CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# MODULE 1 - INTRODUCTION


## Geethu S Kumar

*Department of*
Information Science & Engineering


www.cambridge.edu.in

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

- *Homo sapiens*—man the wise—because our **intelligence** is so important to us.
- For thousands of years, we have tried to understand *how we think*; that is, how a mere handful of matter can perceive, understand, predict, and manipulate a world far larger and more complicated than itself.
- The field of **artificial intelligence**, or AI, goes further still: it attempts not just to understand but also to *build* intelligent entities.
- AI is one of the newest fields in science and engineering.
- Work started in earnest soon after World War II.
- The name itself was coined in 1956.

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

*Artificial intelligence (AI) is technology that enables computers and machines to simulate human learning, comprehension, problem solving, decision making, creativity and autonomy.*

Applications and devices equipped with AI can see and identify objects.
They can understand and respond to human language.
They can learn from new information and experience.
They can make detailed recommendations to users and experts.
They can act independently, replacing the need for human intelligence or intervention.

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

AI is one of the newest fields in science and engineering. Work started in earnest soon after World War II, and the name itself was coined in 1956.
The branch of computer science called Artificial Intelligence is said to have been born at a conference held at Dartmouth, USA, in 1956

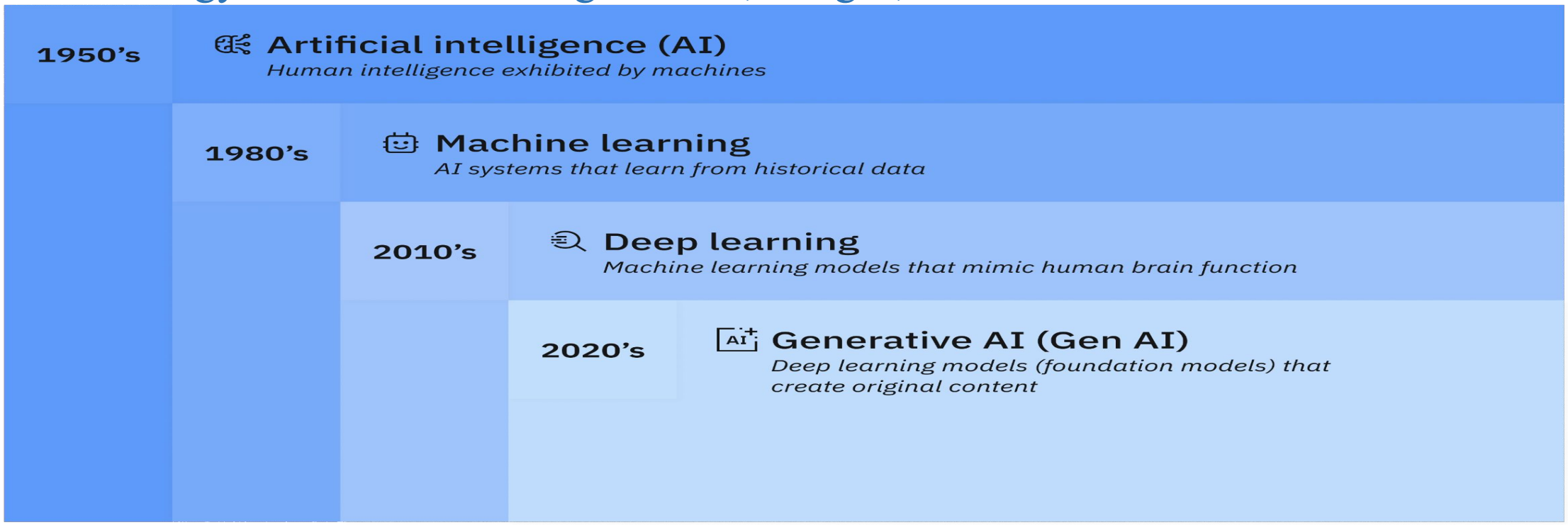
The scientists attending that conference represented several different disciplines: mathematics, neurology, psychology, electrical engineering etc

They had one thing in common: They all were trying to use the recently developed computers to simulate various aspects of human intelligence.

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

But in 2024, most AI researchers and practitioners—and most AI-related headlines—are focused on breakthroughs in generative AI (gen AI), a technology that can create original text, images, video and other content.



CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

An actual definition of AI is very difficult.

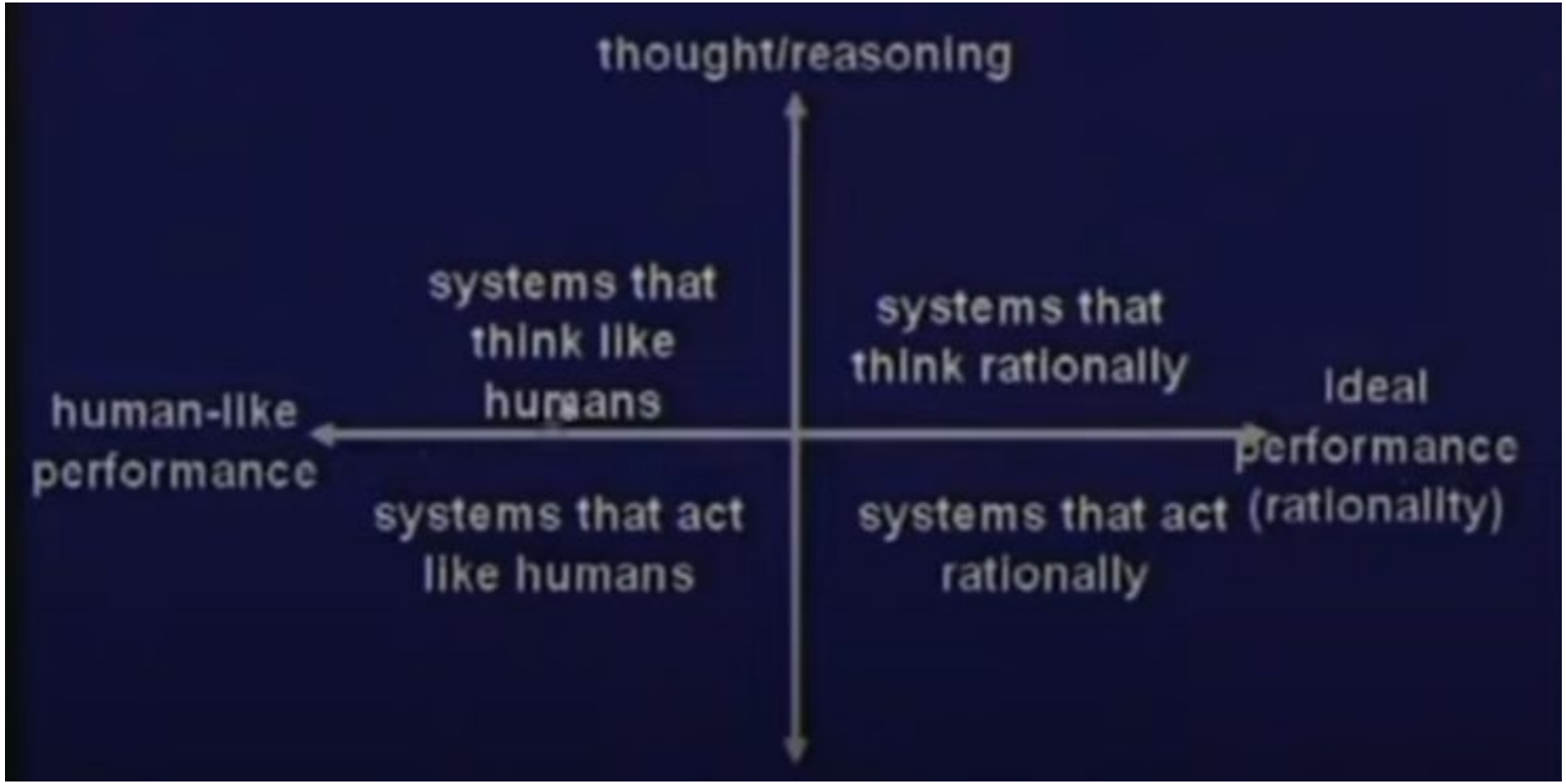
We are going to define AI along two dimensions.

