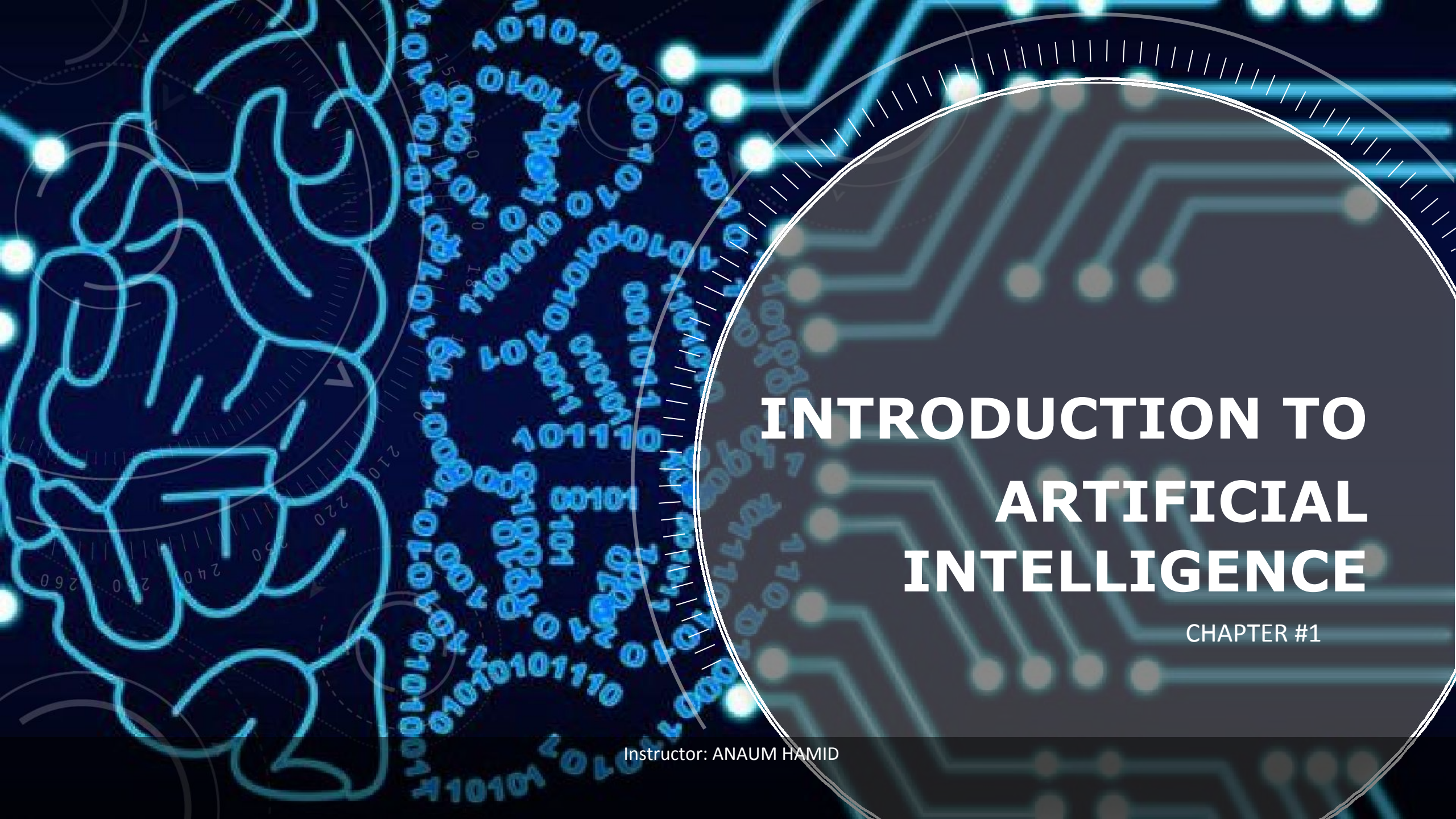


INTRODUCTION TO ARTIFICIAL INTELLIGENCE

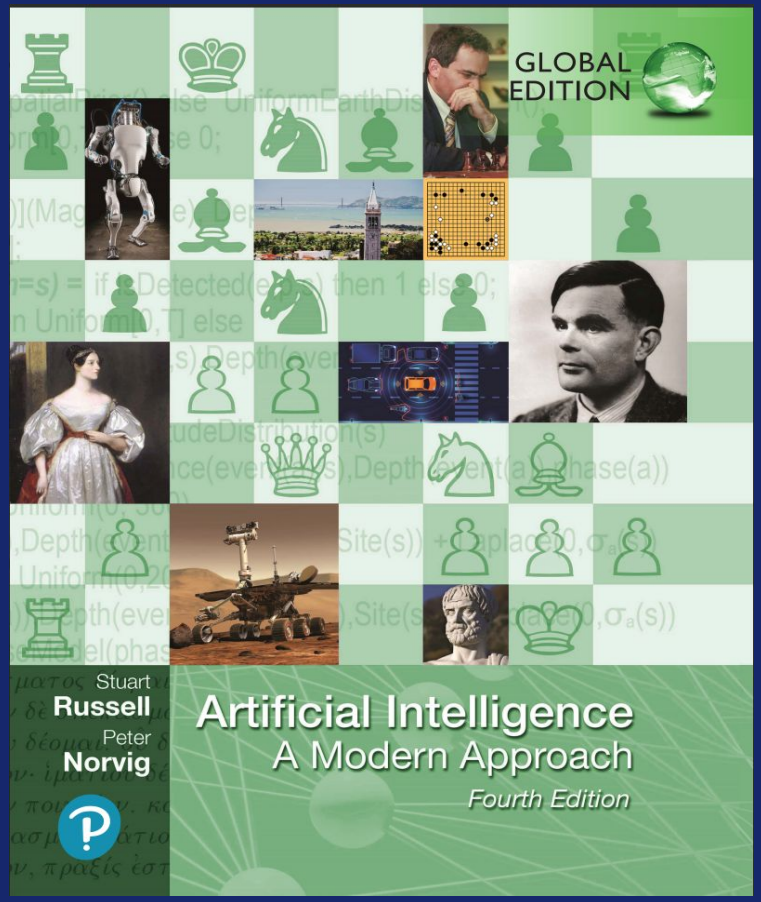
CHAPTER #1

Instructor: ANAUM HAMID

COURSE CATALOG

1. Introduction and Agents (chapters 1,2)
2. Search (chapters 3,4,5,6)
3. Logic (chapters 7,8,9)
4. Planning (chapters 11,12)
5. Uncertainty (chapters 13,14)
6. Learning (chapters 18,20)
7. Reinforcement Learning

TEXTBOOK



Artificial intelligence: A modern approach (4rd edition), Stuart Russell and Peter Norvig

MARKS DISTRIBUTION

- **Assignments** **10 (Best 3 out of 4)**
- **Midterms** **15 each (x2= 30)**
- **Quiz** **10 (Best 3 out of 4)**
- **Final** **50**

AGENDA

- Introduction to artificial intelligence?
- A very brief history of AI
- Foundations of AI
- AI state of Art
  - How much progress has been made in different aspects of AI

WHAT MAKES HUMAN INTELLIGENT?

