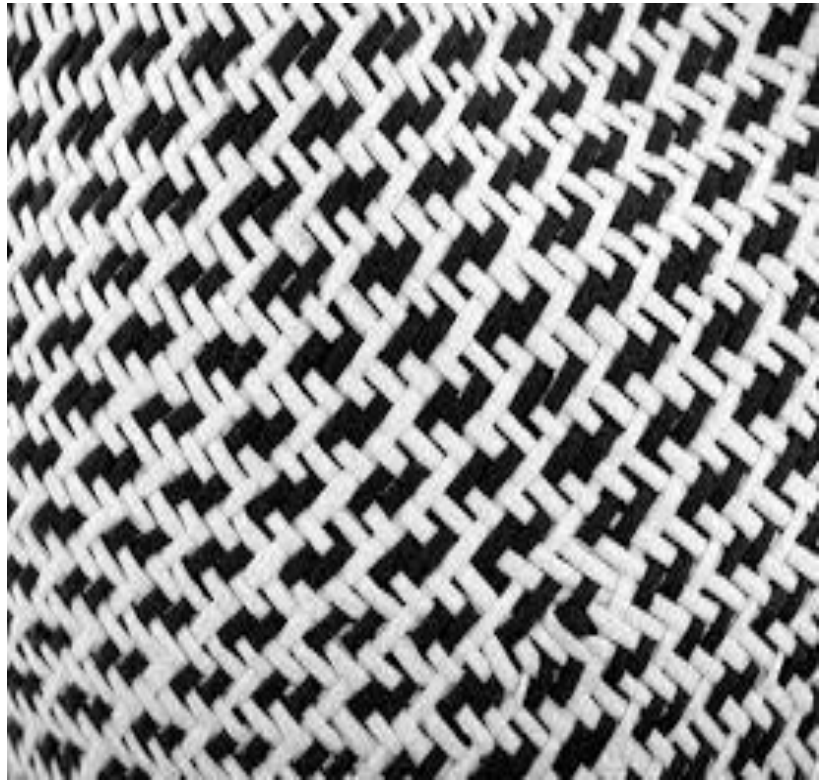
Humans vs computers

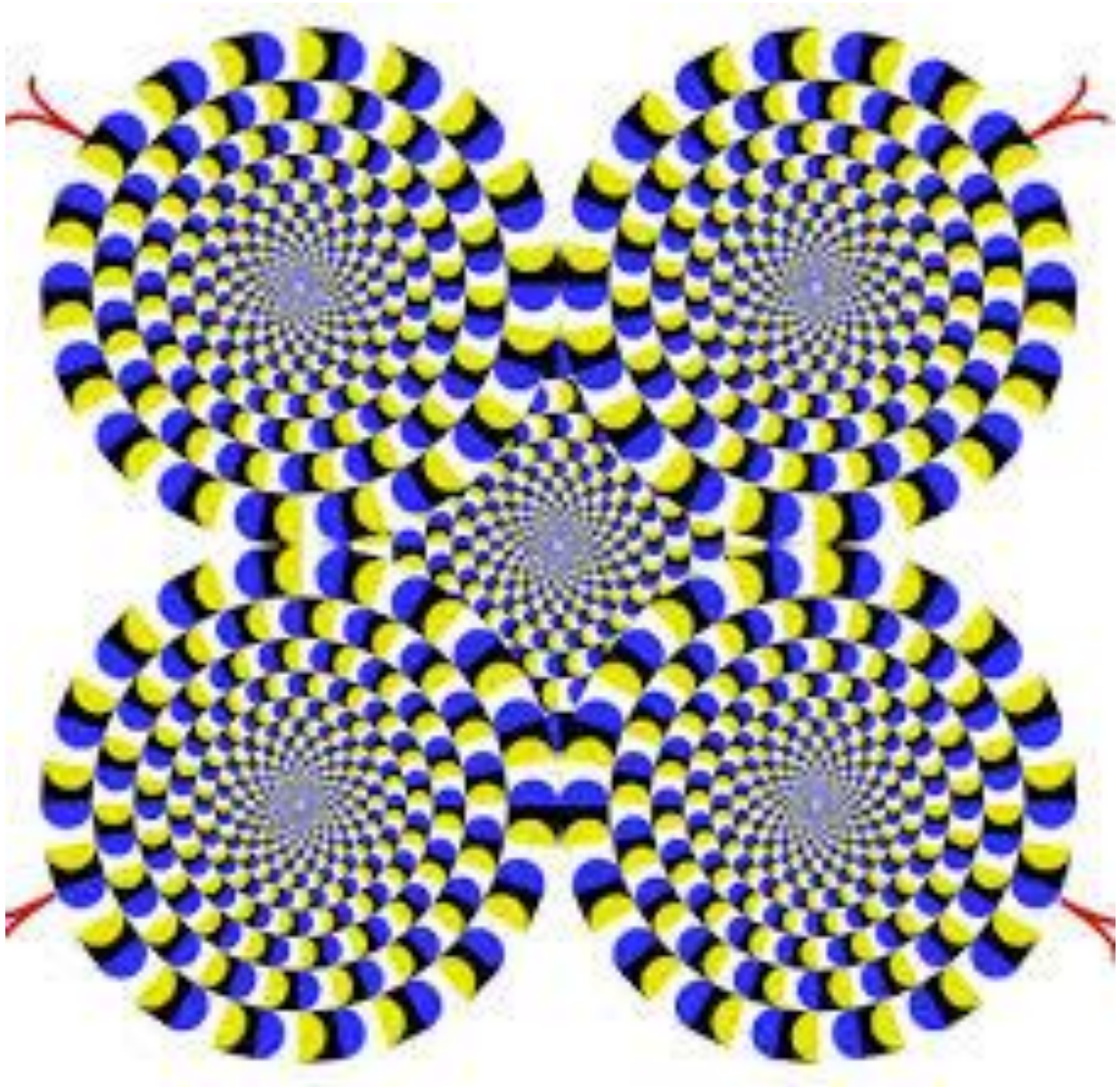
Difference between human and machine intelligence