The definitions on top are concerned with thought processes and reasoning, whereas the ones on the bottom address behavior.

The definitions on the left measure success in terms of fidelity to human performance, whereas the ones on the right measure against an ideal performance measure, called rationality.

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?



CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

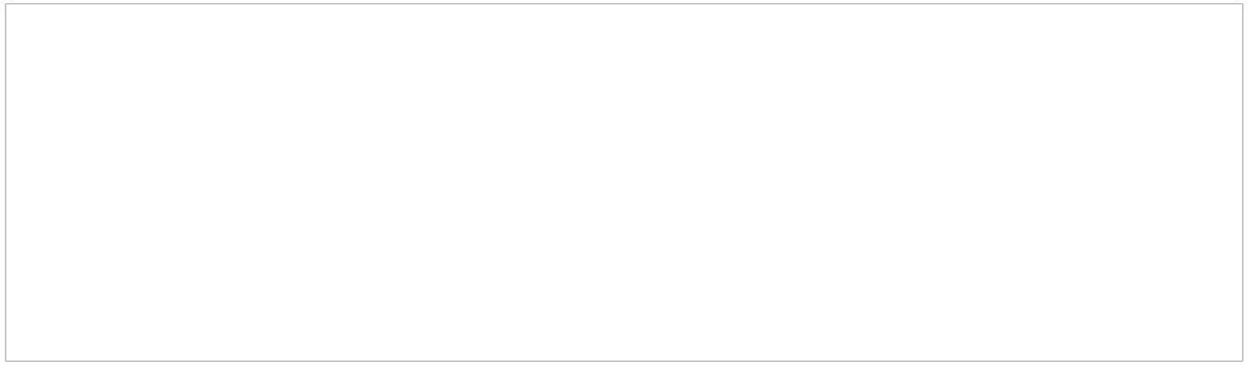
| Thinking Humanly | Thinking Rationally |
| --- | --- |
| **COGNITIVE SCIENCE**<br>Systems that act like humans | **LAWS OF THOUGHT / LOGIC**<br>Systems that think rationally |
| **Acting Humanly** | **Acting Rationally** |
| **TURING TEST**<br>Systems that think like humans | **RATIONAL AGENTS**<br>Systems that act rationally |

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

**Thinking Humanly**

"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)



CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

**Thinking Humanly**

"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)

"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

| Thinking Humanly | Thinking Rationally |
| --- | --- |
| "The exciting new effort to make computers think … *machines with minds*, in the full and literal sense." (Haugeland, 1985) | |
| "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning …" (Bellman, 1978) | |

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

| 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 and McDermott, 1985) |
| "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | |

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

| 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 and McDermott, 1985) |
| "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning …" (Bellman, 1978) | "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# What is AI?

Concerned with thought processes and reasoning

| 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 and McDermott, 1985) |
| "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Concerned with thought processes and reasoning

| Thinking Humanly | Thinking Rationally |
| --- | --- |
| "The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br><br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | "The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br><br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly** | |
| | |

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Concerned with thought processes and reasoning

| Thinking Humanly | Thinking Rationally |
| --- | --- |
| "The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br><br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, leaming . . ." (Bellman, 1978) | "The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br><br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly** | |
| "The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) | |

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Concerned with thought processes and reasoning

| Thinking Humanly | Thinking Rationally |
| --- | --- |
| "The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br><br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | "The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br><br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly** | |
| "The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)<br><br>"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991) | |

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Concerned with thought processes and reasoning

| Thinking Humanly | Thinking Rationally |
|---|---|
| "The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | "The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly** | **Acting Rationally** |
| "The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)<br>"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991) | |

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Concerned with thought processes and reasoning

| Thinking Humanly | Thinking Rationally |
|---|---|
| "The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br><br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | "The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br><br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly** | **Acting Rationally** |
| "The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)<br><br>"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991) | "Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) |

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Concerned with thought processes and reasoning

| Thinking Humanly | Thinking Rationally |
|---|---|
| "The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | "The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly** | **Acting Rationally** |
| "The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)<br>"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991) | "Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)<br>"AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998) |

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Concerned with thought processes and reasoning

Address behavior

| **Thinking Humanly** | **Thinking Rationally** |
|---|---|
| "The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | "The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly** | **Acting Rationally** |
| "The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)<br>"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991) | "Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)<br>"AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998) |

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Measure success in terms of fidelity to human performance

Concerned with thought processes and reasoning

Address behavior

| Thinking Humanly | Thinking Rationally |
|---|---|
| "The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | "The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly** | **Acting Rationally** |
| "The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)<br>"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991) | "Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)<br>"AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998) |

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Measure success in terms of fidelity to human performance

Measure success against rationality

| | |
|---|---|
| **Thinking Humanly**<br>"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | **Thinking Rationally**<br>"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly**<br>"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)<br>"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991) | **Acting Rationally**<br>"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)<br>"AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998) |

Concerned with thought processes and reasoning

Address behavior

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Measure success in terms of fidelity to human performance

Measure success against rationality

| | |
|---|---|
| **Thinking Humanly**<br>"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | **Thinking Rationally**<br>"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly**<br>"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)<br>"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991) | **Acting Rationally**<br>"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)<br>"AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998) |

Concerned with thought processes and reasoning

Address behavior

A system is **rational** if it does the "right thing," given what it knows.