Learn

Learning and Adapting by Experiences from Surroundings

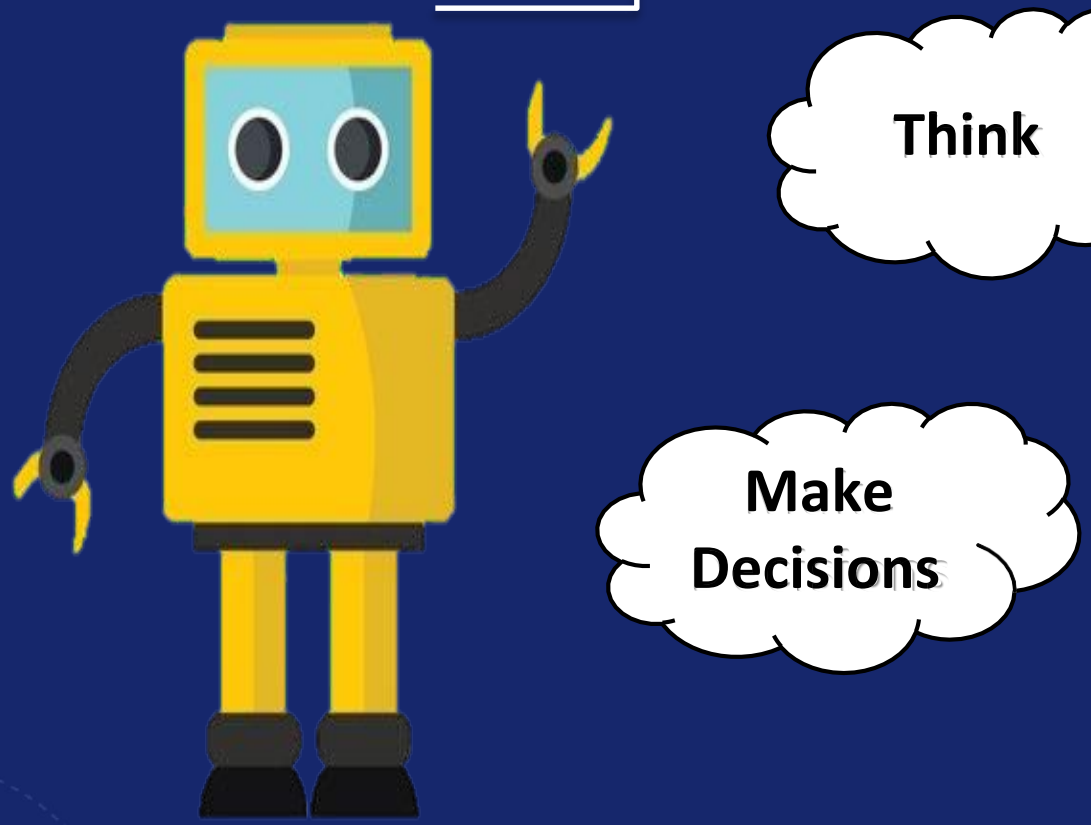
Think

Problem solving (Game theory)