- Humans perceive by patterns whereas the machines perceive by set of rules and data.
- Humans store and recall information by patterns, machines do it by searching algorithms.
- Humans can figure out the complete object even if some part of it is missing or distorted; whereas the machines cannot do it correctly.



What is the pattern here?





Dependencies of AI learning

- Learning depends on:
  - ✓Reasoning
    - Is the calculative capability to solve problems
  - ✓Knowledge
    - Is the ability to represent and understand an environment (a world)
  - ✓Planning
    - Is the capability of setting up strategies to achieving goals
  - ✓Communication
    - Is the ability to understand inputs and communicate the output.
  - ✓Perception
    - Is the ability to transform raw sensorial inputs (e.g., images, sounds, etc.) into usable information.

Important questions in AI learning

- ✓ How do we generate new facts from old ?
- ✓ How do we generate new concepts ?
- ✓ How do we learn to distinguish different situations in new environments?

- AI learning is usually a hard task for programmers in terms of articulating the knowledge needed to the build AI systems
  - ➢ E.g. recognizing visual input like various types of flowers

Classification of AI learning

- AI Learning is categorized as –
- **Auditory Learning** – is learning by listening and hearing.
  - E.g. Through listening to audio output.
- **Episodic Learning** – is learning by remembering sequences of events that one has witnessed or experienced.
  - This is linear and orderly.
- **Motor Learning** – is learning by precise movement of muscles.
  - E.g. Picking objects, Writing, etc.
- **Observational Learning** – is learning by watching and imitating others.
  - For example: Through mimicking another object.

Classification of AI learning…

- **Perceptual Learning** – is learning to recognize stimuli that one has seen before.
  - Eg. Identifying and classifying objects and situations.
- **Relational Learning** – involves learning to differentiate among various stimuli on the basis of relational properties, rather than absolute properties.
  - Eg. Adding ‘little/less’ salt at the time of cooking potatoes that came up more salty last time.

Classification of AI learning…

- **Spatial Learning** – is learning through visual stimuli such as images, colors, maps, etc.
  - E.g. Create roadmap in the mind before actually following the road.
- **Stimulus-Response Learning** – is learning to perform a particular behavior when a certain stimulus is present.
  - For example, a robot raises its ear on hearing doorbell.

Core segmentation of AI by learning approach

- Based on learning ability, AI can be subdivided into symbolic AI and statistical learning
  - ✓**Symbolic** AI approach – emphasizes how human intelligence can be reduced to symbol manipulation
  - ✓**Statistical** AI approach – is based on mathematical tools to solve specific problems.

Symbolic AI approach

- **Symbolic** AI approach involves algebraic manipulation of historical knowledge in order to answer a new question.
  - Symbolic AI involves a searching process.
  - A subset of symbolic AI is **Sub-symbolic AI**.
- Symbolic AI is concerned with describing and manipulating our knowledge of the world as explicit symbols.
  - It is where these symbols have clear relationships to entities in the real world.
- Sub-symbolic AI is concerned with specific representations of knowledge based on forecasting results rather than the actual results.
  - The choice of **sub**-symbolic approach is used to make mathematical problems account for only a small part of the population.

