ARTIFICIAL INTELLIGENCE

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BOOK : Artificial Intelligence A Modern Approach
Stuart J. Russell and Peter Norvig

By: Teame M.

CHAPTER ONE

Introduction to AI

Goals of this Course

AI is a very broad field with many subareas

- Make machines smarter (primary goal)
- Understand what intelligence is (Nobel Laureate purpose)
- Make machines more useful (entrepreneurial purpose)
- Probabilistic Learning, and Machine Learning

Artificial Intelligence

- Definition AI
- Objectives /Goals of AI
- Approaches to AI and Hypothesis of AI
- The Foundations of AI : Bits of History and the State of the Art
- Application Areas of AI

Artificial Intelligence

- **Artificial Intelligence made of:**

- **Artificial:**
  - ✓ Produced by human art or effort,
  - ✓ Not originating naturally.
- **Intelligence:**

Thinking capability

Artificial Intelligence

- What is Intelligence?

Intelligence:

- ✓ The capacity to learn and solve problems

  (Websters dictionary)

In particular,

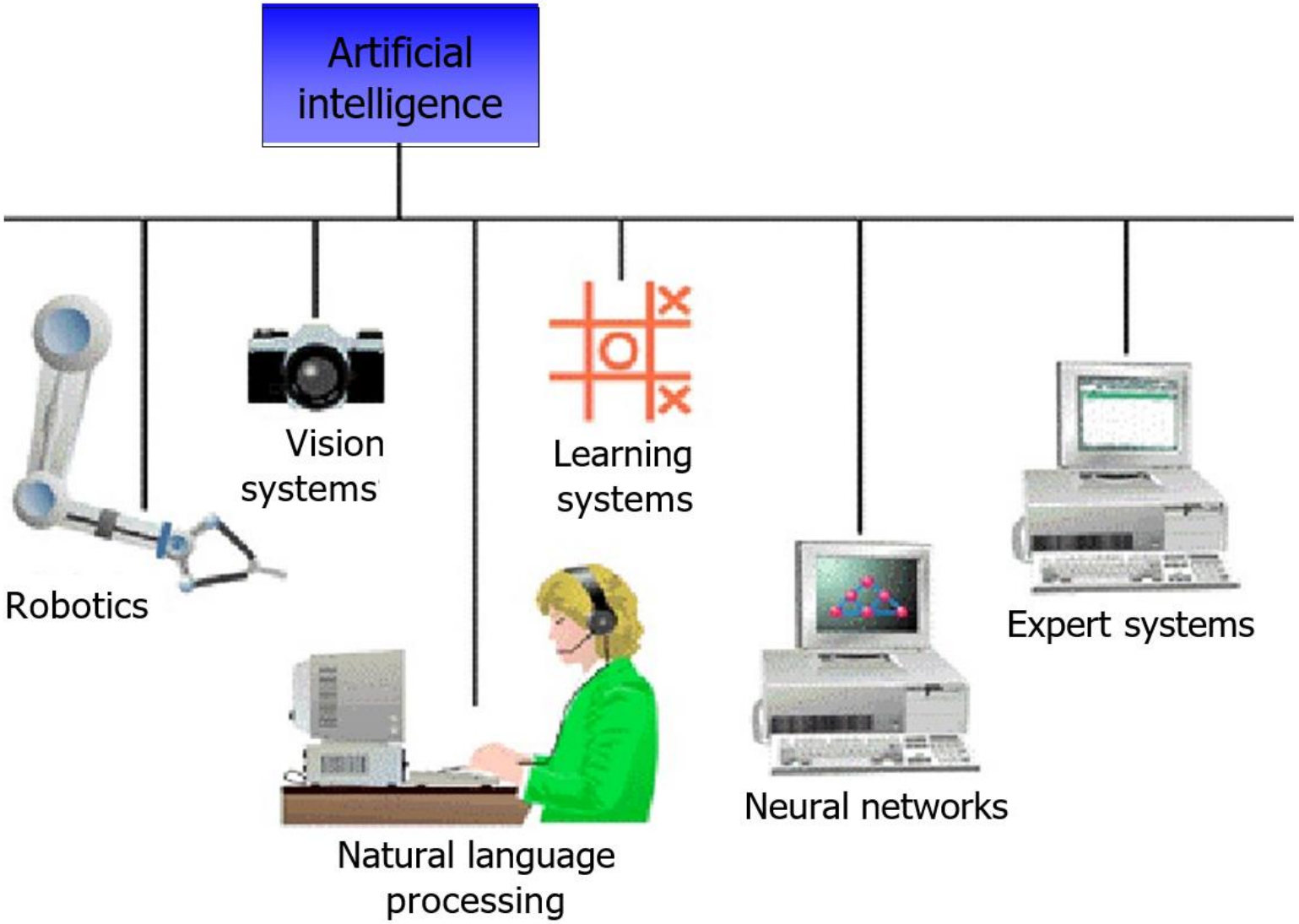
- The ability to solve novel problems
- The ability to act rationally
- The ability to act like humans

