

**University of Science and Technology**  
**Faculty of Computer Science and Information**  
**Technology**



# **Artificial Intelligence (AI)**



**4<sup>th</sup> Year B.Sc : Information Technology**

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**Introduction to AI –(2/2)**

# What is Artificial Intelligence ?

- ❑ جعل الحاسب يفكر كما الإنسان? Making computers that think
- ❑ The automation of activities we associate with human thinking, like :decision making (إتخاذ القرارات), learning , pattern matching (مطابقة الأنماط) , pattern recognition (التعرف) ( ... , علي الأنماط) ?
- ❑ The art of creating machines that perform functions that require intelligence when performed by people ?
- ❑ The study of mental faculties (القدرات العقلية) through the use of computational models ?
- ❑ The study of computations that make it possible to perceive (يدرك / يشعر) , reason (يفسر/يعلل) and act ?

# What is Artificial Intelligence ?

- A field of study that seeks to explain and emulate intelligent behaviour in terms of computational processes ?
- A branch of computer science that is concerned with the automation of intelligent behaviour ?
- Anything in Computing Science that we don't yet know how to do properly ? (!)

# Overview of Artificial Intelligence

- **Artificial**

- Produced by human art or effort, rather than originating naturally.

- **Intelligence**

- is the ability to acquire knowledge and use it"  
[Pigford and Baur]

- **So AI was defined as:**

- AI is the study of ideas that enable computers to be intelligent.
- AI is the part of computer science concerned with design of computer systems that exhibit human intelligence(From the Concise Oxford Dictionary)

# Strong AI Vs Weak AI

## ❑ Strong AI

- Create a robot which is autonomous, thinks for itself, makes its own decisions, can deliberate about its own thoughts, can learn and adapt to new situations and can communicate with humans through the use of language.

## ❑ Weak AI

- To build a computer program that simulates a particular intelligent activity, e.g. playing chess.

# Overview of Artificial Intelligence

- **What is AI ?**
- Artificial intelligence is the study of how to make computers do things which, at the moment people do better.
- Some definitions of artificial intelligence, organized into four categories