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Measure success in terms of fidelity to human performance

Measure success against rationality

| | |
|---|---|
| **Thinking Humanly**<br>"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | **Thinking Rationally**<br>"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly**<br>"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)<br>"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991) | **Acting Rationally**<br>"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)<br>"AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998) |

Concerned with thought processes and reasoning

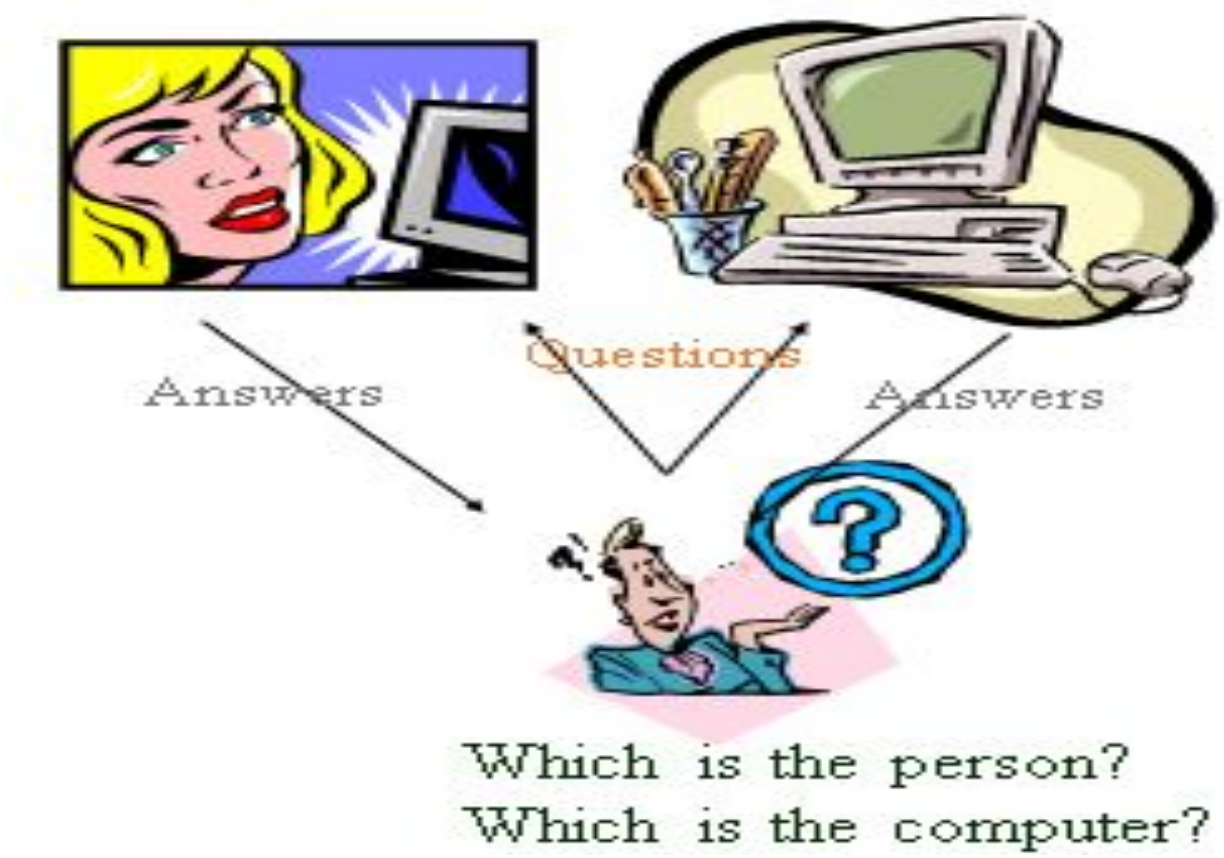
Address behavior

Some definitions of artificial intelligence, organized into four categories

A system is **rational** if it does the "right thing," given what it knows.

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

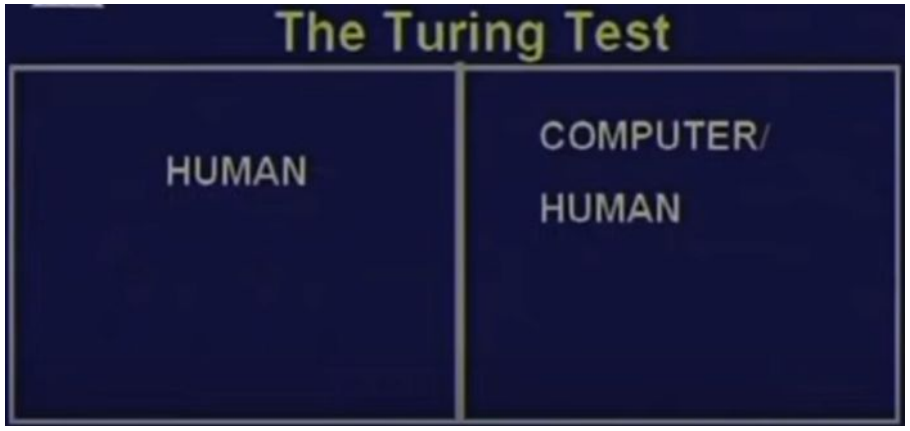
# Acting humanly: The Turing Test Approach



CAMBRIDGE INSTITUTE OF TECHNOLOGY

# Acting humanly: The Turing Test Approach

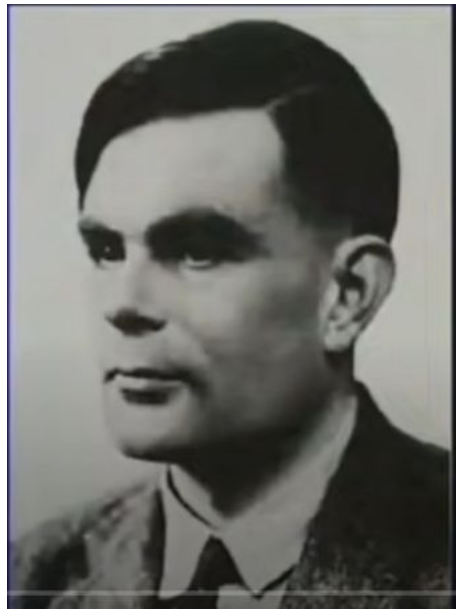
- Proposed by Alan Turing - TURING TEST (1950),
- Designed to provide a satisfactory operational definition of intelligence.
- A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer.