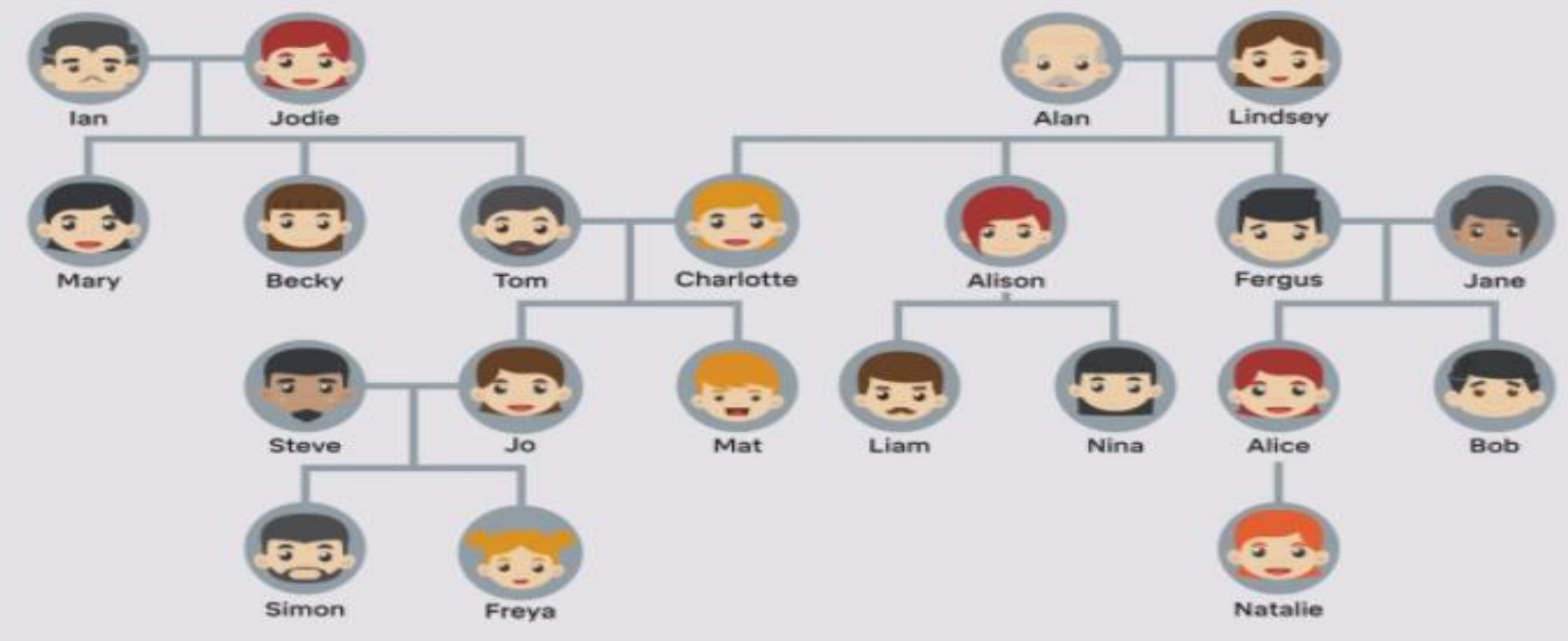
Symbolic AI approach

- Symbolic AI is based on high-level human-readable ("symbolic") representations of problems, logic and search.
  - ➢ The first implementations of AI was based on symbolic approach.
  - ➢ Unlike current techniques to AI, symbolic AI was intended to produce general human-like machine intelligence.
    - ○ Current techniques are diverse, beyond human intelligence.
  - ➢ Symbolic AI represents a concept, rather than a value.
- Before John Haugeland named it ”Good Old-Fashioned Artificial Intelligence” (GOFAI) in 1985, it had been the dominant approach from the 1950s.
  - ➢ In reference particularly to robotics, GOFAI is also terms as “Good Old-Fashioned Robotics” (GOFR).

Features in symbolic approach to AI

- It requires a knowledge base
  - Relational, non-relational or graph database.
- It requires a collection of symbolic facts, rules and relationships.
- It requires an inference engine, that takes a question or query and generates an answer by using the set of rules and the knowledge-base.

Knowledge graph of a family tree



- The question is: Who is the maternal uncle of Freya?

Symbolic clauses about the family tree

- father(X,Z), father(Z,Y) ⟹ grandfather(X,Y)
- mother(X,Z), father(Z,Y) ⟹ paternalgrandmother(X,Y)
- father(X,Z), mother(Z,Y) ⟹ grandfather(X,Y)
- maternalgrandfather(X,Z), mother(Z,P), son(P,Y) ⟹ ?