Make Decisions

YES/NO

I can show human like intelligence

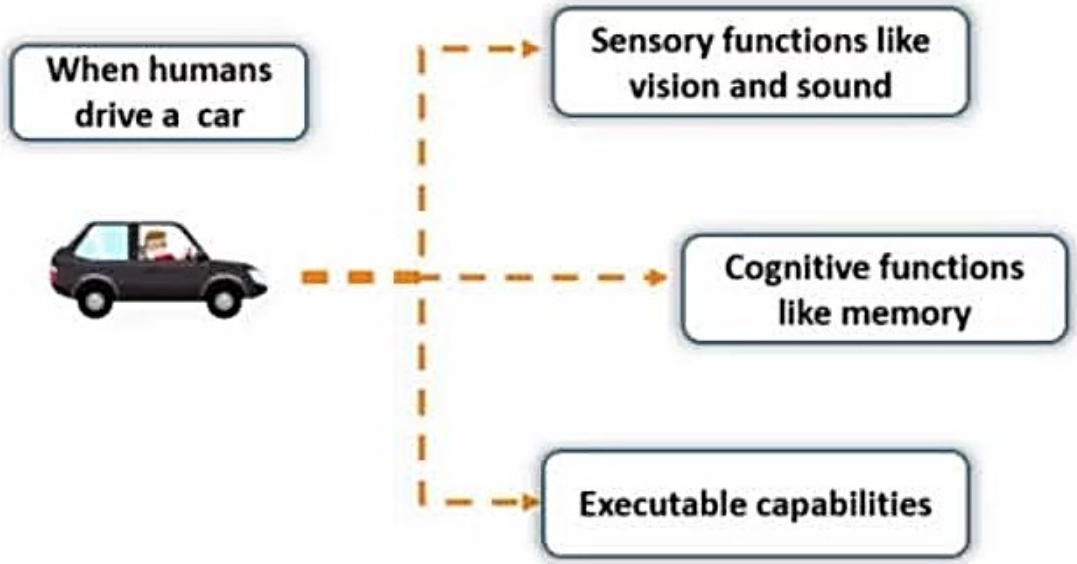


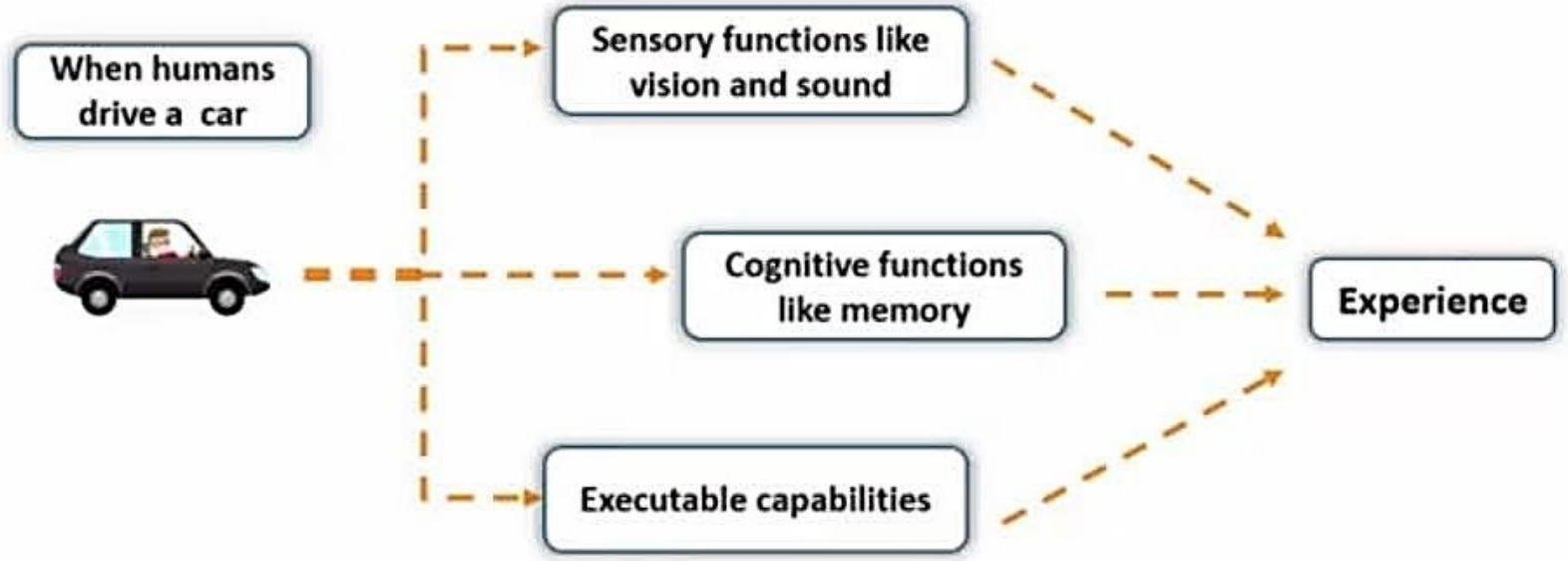
Think

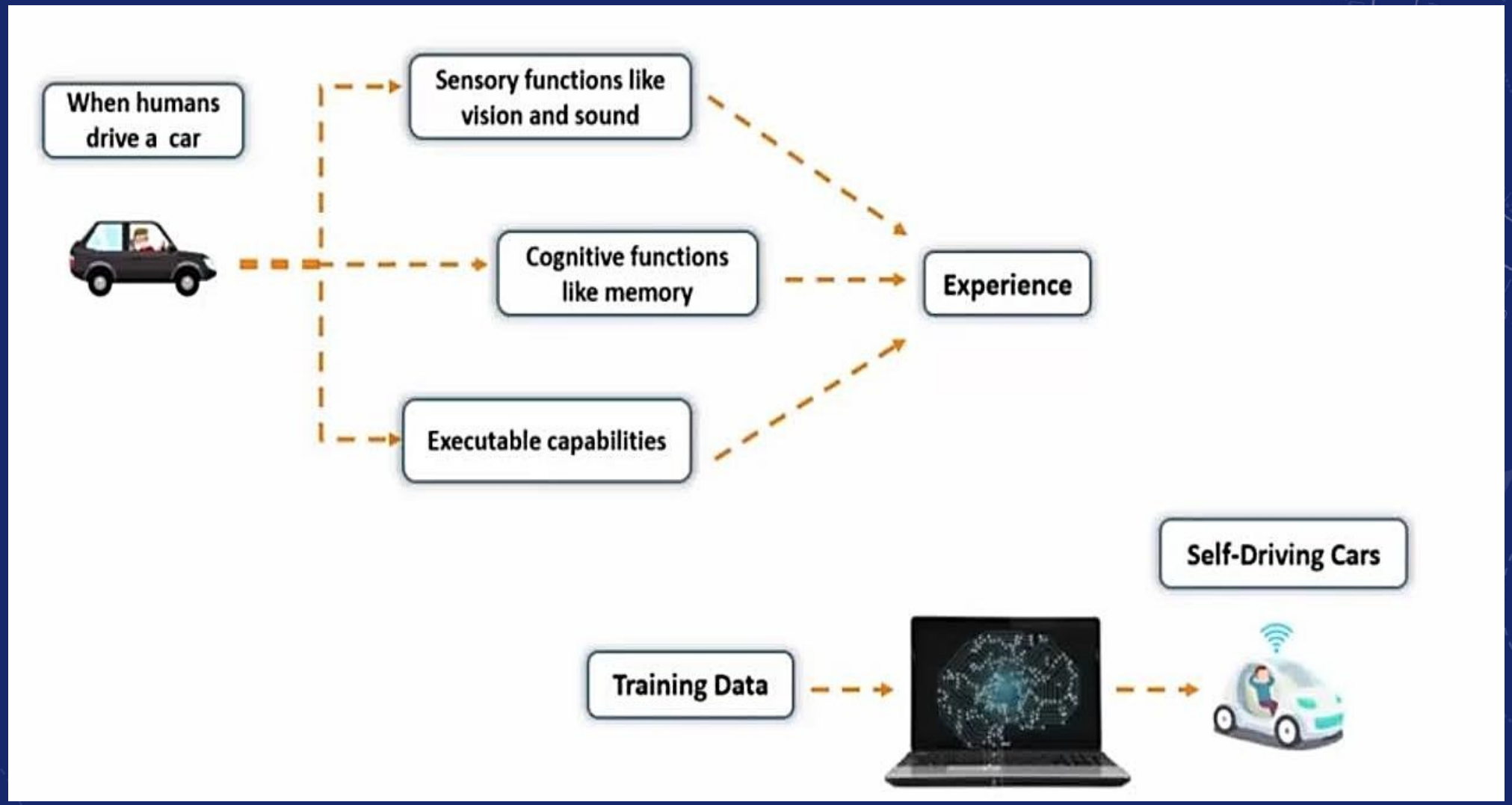
Make Decisions

Human intelligence

When humans drive a car


When humans drive a car
Sensory functions like vision and sound
Cognitive functions like memory
Executable capabilities


When humans drive a car
Sensory functions like vision and sound
Cognitive functions like memory
Executable capabilities
Experience


When humans drive a car
Sensory functions like vision and sound
Cognitive functions like memory
Executable capabilities
Experience
Self-Driving Cars
Training Data

LEFT REARWARD VEHICLE CAMERA
MEDIUM RANGE VEHICLE CAMERA
RIGHT REARWARD VEHICLE CAMERA
MOTION FLOW
LANE LINES
LANE LINES
ROAD FLOW
IN-PATH OBJECTS
ROAD LIGHTS
OBJECTS
ROAD SIGNS

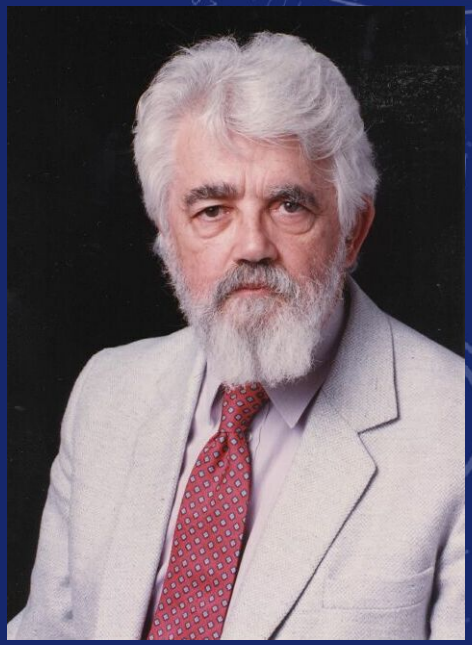
What is AI ?

AI Definition by John McCarthy

(American computer scientist and cognitive scientist)

What is artificial intelligence?

It is the science and engineering of making intelligent machines, especially intelligent computer programs

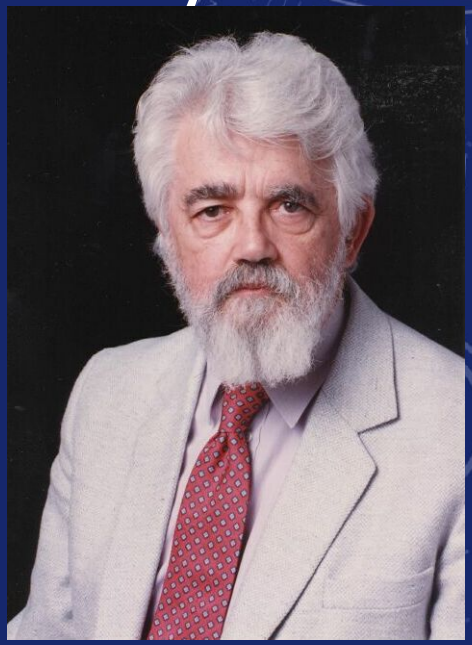


http://www-formal.stanford.edu/jmc/whatisai/whatisai.html

AI Definition by John McCarthy

What is intelligence

Intelligence is the computational part of the ability to achieve goals in the world



http://www-formal.stanford.edu/jmc/whatisai/whatisai.html

What is an AI?