Turing Test Setup

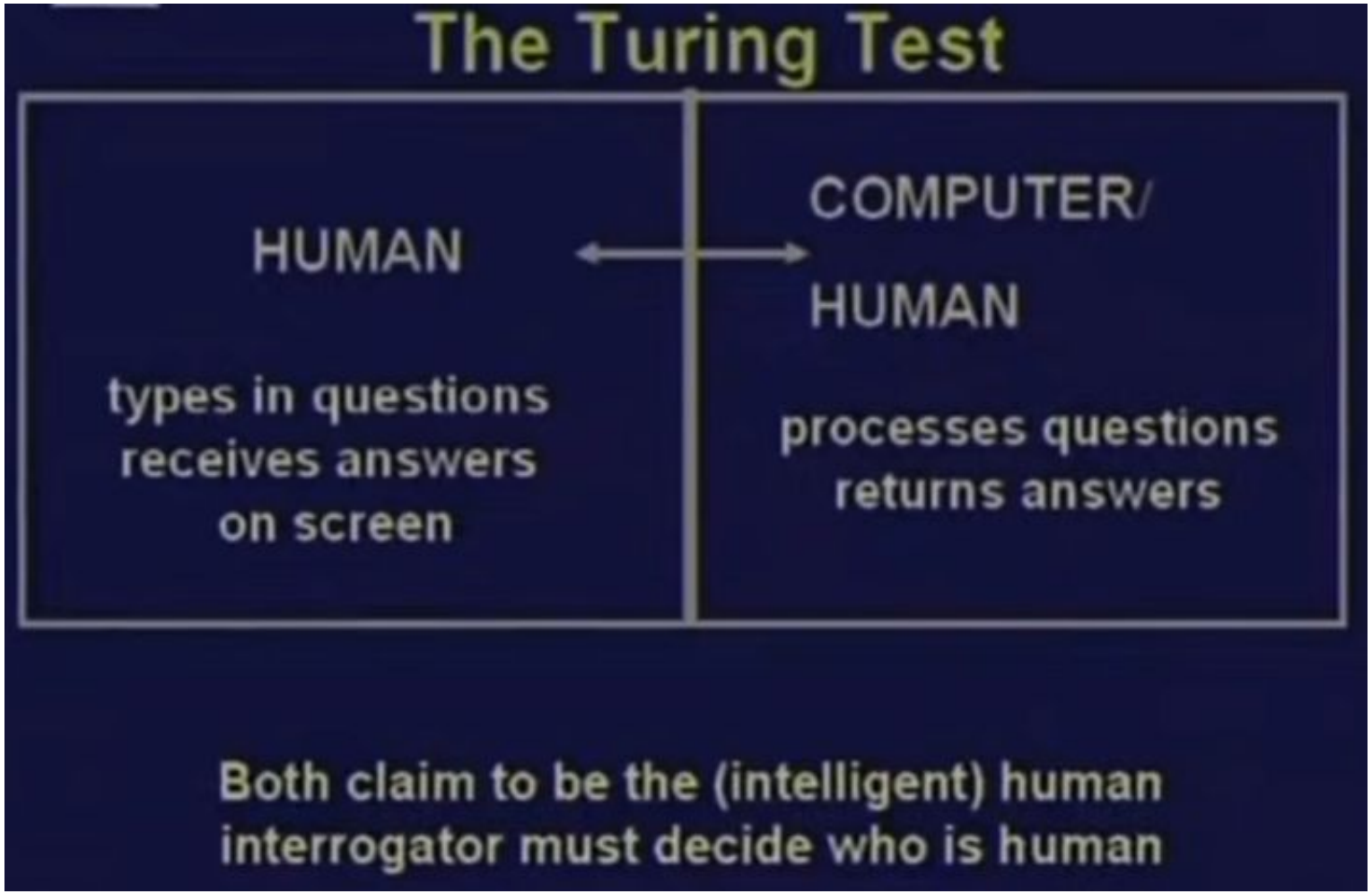
CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# Acting humanly: The Turing Test Approach

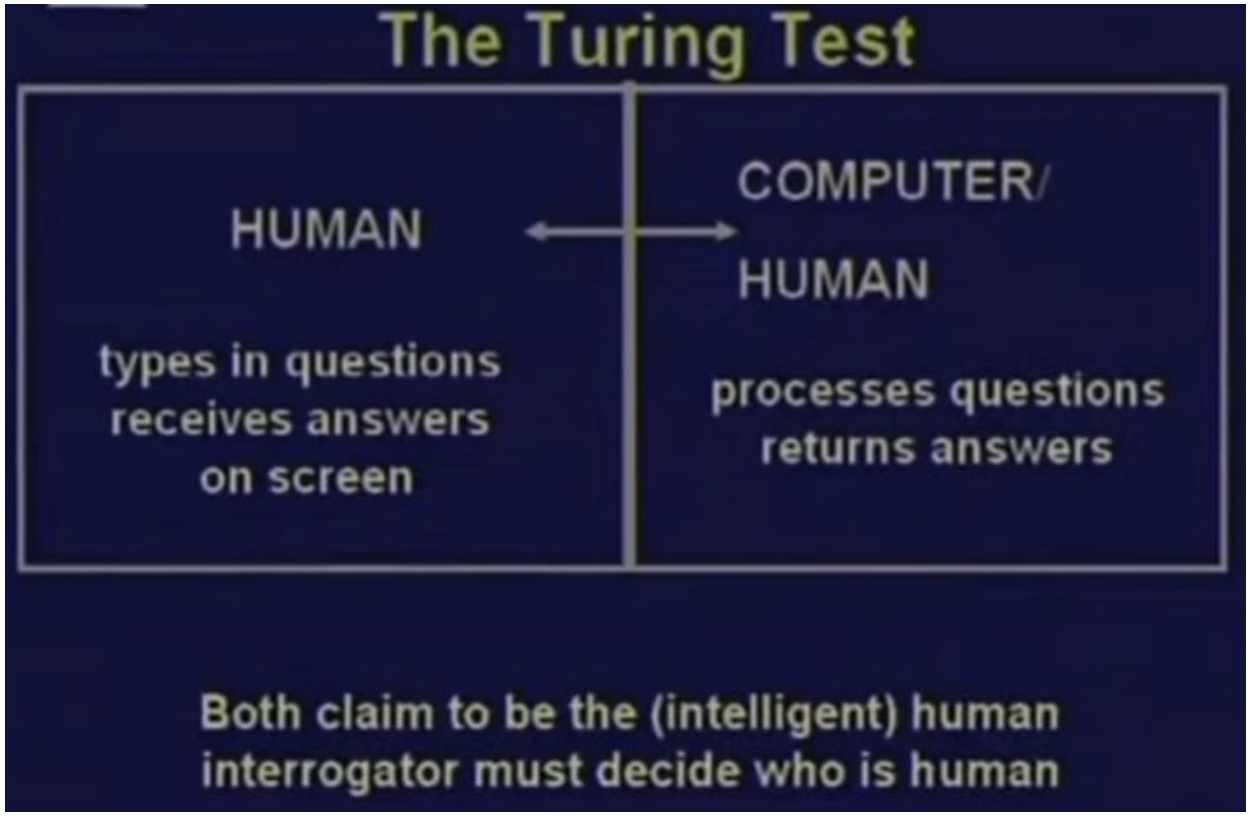
CAMBRIDGE INSTITUTE OF TECHNOLOGY

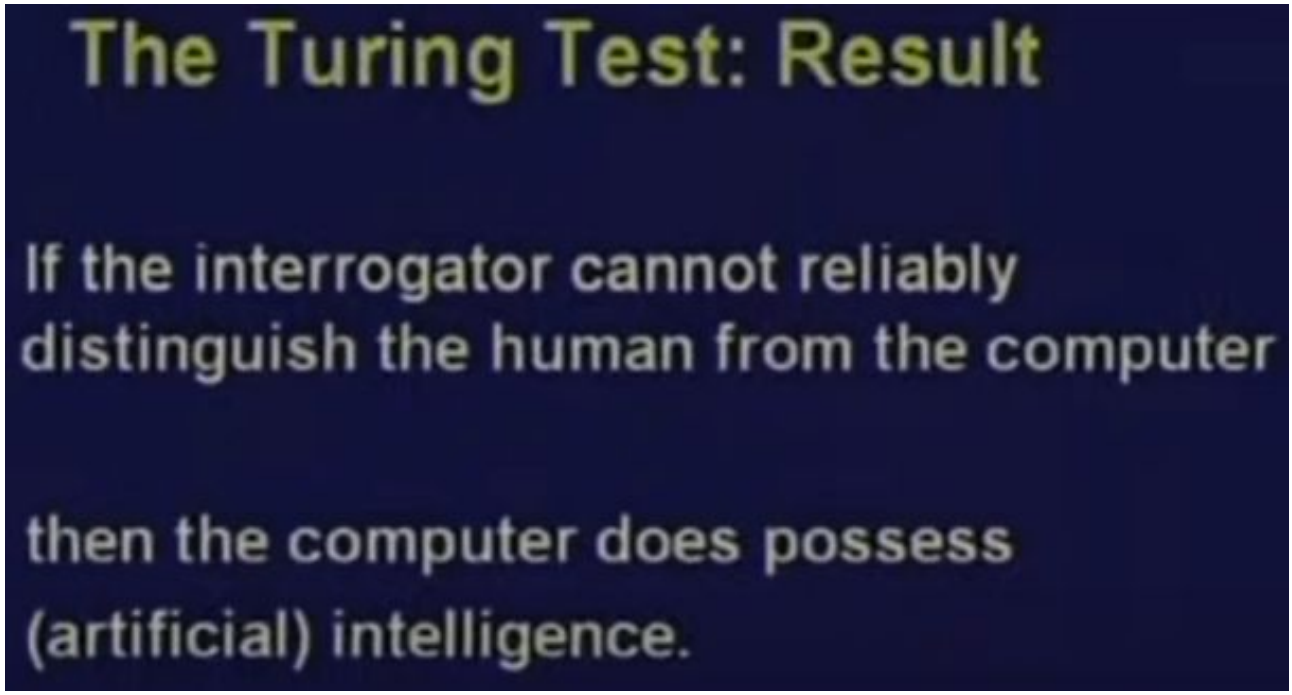
# Acting humanly: The Turing Test Approach