- ✓ the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines.

WHAT'S INVOLVED IN INTELLIGENCE?

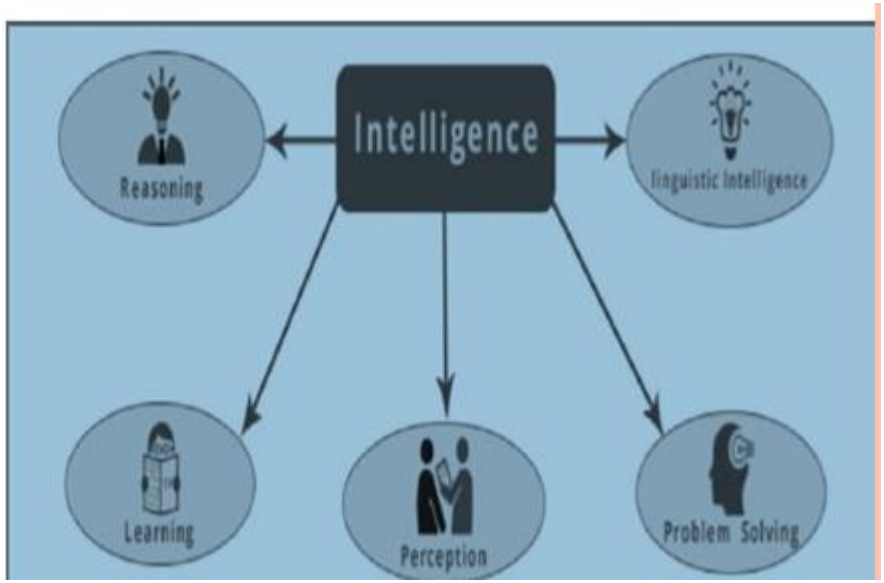
- Ability to interact with the real world
  - to perceive, understand, and act
  - e.g., speech recognition and understanding and synthesis e.g., image understanding
- Reasoning and Planning
  - modeling the external world, given input
  - solving new problems, planning, and making decisions
- Learning and Adaptation
  - we are continuously learning and adapting
  - our internal models are always being "updated" e.g., a baby learning to categorize and recognize animals