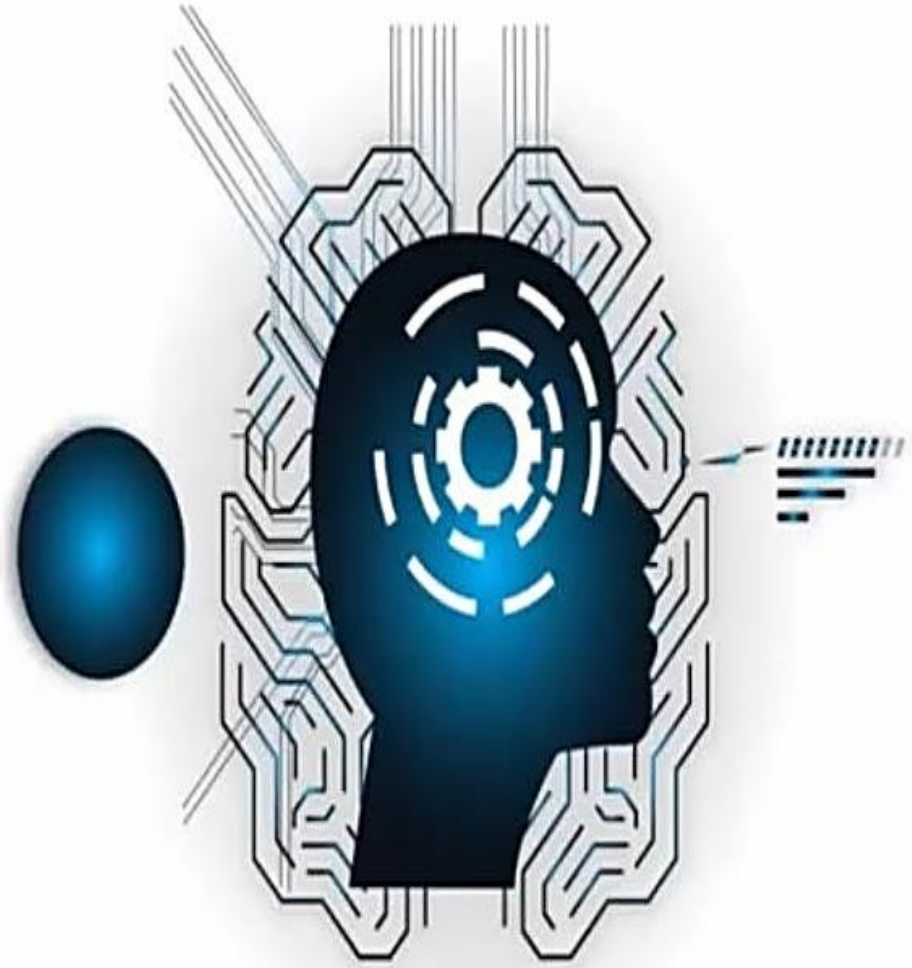
"The study and design of intelligent agents, where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success."

Russel and Norvig, AIMA book

HISTORY OF AI

- 1950: Turing
  - Turing's "Computing Machinery and Intelligence"
- 1956: birth of AI
  - Dartmouth meeting: "Artificial Intelligence" name adopted
- 1950s: initial promise
  - Early AI programs, including
  - Samuel's checkers program
  - Newell & Simon's Logic Theory
- 1986-- Rise of machine learning
  - Neural networks return to popularity
  - Major advances in machine learning algorithms and applications
- 1990-- Role of uncertainty
  - Bayesian networks as a knowledge representation framework
- 1995-- AI as Science
  - Integration of learning, reasoning, knowledge representation
  - AI methods used in vision, language, data mining, etc