CAMBRIDGE INSTITUTE OF TECHNOLOGY

# Acting humanly: The Turing Test Approach



CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# Acting humanly: The Turing Test Approach

The computer would need to possess the following capabilities:

- **natural language processing** to enable it to communicate successfully in English;
- **knowledge representation** to store what it knows or hears;
- **automated reasoning** to use the stored information to answer questions and to draw new conclusions;
- **machine learning** to adapt to new circumstances and to detect and extrapolate patterns.

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# Acting humanly: Total Turing Test

- Turing's test deliberately avoided direct physical interaction between the interrogator and the computer, because *physical* simulation of a person is unnecessary for intelligence.
- However, the **total Turing Test** includes a video signal so that the interrogator can test the subject's perceptual abilities, as well as the opportunity for the interrogator to pass physical objects "through the hatch."
- To pass the total Turing Test, the computer will need
  - **computer vision** to perceive objects, and
  - **robotics** to manipulate objects and move about.

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# Thinking humanly: The Cognitive Modeling Approach

If we are going to say that a given program thinks like a human, we must have some way of determining how humans think. 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.

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# Thinking humanly: The Cognitive Modeling Approach

- If the program's input–output behavior matches corresponding human behavior, that is evidence that some of the program's mechanisms could also be operating in humans.
- For example, Allen Newell and Herbert Simon, who developed GPS, the "General Problem Solver" (Newell and Simon, 1961), were not content merely to have their program solve problems correctly. They were more concerned with comparing the trace of its reasoning steps to traces of human subjects solving the same problems.
- **Cognitive science -** The interdisciplinary field that brings together computer models from AI and experimental techniques from psychology to construct precise and testable theories of the human mind.

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Measure success in terms of fidelity to human performance

Measure success against rationality

| | |
|---|---|
| **Thinking Humanly**<br>"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | **Thinking Rationally**<br>"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly**<br>"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)<br>"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991) | **Acting Rationally**<br>"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)<br>"AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998) |

Concerned with thought processes and reasoning

Address behavior

Some definitions of artificial intelligence, organized into four categories

A system is **rational** if it does the "right thing," given what it knows.

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# Thinking rationally: The "Laws of Thought" Approach

- The Greek philosopher Aristotle was one of the first to attempt to codify "right thinking," that is, irrefutable reasoning processes.
- His **syllogisms** provided patterns for argument structures that always yielded correct conclusions when given correct premises.
- For example, "Socrates is a man;
  all men are mortal;
  therefore, Socrates is mortal."
- These laws of thought were supposed to govern the operation of the mind; their study initiated the field called **logic**.

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# Thinking rationally: Logicist

- By 1965, programs existed that could, in principle, solve *any* solvable problem described in logical notation. (If no solution exists, the program might loop forever.)
- The so-called **logicist** tradition within artificial intelligence hopes to build on such programs to create intelligent systems.

# Thinking rationally: The “Laws of Thought” Approach

- Two main obstacles to this approach:
  i. It is not easy to take informal knowledge and state it in the formal terms required by logical notation, particularly when the knowledge is less than 100% certain.
  ii. There is a big difference between solving a problem “in principle” and solving it in practice.
- Even problems with just a few hundred facts can exhaust the computational resources of any computer unless it has some guidance as to which reasoning steps to try first.
- Although both of these obstacles apply to *any* attempt to build computational reasoning systems, they appeared first in the logicist tradition.

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# What is AI?

Measure success in terms of fidelity to human performance

Measure success against rationality

| | |
|---|---|
| **Thinking Humanly**<br>"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985)<br>"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978) | **Thinking Rationally**<br>"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)<br>"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992) |
| **Acting Humanly**<br>"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)<br>"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991) | **Acting Rationally**<br>"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998)<br>"AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998) |

Concerned with thought processes and reasoning

Address behavior

Some definitions of artificial intelligence, organized into four categories

A system is **rational** if it does the "right thing," given what it knows.

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# Acting rationally: The rational agent Approach

- An **agent** is just something that acts.
- *agent* comes from the Latin *agere*, to do.
- All computer programs do something, but computer agents are expected to do more:

  operate autonomously, perceive their environment, persist over a prolonged time period, adapt to change, and create and pursue goals.

- A **rational agent** is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# Acting rationally: The rational agent Approach

- In the “laws of thought” approach to AI, the emphasis was on correct inferences.
- Making correct inferences is sometimes *part* of being a rational agent, because one way to act rationally is to reason logically to the conclusion that a given action will achieve one’s goals and then to act on that conclusion.
- Correct inference is not *all* of rationality; in some situations, there is no provably correct thing to do, but something must still be done.
- There are also ways of acting rationally that cannot be said to involve inference.
- Knowledge representation and reasoning enable agents to reach good decisions.