Introduction to Artificial Intelligence



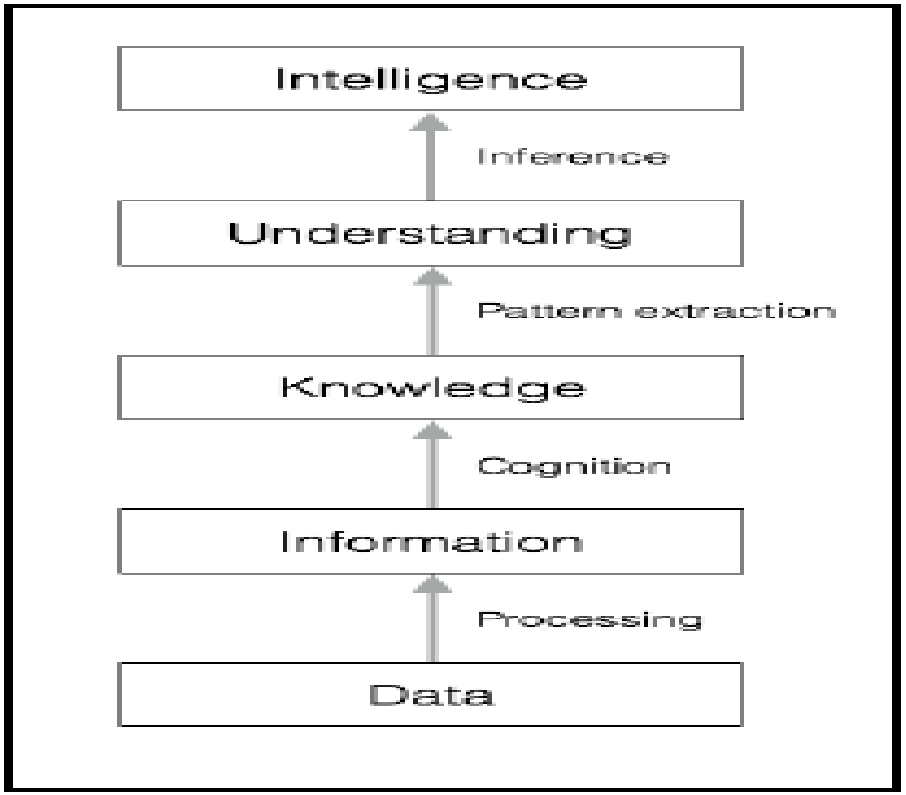
Artificial Intelligence

- Intelligence is composed of
  - Reasoning
  - Learning
  - Problem Solving
  - Perception
  - Linguistic Intelligence



Cont…

- Let's see how raw data gets converted to intelligence through various levels of processing:



What involved in Intelligence (again)

- Intelligent behavior/characteristics
  - Learn from experience
  - Apply knowledge acquired from experience
  - Handle complex situations
  - Solve problems when important information is missing
  - Determine what is important
  - React quickly and correctly to a new situation
  - Understand visual images
  - Process and manipulate symbols
  - Be creative and imaginative
  - Use heuristics

Objectives of AI

- In general, the specific goals of AI are:
  - Make machines smarter (primary goal)
  - Understand what intelligence is
  - Make machines more useful

Approaches of AI

- Approaches to AI do mean making computer:
  - Think like a human (Thinking humanly): **The cognitive modelling approach**
  - Act like a human (Acting humanly): **The Turing Test approach**
  - Think rationally (Thinking rationally): **The "laws of thought" approach**
  - Act rationally (Acting rationally): **The rational agent approach**

Think Humanly

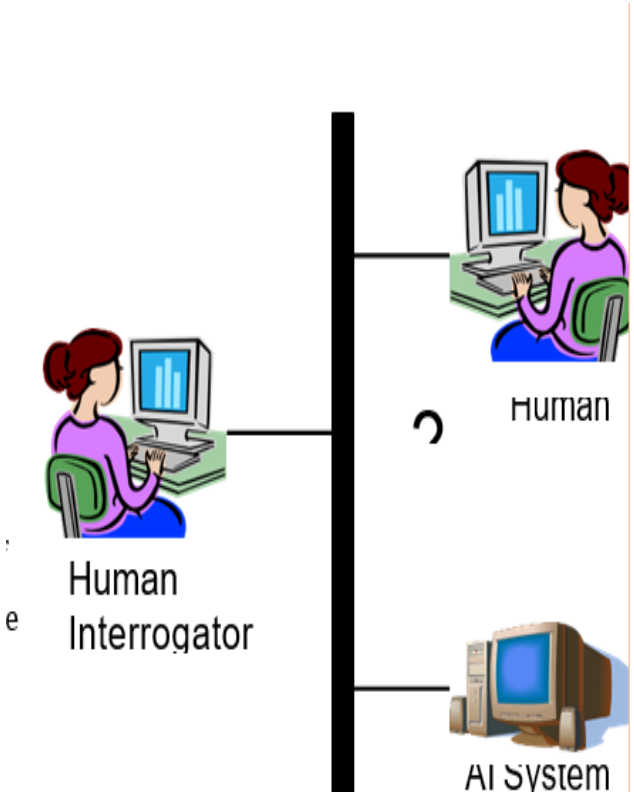
- If we are going to say that a given program thinks like a human, we must have some way of determining how humans think: the actual workings of human minds.
- There are two ways to do this:

1. through introspection trying to catch our own thoughts as they go by-and
2. Through psychological experiments. Through cognitive science

This approach Requires scientific theories of internal activities of the brain.

Acting Humanly: Turing Test

- In general, the specific goals of AI are:
- Use operational qualification rather than listing intelligence qualification
- The Turing Test (1950): "Computing machinery and intelligence“ for testing intelligence of machine.
- This test is proposed by Alan Turing
- He proposed computer pass that tests if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or not Programming.



Cont..

- Turing Test suggests major components required for AI
  - ***knowledge representation*** to store what it knows.
  - ***Automated reasoning :*** use the stored information to answer questions and to draw new conclusions;
  - ***computer vision:*** to perceive objects
  - ***machine learning:*** adapt to new circumstances and to detect and extrapolate patterns.
  - ***Natural language processing :*** *to communicate successfully in NL*
  - ***Robotics*** to manipulate objects and move about.

* Question: is it important that an intelligent system act like a human?

THINKING RATIONALLY

- Idea is from Aristotle philosophy of "**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.**

ACTING RATIONALLY :RATIONAL AGENT APPROACH

- An **agent (**the Latin word to mean ager to do) is just something that acts something.
- A **rational agent** is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.
- Making correct inferences is sometimes part of being a rational agent,
- All the skills needed for the Turing Test are there to allow rational actions.
- Rational behavior
  - Doing the right thing

❑ What is the “right thing”

- That which is expected to maximize goal achievement,
  - given available information

❑ We do many (“right”) things without thinking

THE FOUNDATIONS OF AI

- Philosophy: Logic, methods of reasoning, mind as physical system, foundations of learning, language, rationality.
- Mathematics: Formal representation and proof, algorithms, computation, (un)decidability, (in)tractability
- Neuroscience: neurons as information processing units.
- Psychology/ : how do people behave, perceive, process cognitive Cognitive Science information, represent knowledge.
- Computer: building fast computers engineering
- Linguistics: knowledge representation, grammars
- Probability/Statistics: modeling uncertainty, learning from data
- Economics: utility, decision theory, rational economic agents
- Computer Engineering: building fast computers

History of AI

- 1943: early beginnings
- McCulloch & Pitts: Boolean circuit model of brain/ Invented Artificial neurons
- 1950: Alan Turing
- Turing's "Computing Machinery and Intelligence“ was invented
- 1956: birth of AI
- Dartmouth Conference: "Artificial Intelligence“ name adopted
- 1965: Robinson's complete algorithm for logical reasoning
- 1969-79: Early development of knowledge based systems took place
- 1980-- AI becomes an industry
- 1986-- Neural networks return to popularity
- 1987-- AI becomes a science
- 1995-- The emergence of intelligent agents
- Currently: robotics, drones, self-driving cars etc..

Applications of AI

- AI has been applied in different areas. Such as:

- Expert System(ES)
- Natural Language Processing(NLP)
- Speech(Voice) understanding
- Robotics and sensory
- Computer vision and scene recognition
- Intelligent Computer aided instructions
- Neural Computing
- Game Playing
- Languages Translation
- Fuzzy logic
- Genetic Algorithms
- Intelligent Agents

Home/Dorm Work

- Can Computers Talk?
- Can Computers Recognize Speech?
- Can Computers Understand speech?
- Can Computers Learn and Adapt ?
- Can Computers “see”?
- Can computers plan and make optimal decisions?