Artificial Intelligence



Intelligence displayed by machines

OR

The capacity of a machine to imitate intelligent human behaviour

ML and DL

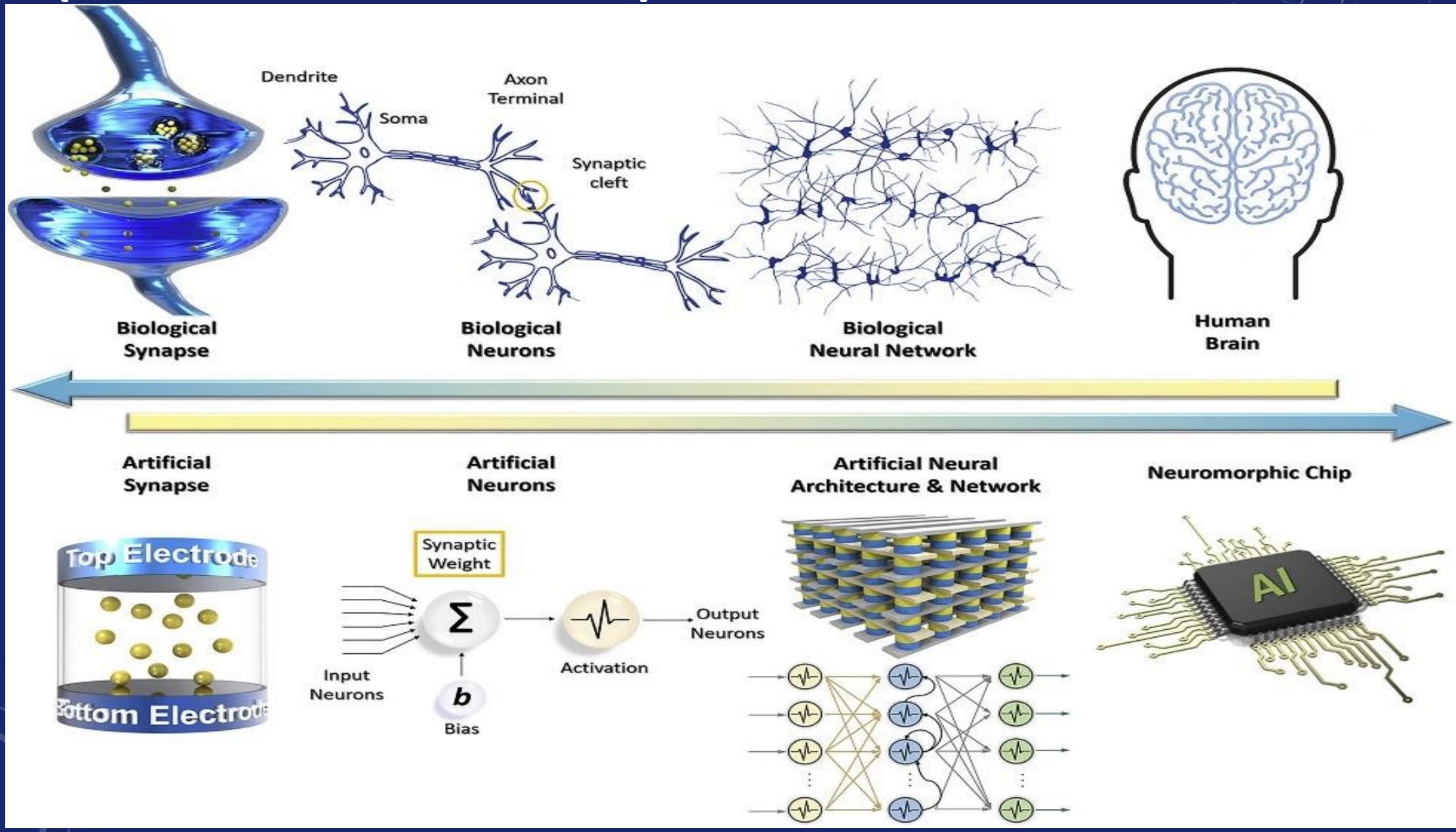
ML

A bunch of statistical algorithms and tools to learn from the data

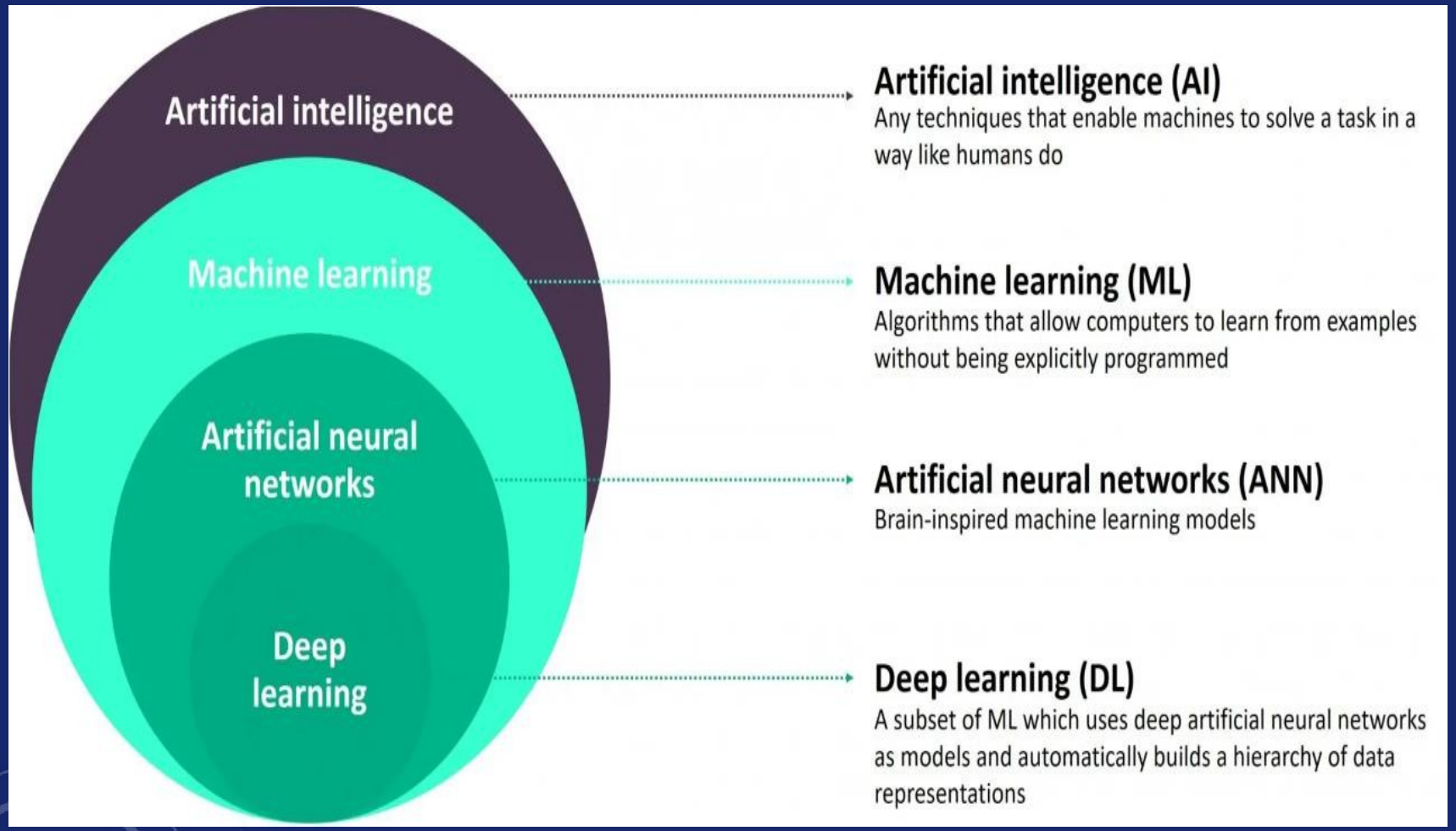
DL

Connected with algorithms inspired by the structure and function of the brain called "Artificial Neural Networks"

DL (BIOLOGICAL NEURON)