# What is Artificial Intelligence ?

## Definition -1

**THOUGHT**

التفكير

Systems that **think**  
like **humans**

Thinking humanly

2

Systems that **think**  
**rationally**

Thinking rationally

3

Systems that **act**  
like **humans**

Acting humanly

1

Systems that **act**  
**rationally**

Acting rationally

4

**BEHAVIOUR**

السلوك

**HUMAN**

الانسان

**RATIONAL**

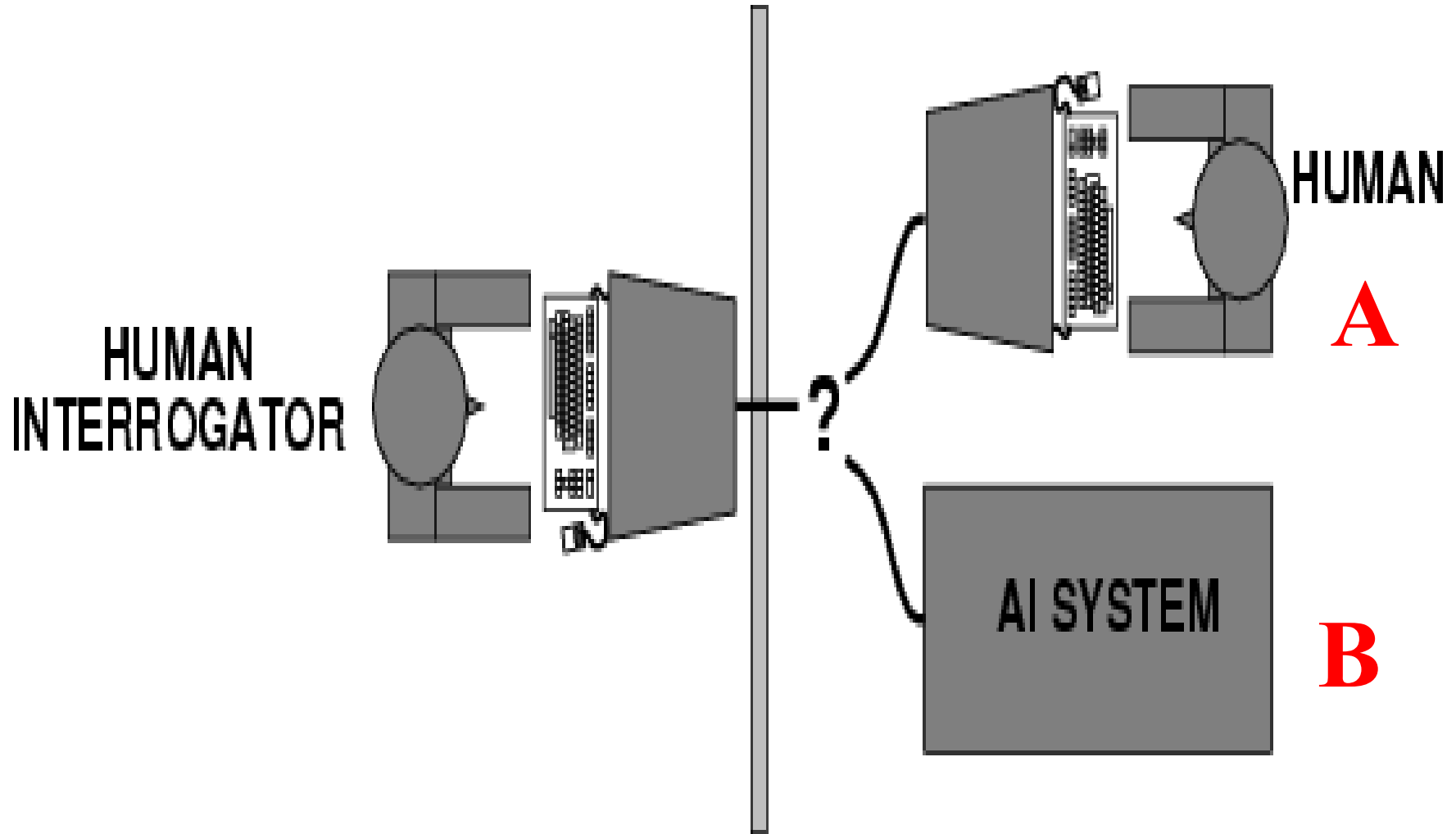
العقلانية

## Systems that **act** like **humans** (Acting humanly) (Turing Machine Test **إختبار تيورنج**)

- ❑ The **Turing Test**, proposed by (Alan Turing -1950)
- ❑ “This test represent the art of creating machines that perform functions that require intelligence when performed by people.” (Kurzweil-1990)
- ❑ “This test represent the study of how to make computers do things at which, at the moment, people are better.” (Rich and Knight-1991)
- ❑ The inability to distinguish computer responses from human responses is called the **Turing test**



# Systems that **act** like **humans** (Acting humanly) (Turing Machine Test **إختبار تيورنج**)



## Systems that **act** like **humans** (Acting humanly) (Turing Machine Test **إختبار تيورنج**)

- ❑ To conduct this test, we need two people and the machine to be evaluated.
- ❑ One person plays the role of the **interrogator**, who is in a separate room from the computer system (AI system) and the other person.
- ❑ The interrogator can ask questions of either the person or the computer by typing questions and receiving typed responses.
- ❑ However, the interrogator knows them only as **A** and **B** and aims to determine (distinguish) which the person is and which is the machine.

# Systems that **act** like **humans** (Acting humanly) (Turing Machine Test **إختبار تيورنج**)

## ❑ **The Turing Test approach**

- A human questioner cannot tell if there is a computer or a human answering his question, via teletype (remote communication)
- The computer must behave intelligently

## ❑ **Intelligent behavior**

- To achieve human-level performance in all cognitive tasks

# Systems that **act** like **humans** (Acting humanly) (Turing Machine Test **إختبار تيورنج**)

- ❑ **Computers would need to possess the following capabilities in order to pass Turing Test:**
  - *Natural language processing*
    - To communicate successfully in English
  - *Knowledge representation*
    - To store information effectively & efficiently
  - *Automated reasoning*
    - To retrieve & answer questions using the stored information
  - *Machine learning*
    - To adapt to new circumstances