Can Computers Talk?

- This is known as “speech synthesis”
  - translate text to phonetic form
    - e.g., “fictitious” -> fik-tish-es
  - use pronunciation rules to map phonemes to actual sound

e.g., “tish” -> sequence of basic audio sounds

Conclusion:

– NO, for complete sentences

– YES, for individual word

Can Computers Recognize Speech?

- Speech Recognition:
  - mapping sounds from a microphone into a list of words
  - classic problem in AI, very difficult
    - "Lets talk about how to wreck a nice beach"
    - (I really said "_____")
- Recognizing single words from a small vocabulary
- systems can do this with high accuracy (order of 99%)
- e.g., directory inquiries
  - limited vocabulary (area codes, city names)
  - computer tries to recognize you first, if unsuccessful hands you over to a human operator
  - saves millions of dollars a year for the phone companies

Recognizing human speech

- Recognizing normal speech is much more difficult
  - speech is continuous: where are the boundariesbetween words?
    - e.g., "John's car has a flat tire"
  - large vocabularies
    - can be many thousands of possible words
    - we can use **context** to help figure out what someone said
      - e.g., hypothesize and test
      - try telling a waiter in a restaurant:
        "I would like some dream and sugar in my coffee"
  - background noise, other speakers, accents, colds, etc
  - on normal speech, modern systems are only about 60-70% accurate

Can Computers Understand speech?

- Understanding is different to recognition:
  - "Time flies like an arrow"
    - assume the computer can recognize all the words
    - how many different interpretations are there?
      - 1. time passes quickly like an arrow?
      - 2. command: time the flies the way an arrow times the flies
      - 3. command: only time those flies which are like an arrow
      - 4. "time-flies" are fond of arrows
    - only 1. makes any sense,
      - but how could a computer figure this out?
      - clearly humans use a lot of implicit commonsense knowledgein communication
- Conclusion: NO, much of what we say is beyond the capabilities of a computer to understand at present.

Can Computers Learn and Adapt ?

- Learning and Adaptation
  - consider a computer learning to drive on the free way
  - we could teach it lots of rules about what to do
  - or we could let it drive and steer it back on course when it heads for the embankment
    - systems like this are under development (e.g., Daimler Benz)e.g., RALPH at CMU
      - in mid 90's it drove 98% of the way from Pittsburgh to San Diego without any human assistance
  - **machine learning** allows computers to learn to do things without explicit programming.
  - many successful applications:
    - requires some "set-up": does not mean your PC can learn to forecast the stock market or become a brain surgeon
- Conclusion: YES, computers can learn and adapt, when presented with information in the appropriate way

Can Computers "see"?

- Recognition v. Understanding (like Speech)
  - Recognition and Understanding of Objects in a scene
    - look around this room
    - you can effortlessly recognize objects
    - human brain can map 2d visual image to 3d "map"

- Why is visual recognition a hard problem?
- Conclusion:
  - mostly NO: computers can only "see" certain types of objects under limited circumstances
  - YES, for certain constrained problems (e.g., face recognition)

Can computers plan and make optimal decisions?

- Intelligence
  - involves solving problems and making decisions and plans
  - e.g., you want to take a holiday in Ethiopia
    - you need to decide on dates, flights
    - you need to get to the airport, etc
    - involves a sequence of decisions, plans, and actions
- What makes planning hard?
  - the world is not predictable:
    - your flight is canceled or there's a backup
  - there are a potentially huge number of details
    - do you consider all flights? all dates?
      - no: commonsense constrains your solutions
  - AI systems are only successful in constrained planning problems
- Conclusion: NO, real-world planning and decision-making is still beyond the capabilities of modern computers
  - exception: very well-defined, constrained problems

The End of chapter One