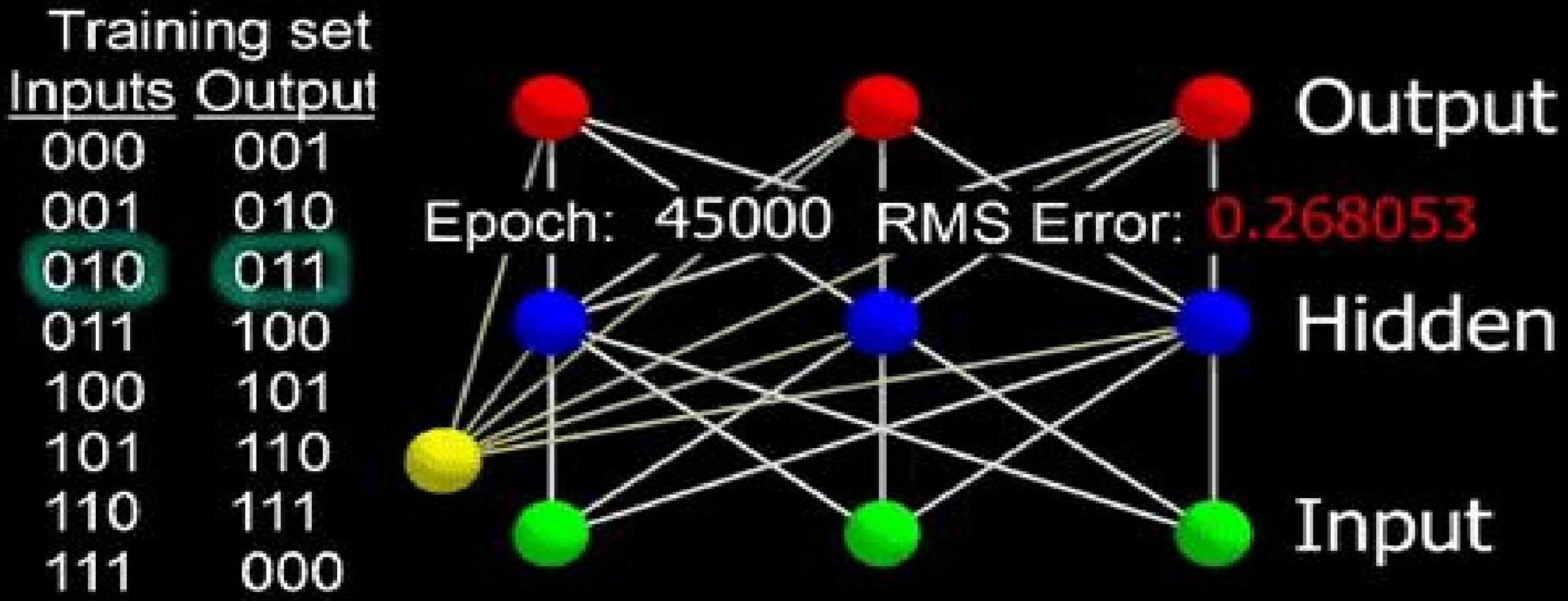


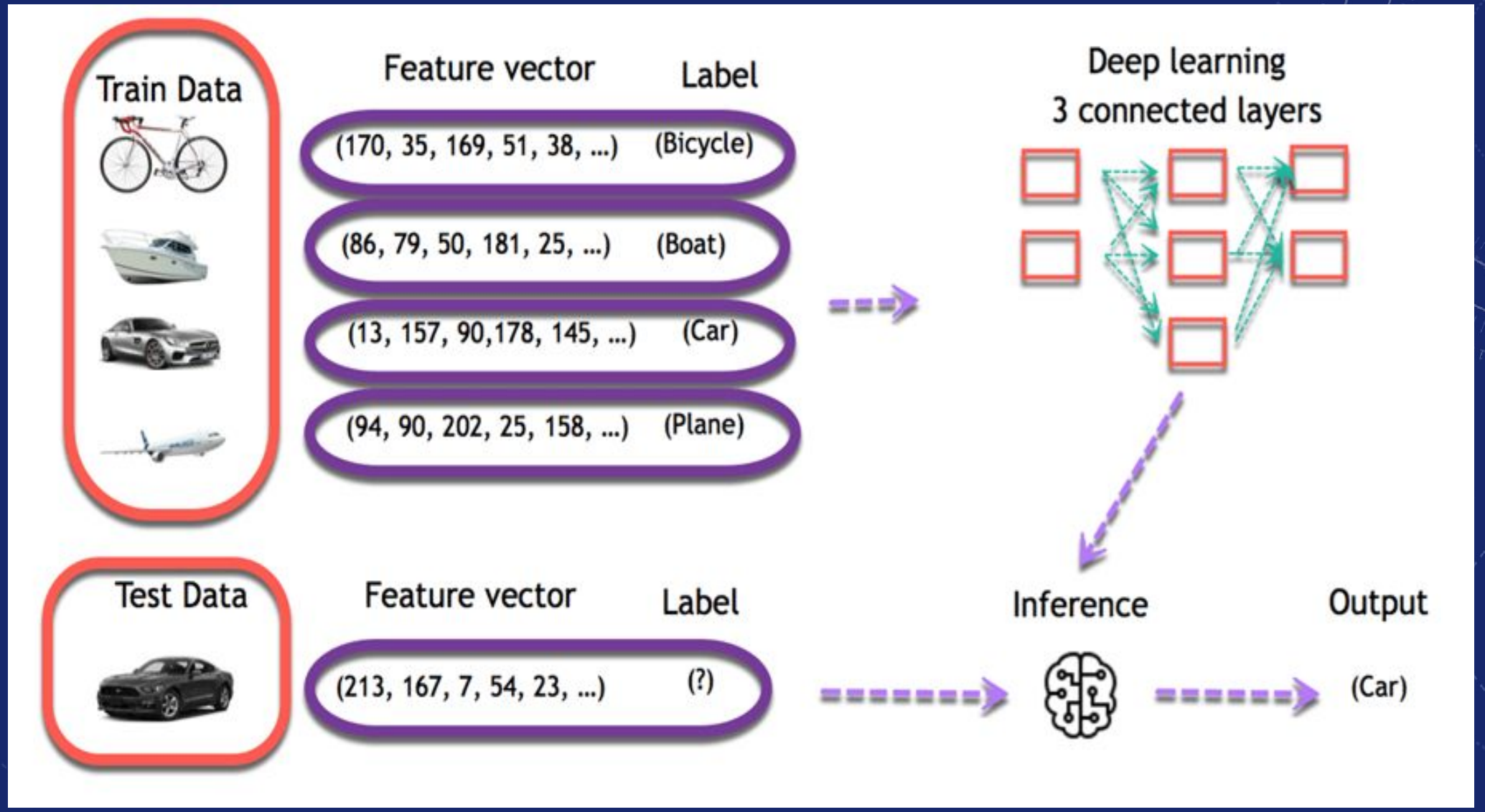
(BIOLOGICAL NEURON)



Biological Neuron	Artificial Neuron
Dendrites	Input
Cell Nucleus(Soma)	Node
Axon	Output
Synapse	Interconnections

ARTIFICIAL NEURON




Train Data
Feature vector
Label
(170, 35, 169, 51, 38, ...)
(Bicycle)
(86, 79, 50, 181, 25, ...)
(Boat)
(13, 157, 90,178, 145, ...)
(Car)
(94, 90, 202, 25, 158, ...)
(Plane)
Deep learning
3 connected layers
Test Data
Feature vector
Label
(213, 167, 7, 54, 23, ...)
(?)
Inference
Output
(Car)

STATE OF THE ART

- Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
- AI program proved a mathematical conjecture (Robbins conjecture) unsolved for decades
- NASA's on-board autonomous planning program controlled the scheduling of operations for a spacecraft
- Speech recognition: A traveler calling United Airlines to book a flight can have the entire conversation guided by an automated speech recognition and dialog management system.
- Face recognition software available in consumer cameras

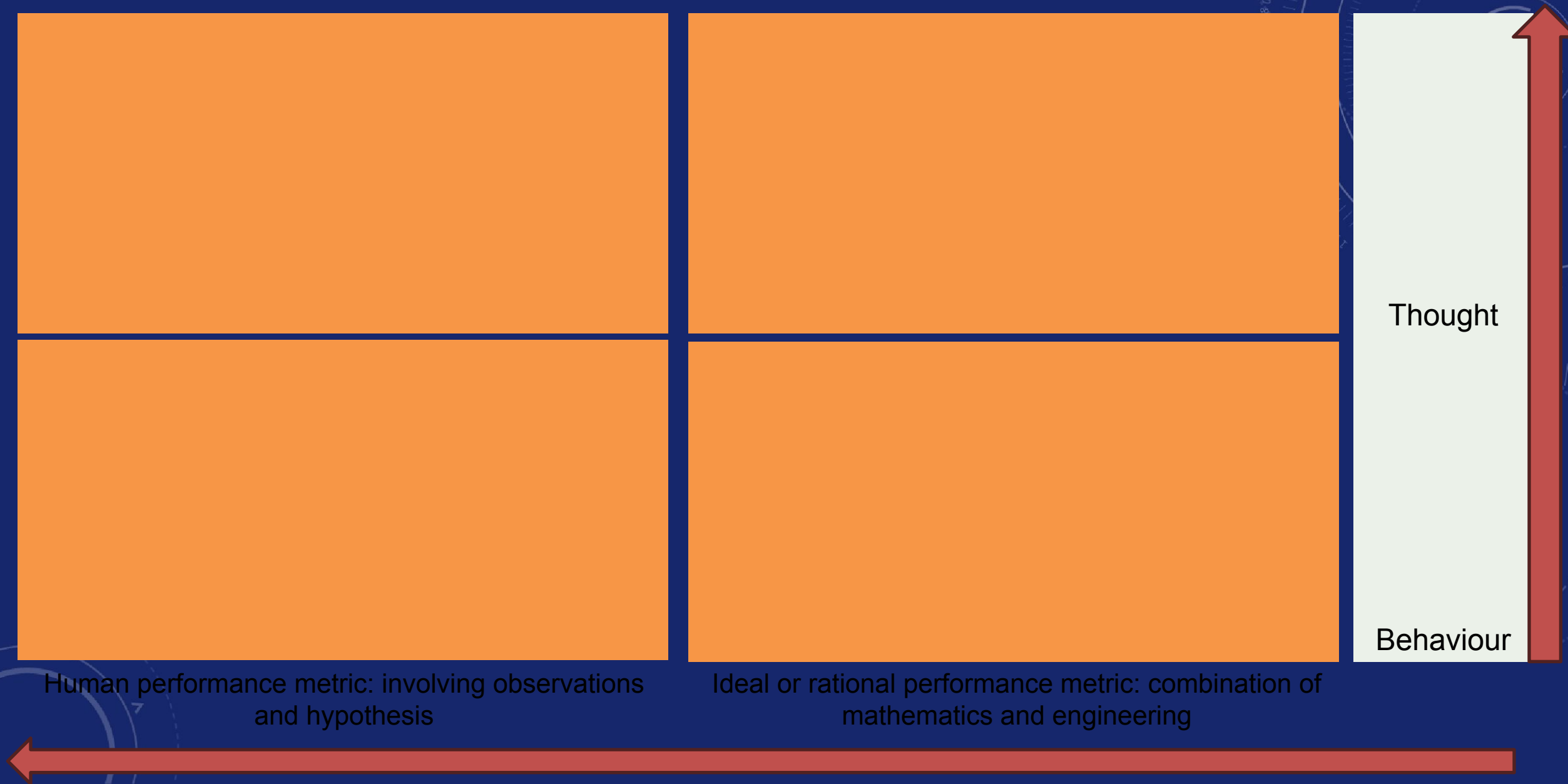
WHAT IS ARTIFICIAL INTELLIGENCE?

It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable.