Systems that **act** like **humans** (Acting humanly)  
(Turing Machine Test **إختبار تيورنج**)

## The total Turing Test

❑ Includes two more issues:

➤ *Computer vision*

- To perceive objects (seeing)

➤ *Robotics*

- To move objects (acting)

# What is Artificial Intelligence ?

## Definition -2

**THOUGHT**  
التفكير

Systems that **think**  
like **humans**

2

Systems that **think**  
**rationally**

**BEHAVIOUR**  
السلوك

Systems that **act**  
like **humans**

Systems that **act**  
**rationally**

**HUMAN**

الانسان

**RATIONAL**

العقلانية

# Systems that **think** like **humans** (Thinking humanly) (Cognitive Modeling **نمذجة المعرفة**)

- ❑ To construct a machine's program to think like a human, it requires two important things:
  - first it requires the knowledge about the actual workings of human mind i.e. **Formulate a theory of mind/brain.**
  - Express the theory in a computer program
- ❑ **Two Approaches**
  - **Cognitive Science and Psychology** (testing/ predicting responses of human subjects)
  - **Cognitive Neuroscience** (observing neurological data)

## Systems that **think** like **humans** (Thinking humanly) (Cognitive Modeling **نمذجة المعرفة** )

- ❑ After completing the study about human mind it is possible to express the theory as a computer program.
- ❑ If the program's **inputs/output** and **timing behavior** **matched** with the **human behavior** then we can say that the program's mechanism is working like a human mind.



# Systems that **think** like **humans** (Thinking humanly) (Cognitive Modeling **نمذجة المعرفة** )

❑ Humans are observed from ‘**inside**’

❑ How humans **think**? Three ways to do this:

- Through Introspection (الاستبطان) —trying to catch our own thoughts as they go by.
- Through psychological experiments (التجارب النفسية)—observing a person in action.
- Through brain imaging (صورة الدماغ) —observing the brain in action.

# Systems that **think** like **humans** (Thinking humanly) (Cognitive Modeling **نمذجة المعرفة** )

## ➤ Cognitive Science

- “The exciting new effort to make computers think ... machines with minds in the full and literal sense” (Haugeland1985)
- “[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning , mental organization...”  
(Bellman1978)

## Systems that **think** like **humans** (Thinking humanly) (Cognitive Modeling **نمذجة المعرفة** )

- ❑ Example: General Problem Solver (GPS) – A problem solvers always keeps track of human mind regardless of right answers.
- ❑ The problem solver is contrast to other researchers, because they are concentrating on getting the right answers regardless of the human mind.
- ❑ An Interdisciplinary field of cognitive science uses computer models from AI and experimental techniques from psychology to construct the theory of the working of the human mind.

# What is Artificial Intelligence ?

## Definition -3

**THOUGHT**  
التفكير

Systems that **think**  
like **humans**

Systems that **think**  
**rationally**

3

**BEHAVIOUR**  
السلوك

Systems that **act**  
like **humans**

Systems that **act**  
**rationally**

**HUMAN**

الانسان

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العقلانية

# Systems that **think rationally** (Thinking rationally)

## "Laws of Thought"

- ❑ Humans are not always 'rational'
- ❑ Rational - defined in terms of logic?
- ❑ Logic can't express everything (e.g. uncertainty)
- ❑ Logical approach is often not feasible in terms of computation time (needs 'guidance')
- ❑ "The study of mental facilities through the use of computational models" (Charniak and McDermott)
- ❑ "The study of the computations that make it possible to perceive, reason, and act" (Winston)

❑ Rational -> ideal intelligence

➤ (contrast with human intelligence)

❑ Rational thinking governed by precise “laws of thought”

➤ syllogisms

➤ notation and logic

❑ Systems (in theory) can solve problems using such laws

# What is Artificial Intelligence ?

## Definition -4

**THOUGHT**  
التفكير

Systems that **think**  
like **humans**

Systems that **think**  
**rationally**

**BEHAVIOUR**  
السلوك

Systems that **act**  
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4

**HUMAN**

الانسان

**RATIONAL**

العقلانية

# Systems that **act rationally** (Acting rationally) “Rational Agent”

- ❑ **Rational** behavior: doing the right thing
- ❑ **The right thing**: that which is expected to maximize goal achievement, given the available information
- ❑ Giving answers to questions is ‘acting’.
- ❑ I don't care whether a system:
  - Replicates human thought processes
  - Makes the same decisions as humans
  - Uses purely logical reasoning