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

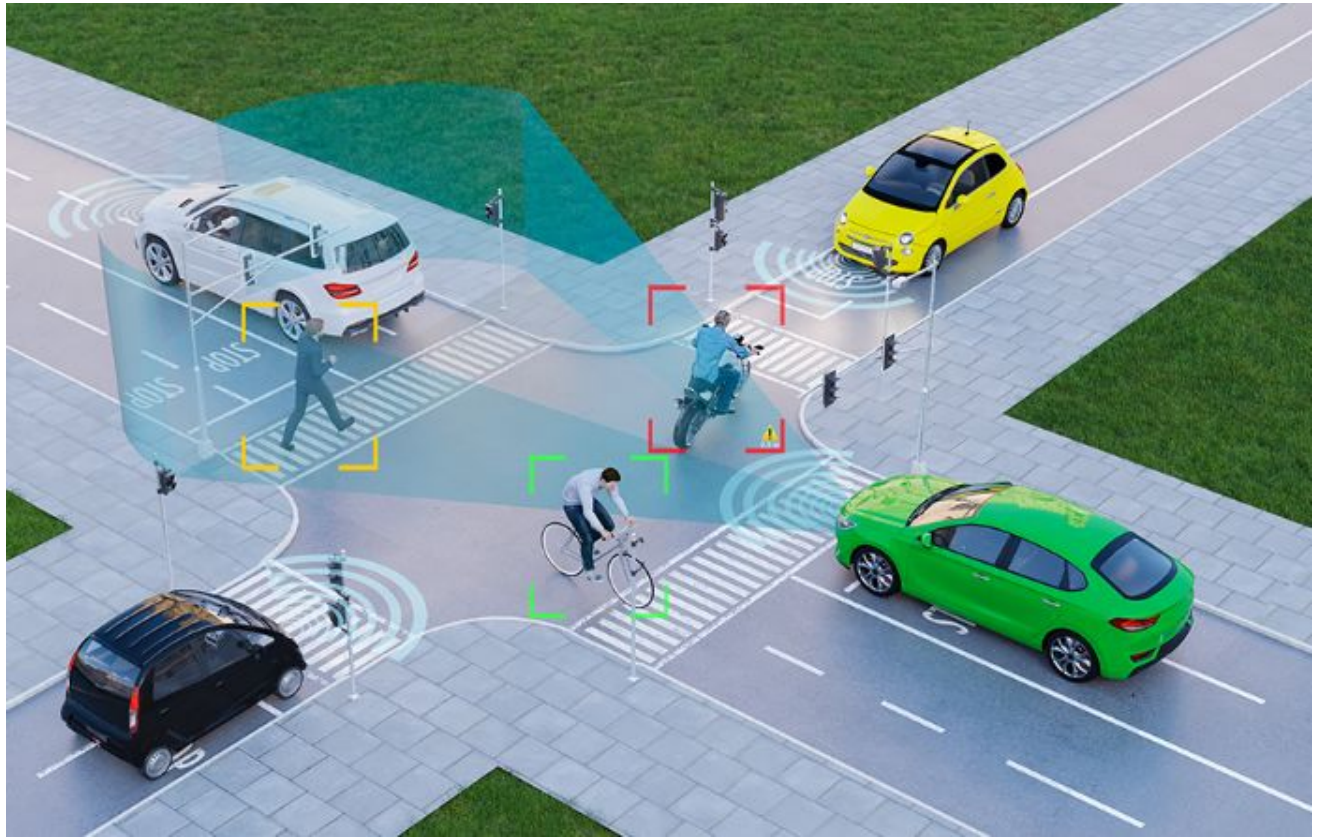
# Acting rationally: The rational agent Approach

- The rational-agent approach has two advantages over the other approaches.
  1. It is more general than the “laws of thought” approach because correct inference is just one of several possible mechanisms for achieving rationality.
  2. It is more amenable to scientific development than are approaches based on human behavior or human thought.