Views of AI fall into four categories:

- Thinking Humanly
- Acting Humanly
- Thinking Rationally
- Acting Rationally

Definitions



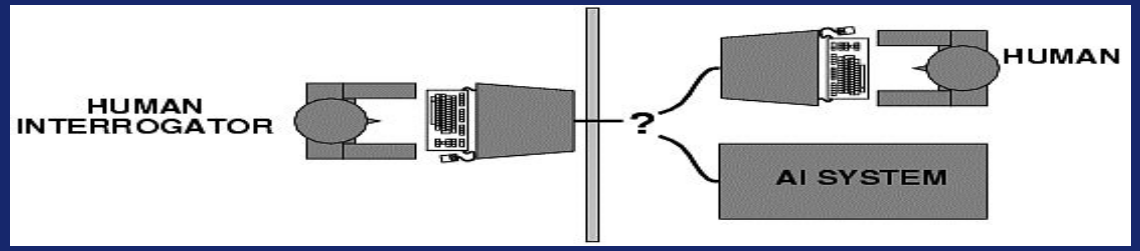
What is AI?

Four schools of thoughts (Russel & Norvig)

Thinking humanly	**Thinking rationally**
"The exciting new effort to make computers think... machines with minds, in the full and literal sense." *(Haugeland, 1985)*	"The study of mental faculties through the use of computational models." (Charniak & McDermott,1985)
Acting humanly	**Acting rationally**
"The study of how to make computers do things which, at the moment, people are better." *(Rich & Knight, 1991)*	"Computational Intelligence is the study of the design of intelligent agents." (Poole et al., 1998)

ACTING HUMANLY: TURING TEST

- Alan Turing (1950) "Computing machinery and intelligence"
- "Can machines think?" □ "Can machines behave intelligently?"
- Operational test for intelligent behavior: the Imitation Game

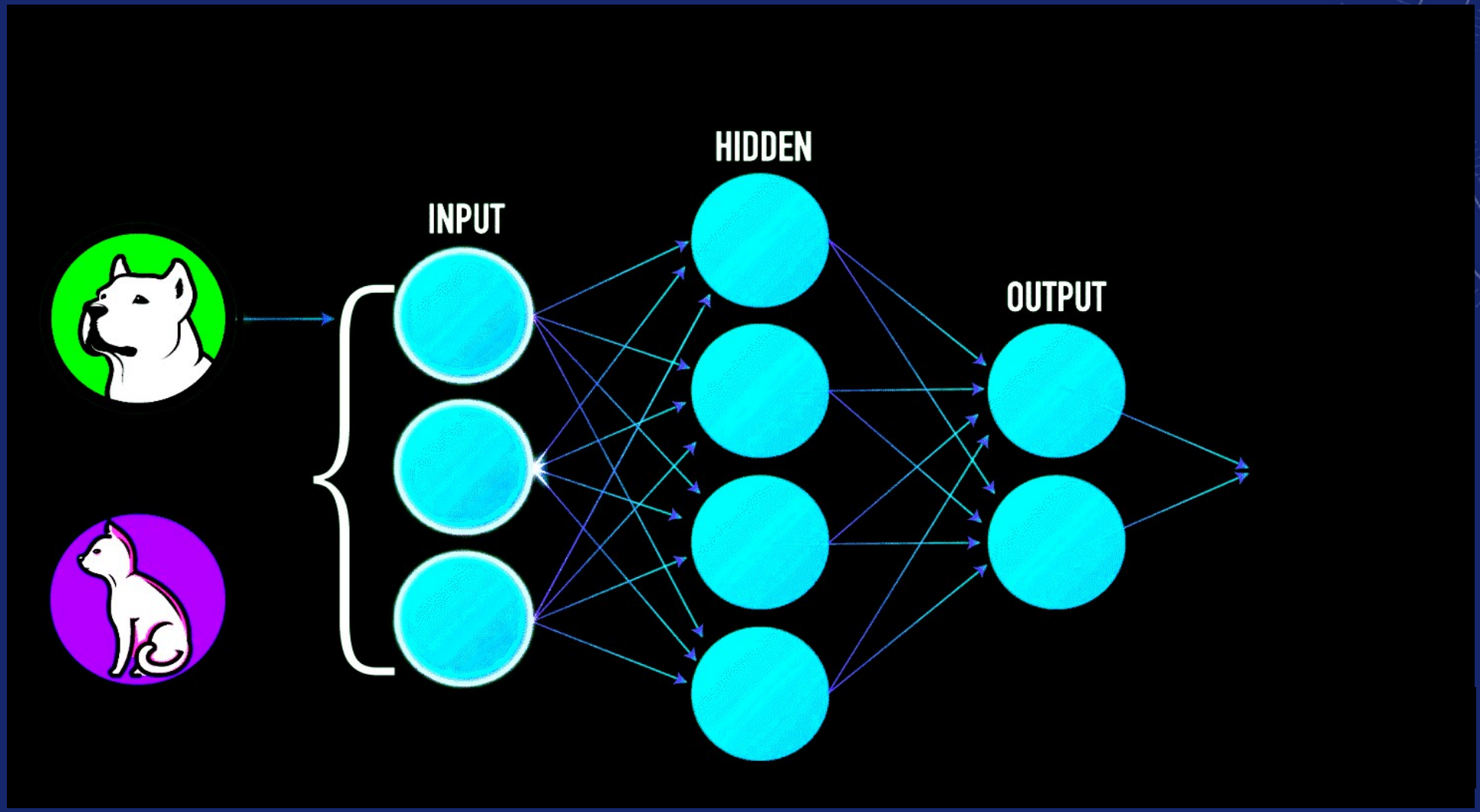


It was designed to provide a satisfactory operational definition of intelligence. A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer.

THINKING HUMANLY: THE COGNITIVE MODELING APPROACH

- **Requires detailed matching of computer behavior and timing to detailed measurements of human subjects gathered in psychological experiments.**

- **Cognitive Science approach**
  - **Try to get "inside" our minds**
  - **E.g., conduct experiments with people to try to "reverse-engineer" how we reason, learning, remember, predict**
- **So, we need to get *inside* the actual workings of human minds.**
- **There are three ways to do this:**
- **through introspection—trying to catch our own thoughts as they go by;**
- **through psychological experiments—observing a person in action;**
- **and through brain imaging—observing the brain in action.**


HIDDEN
INPUT
OUTPUT

THINKING RATIONALLY: LAWS OF THOUGHT

- Formalize “correct” reasoning using a mathematical model (e.g. of deductive reasoning/logical conclusion).

- Logics Program: Encode knowledge in formal logical statements and use mathematical deduction to perform reasoning:
- Problems:
- -Formalizing common sense knowledge is difficult.
- -General deductive inference is computationally intractable.