# Systems that **act rationally** (Acting rationally) “Rational Agent”

- ❑ Logic → only part of a rational agent, not all of rationality
  - Sometimes logic cannot reason a correct conclusion
  - At that time, some specific (in domain) human knowledge or information is used
- ❑ Thus, it covers more generally different situations of problems
  - Compensate the incorrectly reasoned conclusion

# Systems that **act rationally** (Acting rationally) “Rational Agent”

❑ Study AI as rational agent –

## 2 advantages:

- It is more general than using logic only
  - Because: LOGIC + Domain knowledge
- It allows extension of the approach with more scientific methodologies

# Systems that **act rationally** (Acting rationally) “Rational Agent”

- ❑ An agent is an entity that perceives and acts
- ❑ This course is about designing rational agents
- ❑ Abstractly, an agent is a function from percept histories to actions:  $[f: P^* \rightarrow A]$
- ❑ For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance

# Systems that **act rationally** (Acting rationally) “Rational Agent”

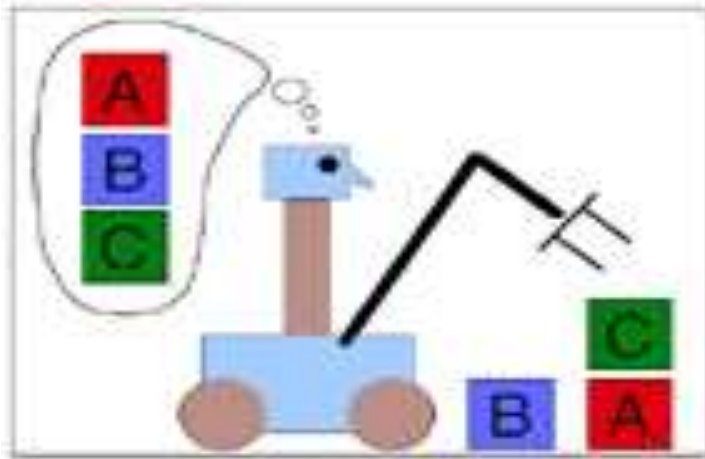
- ❑ Caveat: computational limitations make perfect rationality unachievable → design best program for given machine resources
- ❑ From the above two definitions, we can see that AI has two major roles:
  - Study the intelligent part concerned with humans.
  - Represent those actions using computers.