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# AI Applications

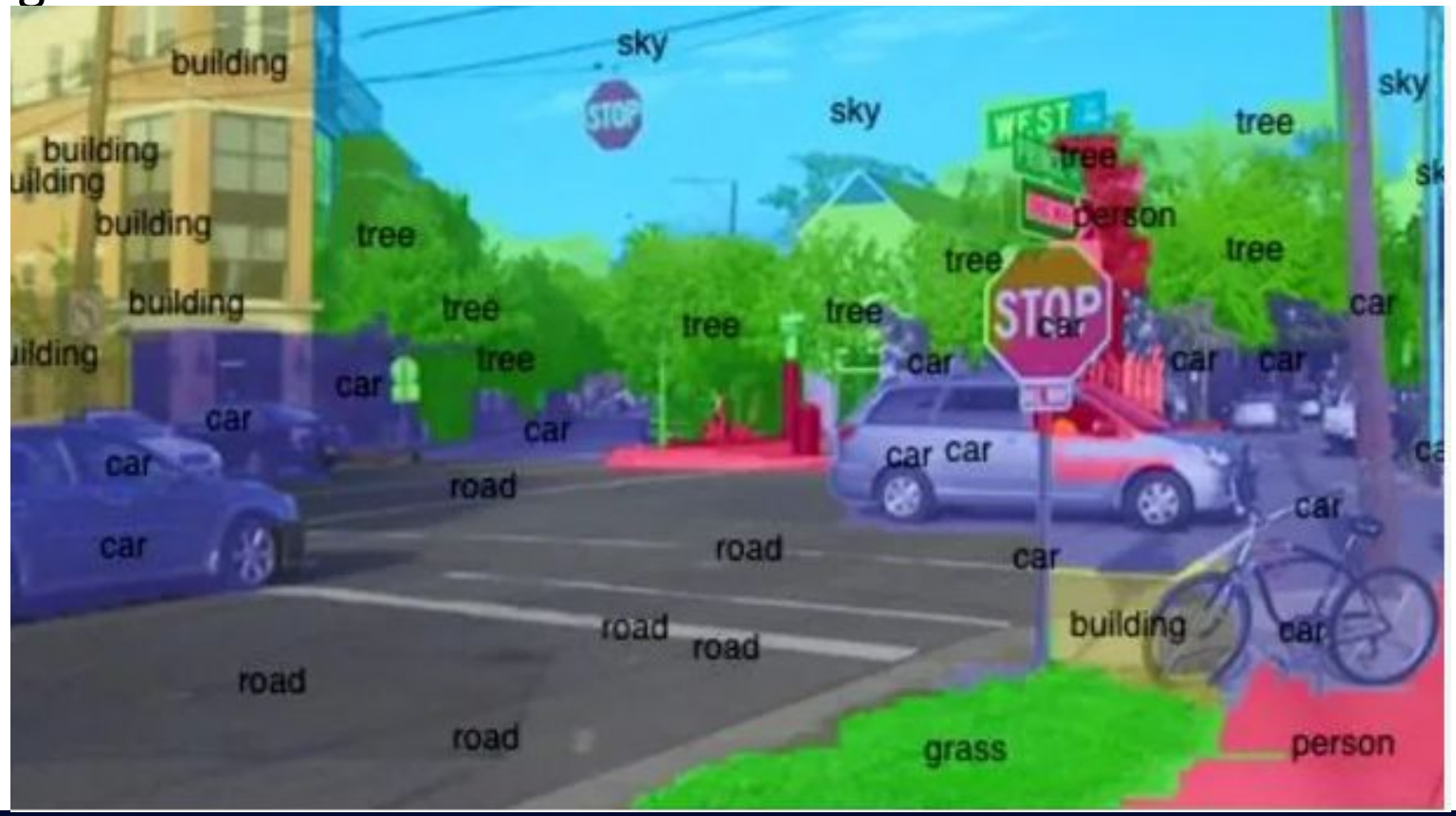
- Computer Vision



CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# AI Applications

- Image Recognition



CAMBRIDGE
INSTITUTE OF TECHNOLOGY

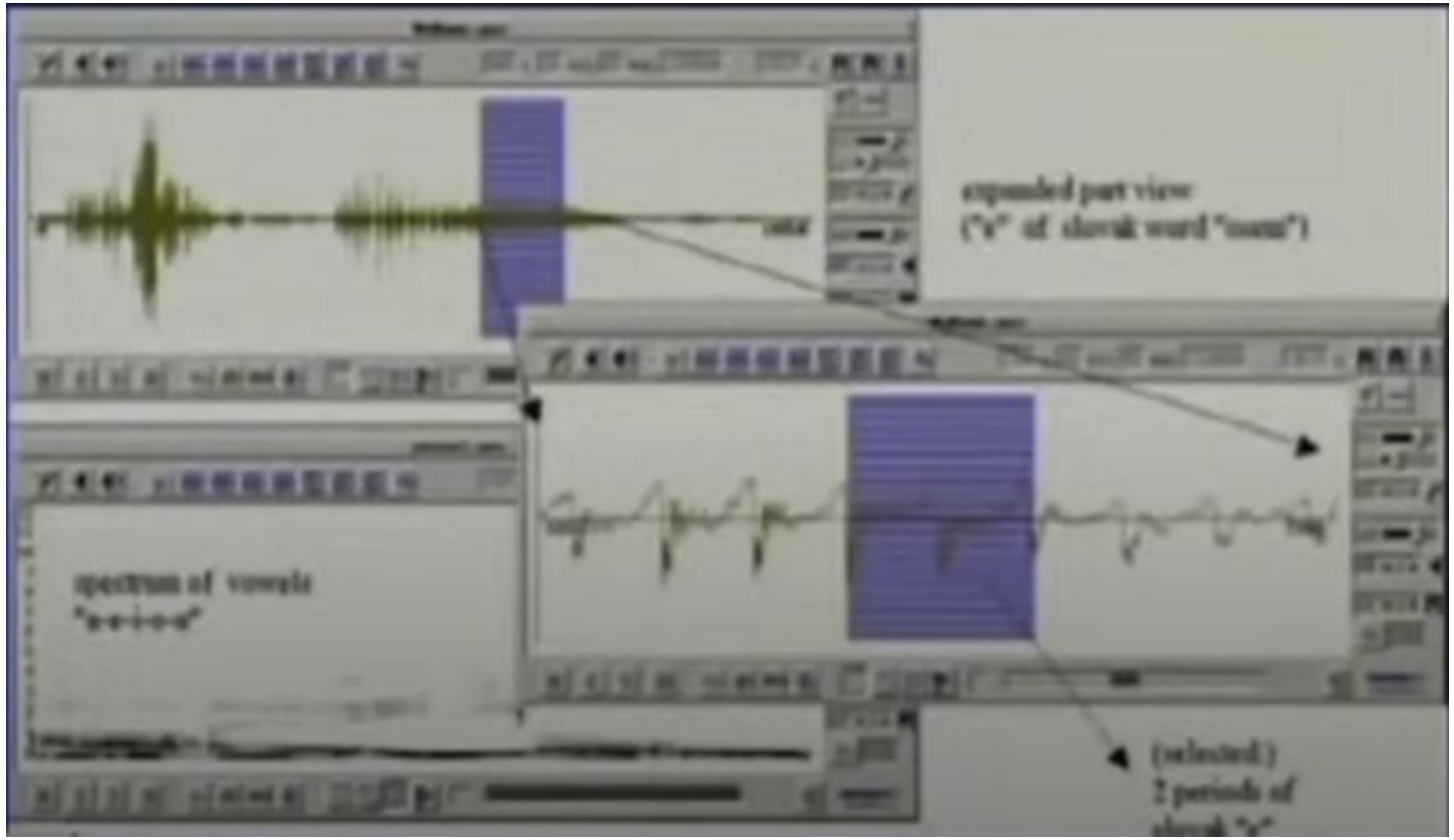
# AI Applications

- Robotics

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# AI Applications

- Speech Processing



CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# AI Applications

- AI components are embedded in numerous devices e.g. copy machines.
- AI systems are in everyday use
  - detecting credit card fraud
  - configuring products
  - aiding complex planning tasks
  - advising physicians.
- Intelligent tutoring systems provide students with personalized attention.

CAMBRIDGE INSTITUTE OF TECHNOLOGY

# AI Applications

- Robotic Vehicles


STANLEY – Stanford team wins the DARPA Grand challenge in 2005


CMU's Boss wins the DARPA Urban Challenge in 2006

CAMBRIDGE
INSTITUTE OF TECHNOLOGY

# AI Applications

- Speech Recognition

# Application areas of AI

## 1. Natural Language Processing

- refers to the branch of computer science—and more specifically, the branch of artificial intelligence or AI—concerned with giving computers the ability to understand text and spoken words in much the same way human beings can.

By combining the power of **artificial intelligence, computational linguistics and computer science**, **Natural Language Processing (NLP) helps machines "read" text** by simulating the human **ability to understand language**.

- **Automatic summarization**
- **summarizing the meaning of documents and information**, but also for **understand the emotional meanings inside the information**, such as in collecting data from social media.
- **Sentiment analysis**
- **The goal of sentiment analysis is to identify sentiment among several posts** or even in the same post **where emotion is not always explicitly expressed**.
- Companies use natural language processing applications, such as **sentiment analysis**, to identify opinions and sentiment online to help them **understand what customers think about their products and services**

- **Machine Translation**
- Machine Translation is the subfield of computer linguistics that involves the use of software applications to translate text or speech from one language to another. One of the best examples of machine translation is Google Translate which is known to translate over 100 billion words every day.
- **Conversational User Interface**
- A conversational user interface is an interface for computers that emulates a conversation with a real human. For example, a chatbot.
- A chatbot is a text-based CUI that can act as a Q/A platform, allow users to place orders, give the status of their orders, sort information, book flight tickets, financial transactions, improve marketing campaigns, and a lot more.

- **Text Prediction**
- Text prediction refers to the process of estimating the next word in a phrase or sentence. One of the popular and common examples of text prediction is Google Search.
- **Text Classification**
- Unstructured text is everywhere. Emails, social media, websites, chat conversations are some of the areas where NLP text classification is an essential component and is rigorously used.
- **Spell Check**
- A spell checker is a software application that identifies and corrects spelling mistakes or typos in a text. One of the popular examples of spell checker software is Grammarly. It's a tool that integrates with a variety of text documents, automatically checks for spelling errors as the user continues to write, and suggests corrections.

- **Autocomplete and Autocorrect**
- Everyone is aware of the autocomplete function on a Google search bar. Just after typing a few letters the Google search bar automatically completes your search query. Or in any case that you have typed something incorrectly, the search gives you the correct and relevant results.

## 2. Vision and speech processing

- Speech processing is the study of speech signals and the processing methods of these signals.
- Computer vision, basically, is to infer different factors such as camera model, lighting, color, texture, shape and motion that affect images and videos, from visual inputs.

# Speech Recognition

- **Applications**
- Speech recognition makes the computer listens, including Siri on the iPhone that we can access in daily life
- Google voice input you can say a sentence, which turns into the text
- Speak to Google map says where I'm going, it can automatically generate navigation for you.

Speech recognition can be divided into three aspects:

- **Speech synthesis**, including online and offline speech synthesis;
- **Speech recognition**, including speech dictation and other aspects;
- **Semantic understanding** is to use neural networks to extract the meaning of speech, including voice evaluation and some features of some of our commonly used machine translation.

# Computer vision

- **Object recognition and detection.** The computer can quickly detect what we commonly see from the photos.

example, if we take out a landscape photo of a tourist area, we can immediately identify plants, people, animals, or vehicles on it, so does the computer.

- **Object Movement Tracking.** We have captured an image of an object on a certain frame. In the subsequent videos, we can continuously track the changes and conditions of this object. It is not an easy task. It is difficult to accurately identify an object because it will be subject to sunlight and light in the constant changes.

