Introduction – Chapter 1

AI is one of the newest fields in science and engineering

AI Definition

- **The exciting new effort to make computers thinks … *machine 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)**

Think Like Humans

AI Definition

- "The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990)
- "The study of how to make computers do things at which, at the moment, people do better", (Rich and Knight, 1991)

Act Like Humans

AI Definition

- "The study of mental faculties through the use of computational models",(Charniak et al. 1985)

- "The study of the computations that make it possible to perceive, reason and act",(Winston, 1992)
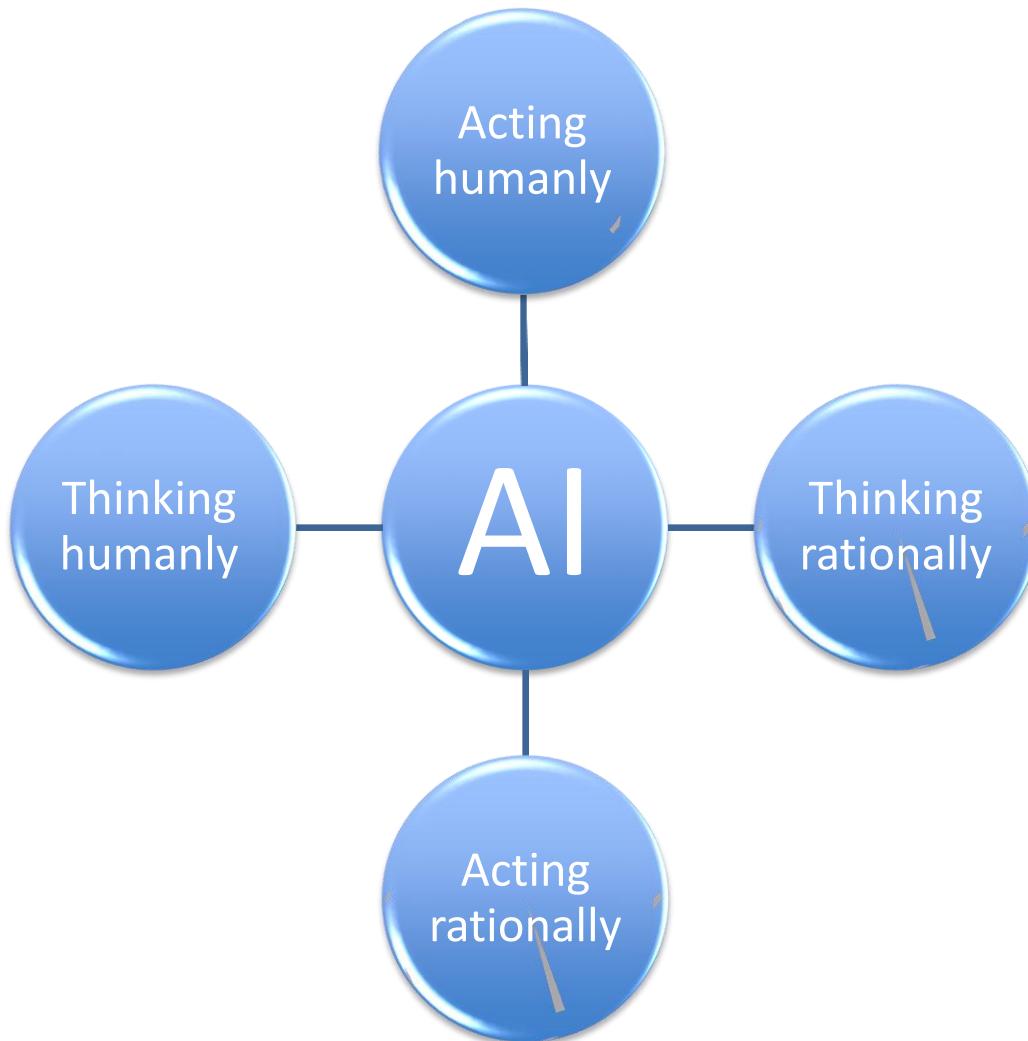
Think Rationally