# Systems that **act rationally** (Acting rationally) “Rational Agent”

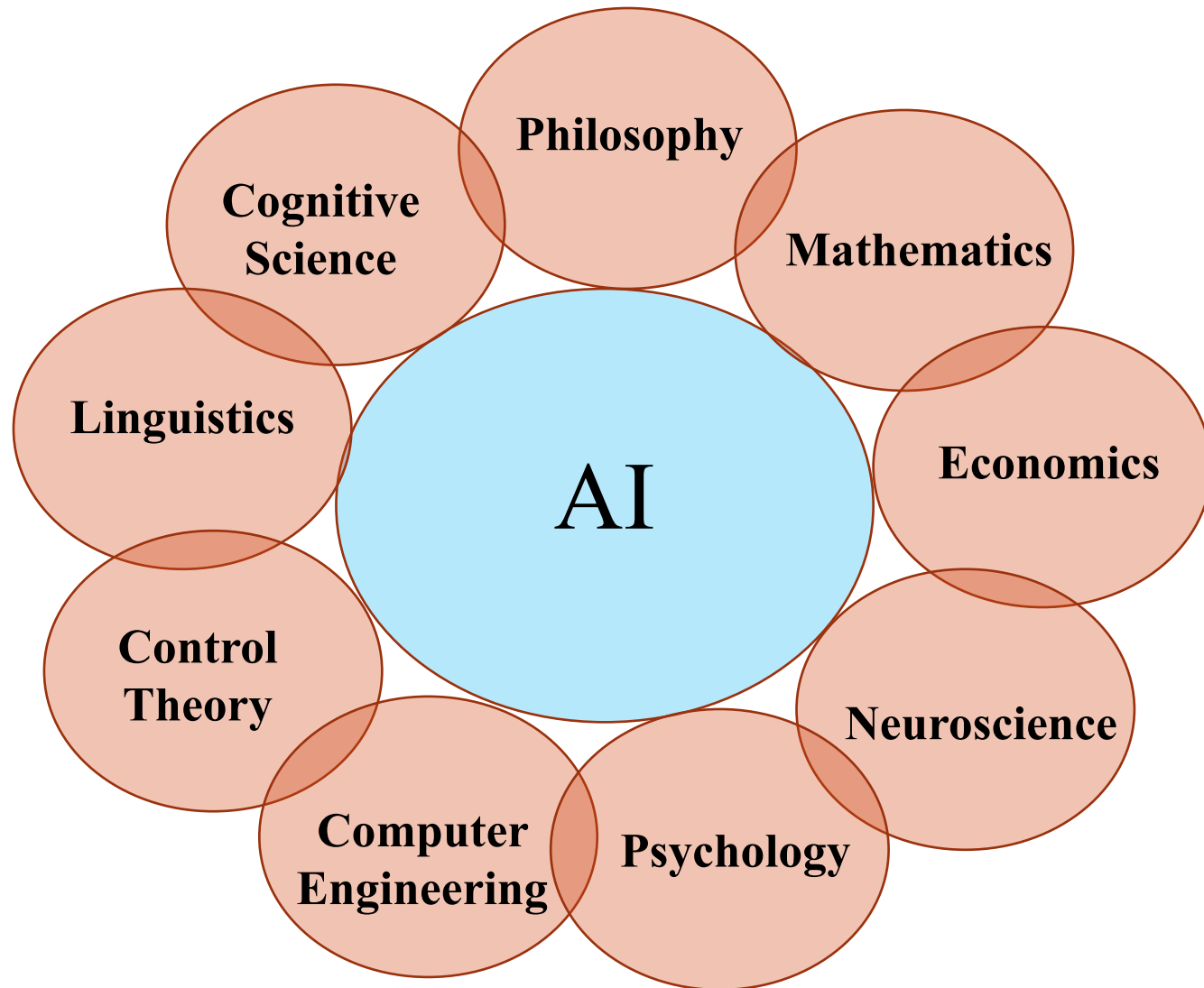
- ❑ Building systems that carry out actions to achieve the **best outcome** .
- ❑ Rational **behaviour** : May or may not involve rational thinking i.e., consider reflex actions.
- ❑ This is the definition we will adopt.

# Goals of AI

- ❑ To make computers more useful by letting them take over dangerous or tedious tasks from human
- ❑ Understand principles of human intelligence



# Academic Disciplines important to AI.



# Academic Disciplines important to AI.

## Philosophy

- Study of human intelligence began with no formal expression
- Initiate the idea of mind as a machine and its internal operations and processes
- Logic, methods of reasoning
- foundations of learning, language rationality.

## Mathematics

- formalizes the three main area of AI: computation, logic, and probability
- Computation leads to analysis of the problems that can be computed (complexity theory)

## Economics

- utility, decision theory

## Neuroscience

- neurons as information processing units.



# Academic Disciplines important to AI.

## Psychology/ Cognitive Science

- How do humans think and act?
- The study of human reasoning and acting
- Provides reasoning models for AI
- How do people behave, perceive, process information, represent knowledge.

## Computer Engineering

- Building fast and efficient computers
- The power of computer makes computation of large and difficult problems more easily