# 3. Robotics

- Robotics is an interdisciplinary sector of science and engineering dedicated to the design, construction and use of mechanical robots.
- A robot is the product of the robotics field, where programmable machines are built that can assist humans or mimic human actions.
- **AI in robotics** helps robots perform the crucial tasks with a human-like vision to detect or recognize the various objects.
- robotic surgery tools that are able to assist surgeons
- law enforcement bomb robots that are able to navigate into dangerous terrain to minimize human injury and casualty
- food and package sorting robots that are able to sense different materials and properly pick and sort the objects.

## 4. Expert systems

An expert system is a computer program that is designed to solve complex problems and to provide decision-making ability like a human expert.

It performs this by extracting knowledge from its knowledge base using the reasoning and inference rules according to the user queries.

Examples:

**DENDRAL:** It was an artificial intelligence project that was made as a chemical analysis expert system. It was used in organic chemistry to detect unknown organic molecules with the help of their mass spectra and knowledge base of chemistry.

- **MYCIN:** It was one of the earliest backward chaining expert systems that was designed to find the bacteria causing infections like bacteraemia and meningitis. It was also used for the recommendation of antibiotics and the diagnosis of blood clotting diseases.

- **PXDES:** It is an expert system that is used to determine the type and level of lung cancer. To determine the disease, it takes a picture from the upper body, which looks like the shadow. This shadow identifies the type and degree of harm.

- **CaDeT:** The CaDet expert system is a diagnostic support system that can detect cancer at early stages.

## Applications of Expert System

- **In designing and manufacturing domain**
  It can be broadly used for designing and manufacturing physical devices such as camera lenses and automobiles.
- **In the knowledge domain**
  These systems are primarily used for publishing the relevant knowledge to the users. The two popular ES used for this domain is an advisor and a tax advisor.
- **In the finance domain**
  In the finance industries, it is used to detect any type of possible fraud, suspicious activity, and advise bankers that if they should provide loans for business or not.
- **In the diagnosis and troubleshooting of devices**
  In medical diagnosis, the ES system is used, and it was the first area where these systems were used.
- **Planning and Scheduling**
  The expert systems can also be used for planning and scheduling some particular tasks for achieving the goal of that task.

# The State of The Art


## *What can AI do today?*

- Robotic vehicles

A driverless robotic car named STANLEY sped through the rough terrain of the Mojave dessert at 22 mph, finishing the 132-mile course first to win the 2005 DARPA Grand Challenge. STANLEY is a Volkswagen Touareg outfitted with cameras, radar, and laser rangefinders to sense the environment and onboard software to command the steering, braking, and acceleration (Thrun, 2006). The following year CMU's BOSS won the Urban Challenge, safely driving in traffic through the streets of a closed Air Force base, obeying traffic rules and avoiding pedestrians and other vehicles.

- 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.

- Autonomous planning and scheduling

A hundred million miles from Earth, NASA's Remote Agent program became the first on-board autonomous planning program to control the scheduling of operations for a spacecraft (Jonsson et al., 2000).

REMOTE AGENT generated plans from high-level goals specified from the ground and monitored the execution of those plans—detecting, diagnosing, and recovering from problems as they occurred.

Successor program MAPGEN plans the daily operations for NASA's Mars Exploration Rovers, and MEXAR2 did mission planning—both logistics and science planning—for the European Space Agency's Mars Express mission in 2008.

- Game playing

IBM's DEEP BLUE became the first computer program to defeat the world champion in a chess match when it bested Garry Kasparov by a score of 3.5 to 2.5 in an exhibition match (Goodman and Keene, 1997).

Kasparov said that he felt a "new kind of intelligence" across the board from him. Newsweek magazine described the match as "The brain's last stand."

The value of IBM's stock increased by $18 billion. Human champions studied Kasparov's loss and were able to draw a few matches in subsequent years, but the most recent human-computer matches have been won convincingly by the computer.

- Spam fighting

Each day, learning algorithms classify over a billion messages as spam, saving the recipient from having to waste time deleting what, for many users, could comprise 80% or 90% of all messages, if not classified away by algorithms.

Because the spammers are continually updating their tactics, it is difficult for a static programmed approach to keep up, and learning algorithms work best (Sahami et al., 1998; Goodman and Heckerman, 2004).

- Logistics planning

During the Persian Gulf crisis of 1991, U.S. forces deployed a Dynamic Analysis and Replanning Tool, DART (Cross and Walker, 1994), to do automated logistics planning and scheduling for transportation.

This involved up to 50,000 vehicles, cargo, and people at a time, and had to account for starting points, destinations, routes, and conflict resolution among all parameters.

The AI planning techniques generated in hours a plan that would have taken weeks with older methods. The Defense Advanced Research Project Agency (DARPA) stated that this single application more than paid back DARPA's 30-year investment in AI.

- Robotics

The iRobot Corporation has sold over two million Roomba robotic vacuum cleaners for home use.

The company also deploys the more rugged PackBot to Iraq and Afghanistan, where it is used to handle hazardous materials, clear explosives, and identify the location of snipers.

Packbot

Roomba

- Machine Translation

A computer program automatically translates from Arabic to English, allowing an English speaker to see the headline “Ardogan Confirms That Turkey Would Not Accept Any Pressure, Urging Them to Recognize Cyprus.”

The program uses a statistical model built from examples of Arabic-to-English translations and from examples of English text totaling two trillion words (Brants et al., 2007). None of the computer scientists on the team speak Arabic, but they do understand statistics and machine learning algorithms.

# ARTIFICIAL INTELLIGENCE – BCS515B

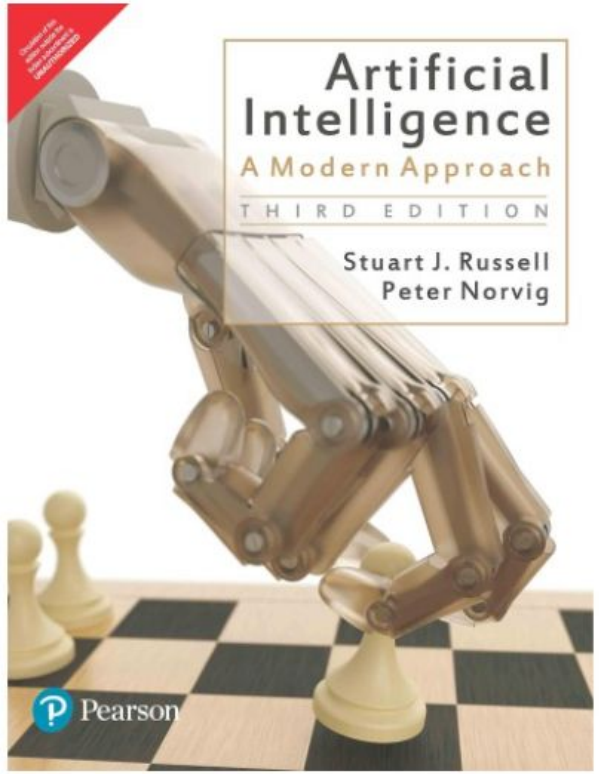
## Module 1

**Introduction:** What Is AI? , The State of The Art.

**Intelligent Agents:** Agents and environment, Concept of Rationality, The nature of environment, The structure of agents.

**Chapter 1 - 1.1, 1.4**

**Chapter 2 - 2.1, 2.2, 2.3, 2.4**



# THANK YOU