AI Definition

- **"Computational Intelligence is the study of the design of intelligent agents"** (Poole et al, 1998)

- **"AI….is concerned with intelligent behavior in artifact", (Nilsson, 1998)**
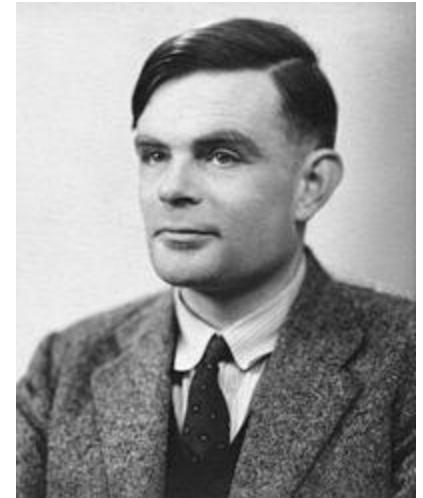
Act Rationally

How to Achieve AI?

Acting Humanly: The Turing Test

- The **Turing Test**, proposed by Alan Turing TURING TEST (1950),

- 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.

❖ To be intelligent, a program should simply act like a human

Alan Turing

1912-1954
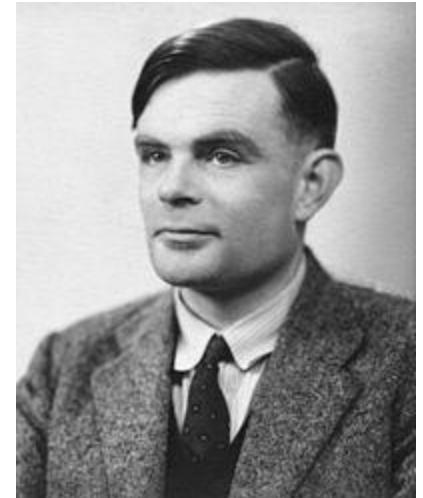
Acting Humanly

- To pass the Turing test, the computer/robot needs:

  - **Natural language processing** to communicate successfully.

  - **Knowledge representation** to store what it knows or hears.

  - **Automated reasoning** to answer questions and draw conclusions using stored information.

  - **Machine learning** to adapt to new circumstances and to detect and extrapolate patterns.

  - These are the main branches of AI.

Acting Humanly: The Turing Test

Turing test+ physical interaction => Total Turing Test

- **Recognize objects and gestures**
- **Move objects**

❖ To be intelligent, a program should simply act like a human

Alan Turing

1912-1954

Acting Humanly – for Total Turing

- To pass the Turing test, the computer/robot needs:

    – **Natural language processing** to communicate successfully.

    – **Knowledge representation** to store what it knows or hears.

    – **Automated reasoning** to answer questions and draw conclusions using stored information.

    – **Machine learning** to adapt to new circumstances and to detect and extrapolate patterns.

    – **Computer vision** to perceive objects. (Total Turing test)

    – **Robotics** to manipulate objects and move. (Total Turing test)

    ➢ These are the main branches of AI.

Thinking Humanly
The cognitive modeling approach

- Real intelligence requires thinking → think like a human !

- First, we should know how a human think
  - **Introspect ones thoughts:** Trying to catch our own thoughts
  - **Physiological experiment**: observing a person in action
  - **Brain imaging:** observing the brain in action

- Then, we can build programs and models that think like humans
  - **Resulted in the field of cognitive science**: a merger between AI and psychology.

Problems with Imitating Humans

- The human thinking process is difficult to understand: how does the mind raises from the brain ? Think also about unconscious tasks such as vision and speech understanding.

- Real cognitive science, is based on experimental investigation of actual humans or animals.