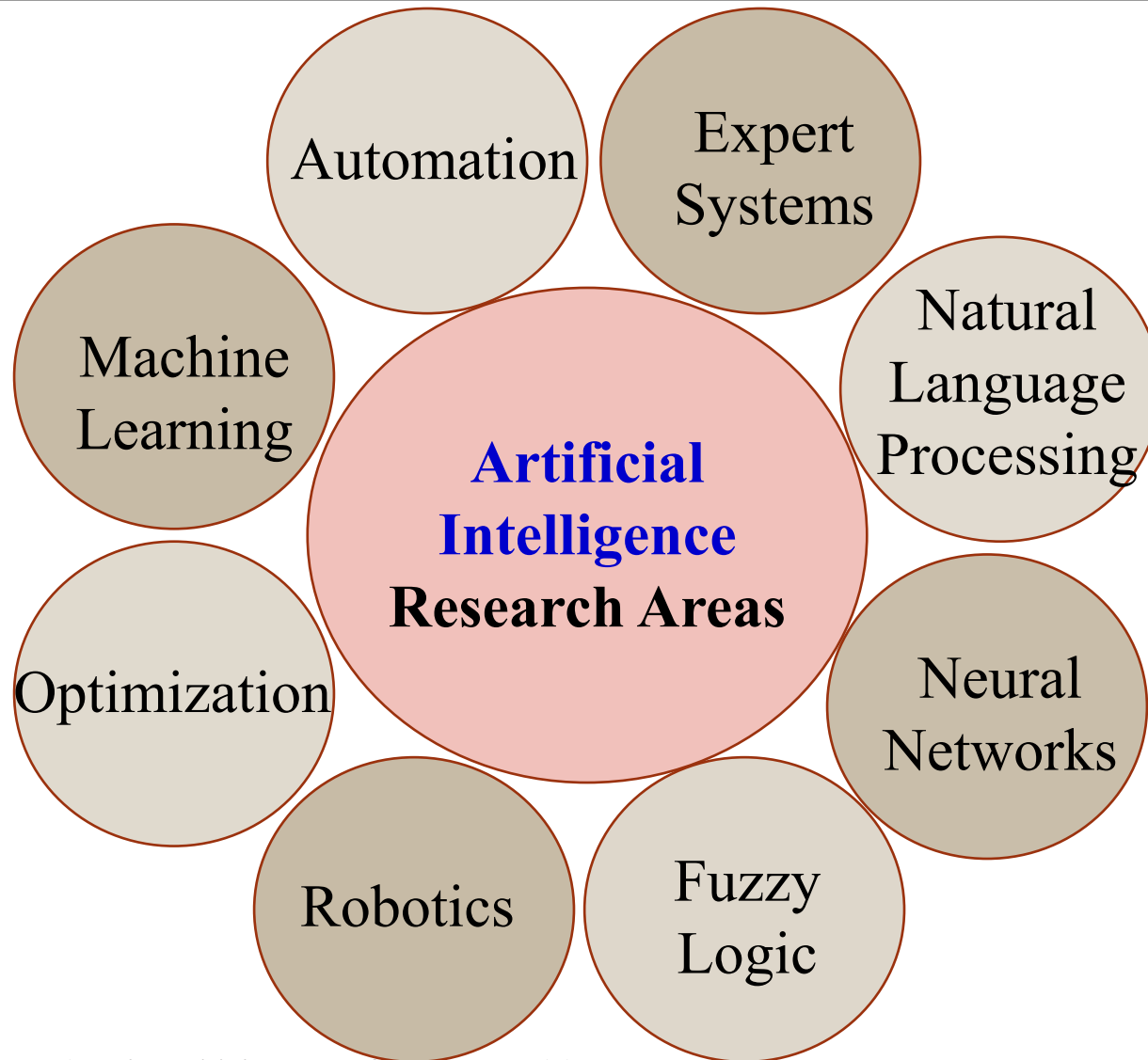
## Control Theory

- Design systems that maximize an objective function over time
- How can artifacts operate under their own control?
- The artifacts adjust their actions

## Linguistics

- Knowledge representation, grammar
- For understanding natural languages
- Syntactic and semantic analysis

# AI Research Areas



## Typical problems to which AI methods are applied

- ❑ Pattern recognition
- ❑ Optical character recognition
- ❑ Handwriting recognition
- ❑ Speech recognition
- ❑ Face recognition
- ❑ Computer vision
- ❑ Virtual reality
- ❑ Image processing
- ❑ Diagnosis

## Typical problems to which AI methods are applied

- ❑ Translation and Chatterboxes
- ❑ Nonlinear control and Robotics
- ❑ Artificial life
- ❑ Automated reasoning
- ❑ Automation
- ❑ Biologically inspired computing
- ❑ Concept mining
- ❑ Data mining
- ❑ Knowledge representation