the pigeon experiment classic box-and-banana problem

https://www.youtube.com/watch?v=mDntbGRPeEU

ACTING RATIONALLY: THE RATIONAL AGENT

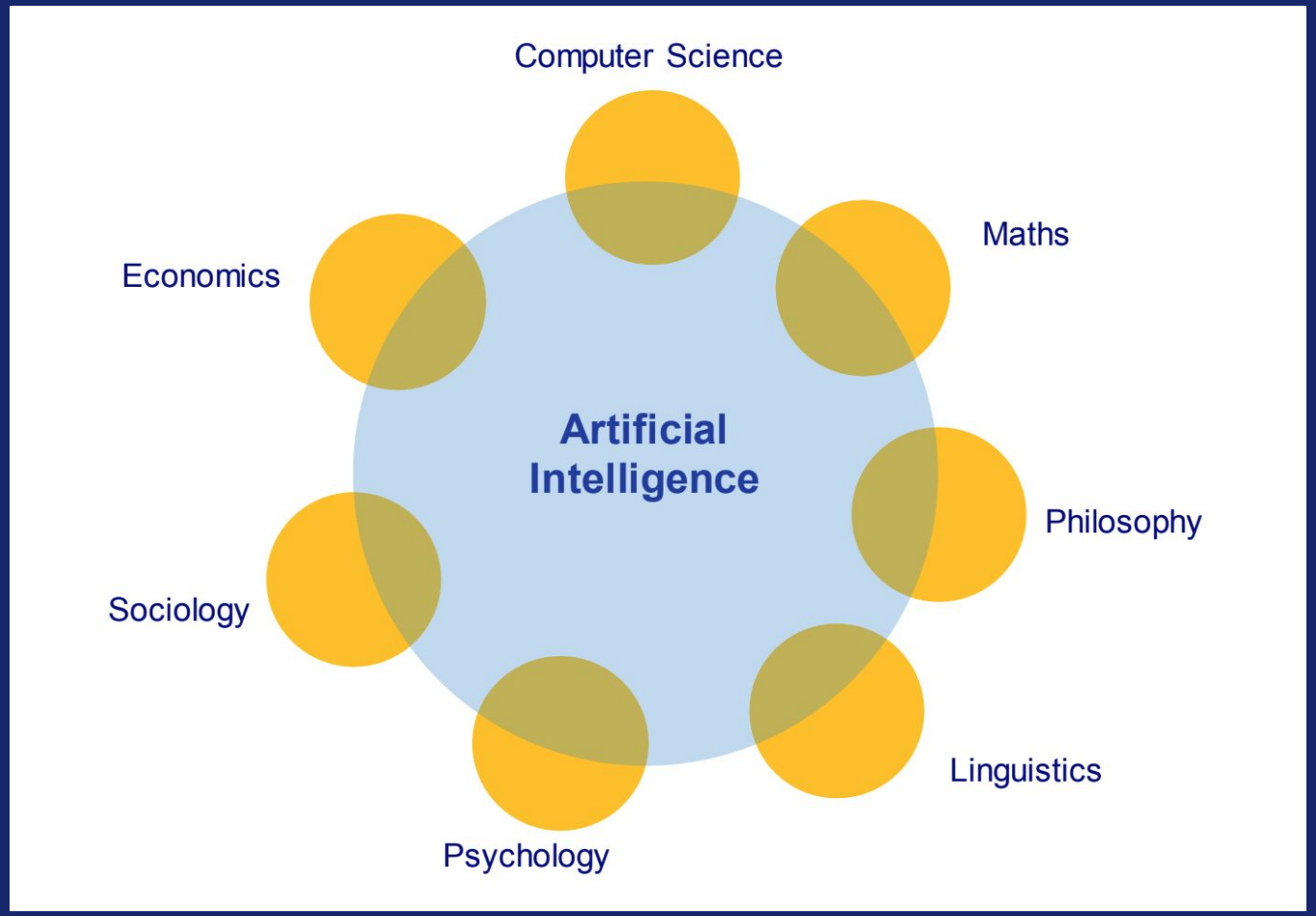
- An agent is an entity that perceives its environment and is able to execute actions to change it.
- Agents have inherent goals that they want to achieve (e.g. survive, reproduce).
- A rational agent acts in a way to maximize the achievement of its goals.
- True maximization of goals requires omniscience and unlimited computational abilities.
- Limited rationality involves maximizing goals within the computational and other resources available.

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

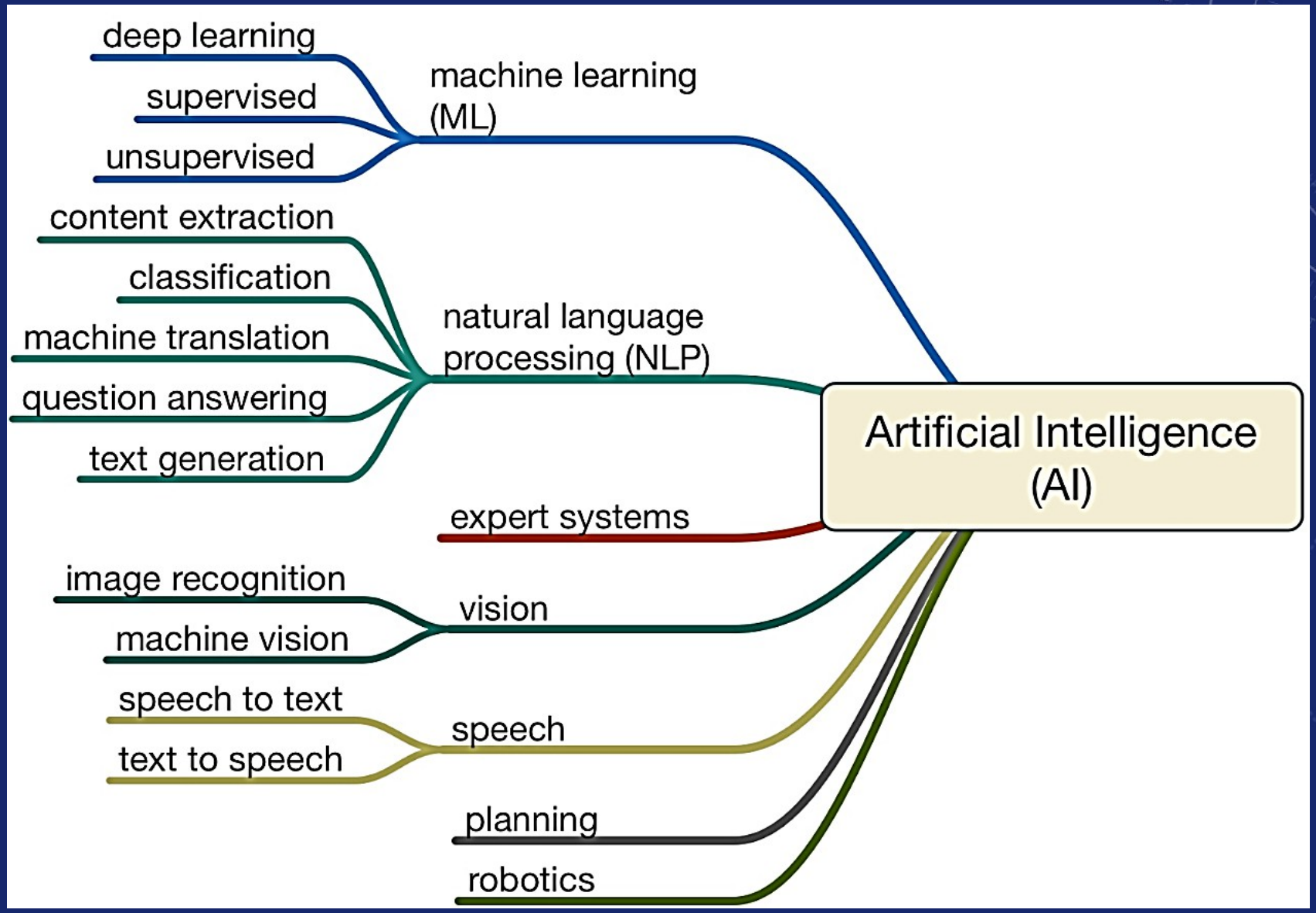
- **Philosophy** Logic, methods of reasoning, mind as physical system, foundations of learning, language , rationality.
- **Mathematics** formal representation and proof, algorithms , computation.
- **Probability/statistics** modeling uncertainty, learning from data
- **Economics** utility, decision theory, rational economic agents
- **Neuroscience** neurons as information processing units.
- **Computer engineering** building fast computers
- **Psychology** how do people behave, perceive, process cognitive information, represent knowledge.
- **Linguistics** knowledge representation, grammars

science

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE



AI UMBRELLA


deep learning
supervised
unsupervised
machine learning (ML)
content extraction
classification
machine translation
question answering
text generation
natural language processing (NLP)
Artificial Intelligence (AI)
expert systems
image recognition
machine vision
vision
speech to text
text to speech
speech
planning
robotics