Answer:

- maternalgrandfather(X,Z), mother(Z,P), son(P,Y) ⟹ grandfatherinlaw(X,Y)

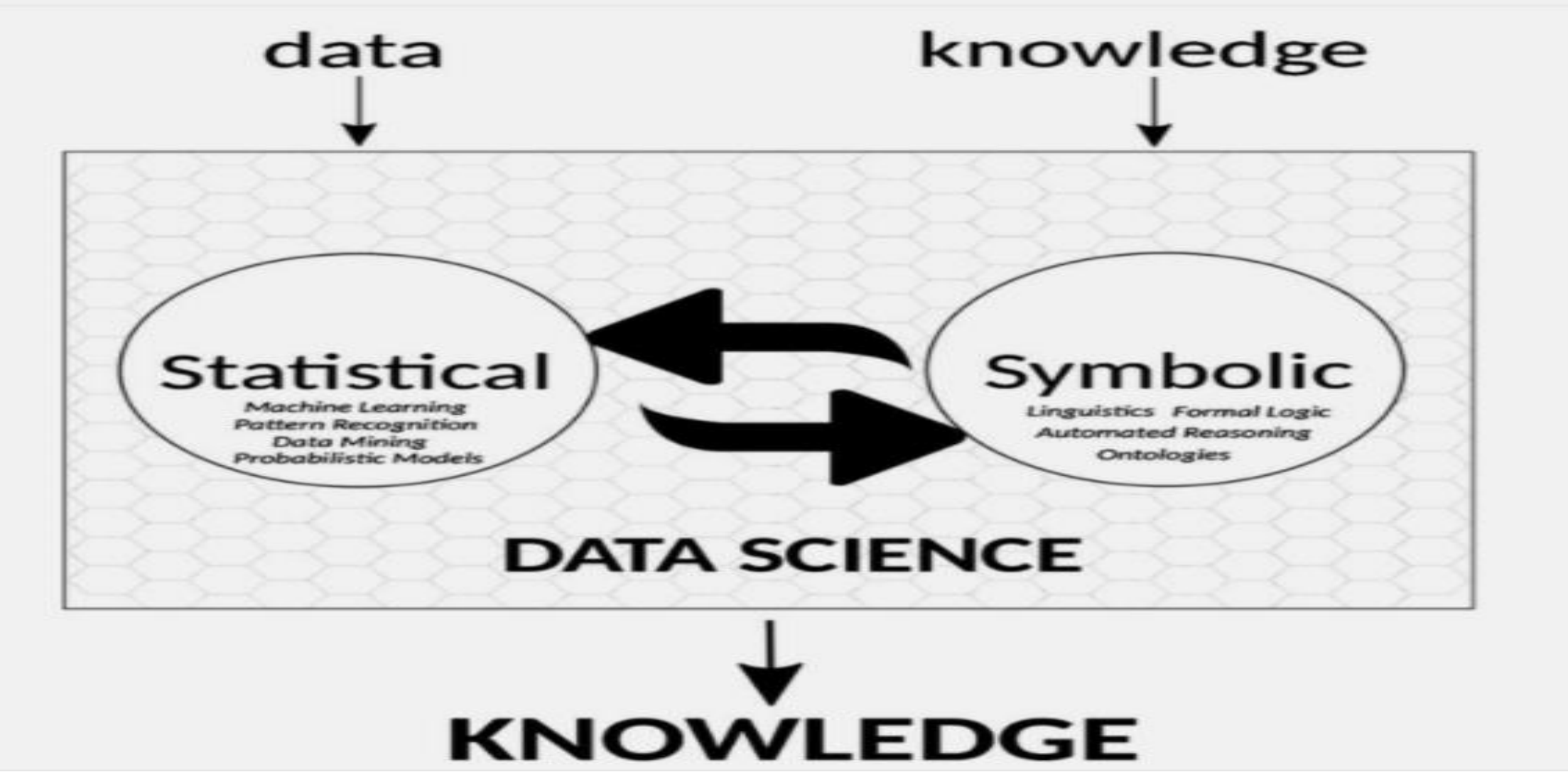
Branches of Symbolic AI

- Symbolic Computation has two branches
  - ✓Heuristic search
    - oE.g. ranking alternatives
  - ✓Knowledge-based search
    - oE.g. by search engines

Statistical approach

- Is where machines learn from historical data to make inference and prediction about future occurrences of similar objects.
  - ➢Statistical approach is also referred to as machine learning
- Machine learning is the approach that is currently eminent among artificial intelligence practitioners and researchers.

Core segmentation of AI by learning approach



Thank you