## Typical problems to which AI methods are applied

- ❑ Game theory and Strategic planning
- ❑ Natural Language Processing(NLP)
- ❑ Semantic Web
- ❑ E-mail spam filtering
- ❑ Cognitive
- ❑ Cybernetics
- ❑ Hybrid intelligent system
- ❑ Intelligent agent
- ❑ Intelligent control

# History of AI

## The birth of artificial intelligence (1943–56)

- McCulloch and Pitts, A Logical Calculus of the Ideas Immanent in Nervous Activity, 1943
- Alan Turing, Computing Machinery and Intelligence, 1950
- The Electronic Numerical Integrator and Calculator (ENIAC) project (Von Neumann)
- Shannon, Programming a Computer for Playing Chess, 1950
- The Dartmouth College summer workshop on machine intelligence, artificial neural nets and automata theory, 1956

## The rise of artificial intelligence (1956–late 1960s)

- Invention of LISP (John McCarthy)
- The General Problem Solver (GPR) project (Newell and Simon)
- Gelertner: Geometry Theorem Prover
- Newell and Simon, Human Problem Solving, 1972
- Minsky, A Framework for Representing Knowledge, 1975

# History of AI

## Reality dawns 1966—73:

- Realization that many AI problems are intractable
- Limitations of existing neural network methods identified
- Neural network research almost disappears

## Adding domain knowledge 1969—85:

- Development of knowledge-based systems
- Success of rule-based expert systems,
  - E.g., DENDRAL, MYCIN
- But were brittle and did not scale well in practice

## Rise of machine learning 1986--

- Neural Networks return to popularity
- Major advances in machine learning algorithms and applications

# History of AI

## Role of uncertainty 1990--

- Bayesian networks as a knowledge representation framework

## Major advances in all areas of AI – 1990

- Significant demonstrations in machine learning
- Case-based reasoning
- Multi-agent planning
- Scheduling
- Data mining, Web Crawler
- natural language understanding and translation
- Vision, Virtual Reality
- Games



# History of AI

## AI as Science 1995--

- Integration of learning, reasoning, knowledge representation
- AI methods used in vision, language, data mining, etc

1997

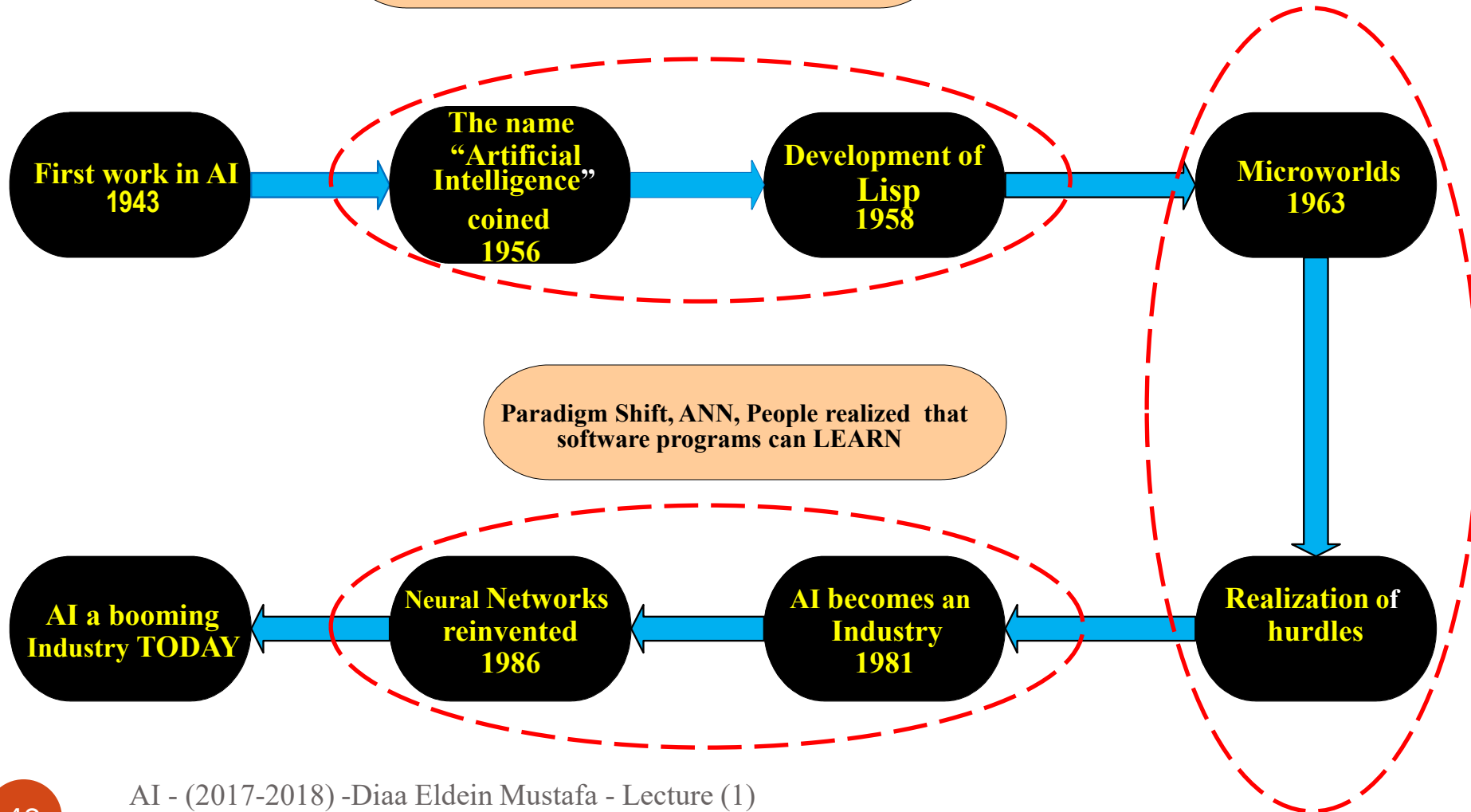
- The Deep Blue Chess Program beats the then world chess champion, Garry Kasparov.