- Humans are not perfect ! We make a lot of systemic mistakes:

Thinking Rationally

- Instead of thinking like a human think rationally.
- Find out how correct thinking must proceed: **the laws of thought.**
- **Aristotle syllogism:** "Socrates is a man; all men are mortal, therefore Socrates is mortal."
- This initiated logic a traditional and important branch of mathematics and computer science.
- **Problem:**
  - **First,** 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.
  - **Second**, there is a big difference between solving a problem "in principle" and solving it in practice.

Acting Rationally

- **Agent:** something that acts

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

- **Rational agent:** acts as to achieve the best outcome or when there is uncertainty, the best expected outcome.

- Logical thinking is only one aspect of appropriate behavior: reactions like getting your hand out of a hot place is not the result of a careful deliberation, yet it is clearly rational.

- **Advantages** (rational-agent approach):
  - more general than "thinking rationally" and more
  - Mathematically principled; proven to achieve rationality unlike human behavior or thought

Acting Rationally

This is how birds fly

Humans tried to mimic birds for centuries

This is how we finally achieved "artificial flight"

Relations to Other Fields

- **Philosophy**
  - Logic, methods of reasoning and rationality.
- **Mathematics**
  - Formal representation and proof, algorithms, computation, (un)decidability, (in)tractability, probability.
- **Economics**
  - utility, decision theory (decide under uncertainty)
- **Neuroscience**
  - neurons as information processing units.
- **Psychology/Cognitive Science**
  - how do people behave, perceive, process information, represent knowledge
- **Computer engineering**
  - building fast computers
- **Control theory**
  - design systems that maximize an objective function over time
- **Linguistics**
  - knowledge representation, grammar

AI History

- Gestation of AI (1934 - 1955)
  - In 1943, proposed a binary-based model of neurons
  - Any computable function can be modeled by a set of neurons
  - A serious attempt to model brain
  - 1950, Turing's "Computing Machinery and Intelligence ": turing test, reinforcement learning and machine learning
- The Inception of AI (1956)
  - Dartmouth meeting to study AI
  - an AI program "Logic Theorist" to prove many theorems
- Early Enthusiasm and great Expectation (1952-1969)
  - General Problem Solver imitates the human way of thinking
  - LISP (AI programming language) was defined
  - 1965, Robinson discovered the resolution method – logical reasoning
- AI Winter (1966-1973)
  - Computational intractability of many AI problems
  - Neural Network starts to disappear

AI History

- Knowledge-based systems (1969-1979)
  - Use domain knowledge to allow for stronger reasoning
- Becomes an Industry (1980-now)
  - Digital Equipment Corporation selling R1 "expert sytem"
  - From few million to billions in 8 years
- The return of neural network (1986-now)
  - With the back-propagation algorithm
- AI adopts scientific method (1987-now)
  - More common to base theorems on pervious ones or rigorous evidence rather than intuition
  - Speech recognition and HMM
- Emergence of intelligent agent (1995-now)
  - search engines, recommender systems,….
- Availability of very large data sets (2001 – now)
  - Worry more about the data

The State of the Art

- ## Robotics Vehicle: DARPA Challenge
- ## Speech Recognition : United Airlines
- ## Autonomous Planning and Scheduling
  - Remote Agent: Plan and control spacecraft
  - MAPGEN: daily planning of operations on NASA's exploration Rover
- ## Game Playing: IBM Deep Blue
- ## Spam Fighting
- ## Logistic Planning
  - DART – Dynamic Analysis and Replacing Tool
  - Gulf War 1991
  - To plan the logistic for transportation of 50k vehicles, cargo and people
  - Generated in hour a plan that could take weeks
- ## Robotics
- ## Machine Translation: Statistical models

Summary

- This course is concerned with creating rational agents: **artificial rationality**.

- AI has passed the era of infancy and is now attacking real life, complex problems, and it is succeeding in many of them.

- The history of AI has had a turbulent history with many ups and downs, phenomenal successes and deep disappointments resulting in fund cutbacks and economic losses.

- AI has flourished in the last two decades and it the researchers mentality shifted towards a rigorous scientific methodology:

    Firm theoretical basis & Serious experiments