2000

- Interactive robot pets become commercially available. MIT displays Kismet, a robot with a face that expresses emotions. The robot Nomad explores remote regions of Antarctica and locates meteorites.

Paradigm Shift, GPS, People realized that all the problems can NOT be solved with the same approach

Paradigm Shift, Expert Systems, People realized that software programs can act as EXPERTS



# AI applications

- ❑ **Gaming** – AI plays crucial role in strategic games such as chess, poker, tic-tac-toe, etc., where machine can think of large number of possible positions based on heuristic knowledge.
- ❑ **Natural Language Processing (NLP)**– It is possible to interact with the computer that understands natural language spoken by humans.
- ❑ **Expert Systems(ES)** – There are some applications which integrate machine, software, and special information to impart reasoning and advising. They provide explanation and advice to the users.

# AI applications

- ❑ **Speech Recognition** – Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it. It can handle different accents, slang words, noise in the background, change in human's noise due to cold, etc.
- ❑ **Intelligent Robots** – Robots are able to perform the tasks given by a human. They have sensors to detect physical data from the real world such as light, heat, temperature, movement, sound, bump, and pressure. They have efficient processors, multiple sensors and huge memory, to exhibit intelligence. In addition, they are capable of learning from their mistakes and they can adapt to the new environment

# AI applications

- ❑ **Robotics for Heavy industry** – have become common in many industries and are often given jobs that are considered dangerous to humans.
- ❑ Robots have proven effective in jobs that are very repetitive which may lead to mistakes or accidents due to a lapse in concentration and other jobs which humans may find degrading.
- ❑ In 2014, China, Japan, the United States, the Republic of Korea and Germany together amounted to 70% of the total sales volume of robots.
- ❑ In the automotive industry, a sector with particularly high degree of automation, Japan had the highest density of industrial robots in the world: 1,414 per 10,000 employees.

## AI applications

- ❑ **Smart Cars** – You probably haven't seen someone reading the newspaper while driving to work yet, but self-driving cars are moving closer and closer to reality; Google's self-driving car project and Tesla's "autopilot" feature are two examples that have been in the news lately. Earlier this year, the Washington Post reported on an algorithm developed by Google that could potentially let self-driving cars learn to drive in the same way that humans do: through experience.

## AI applications

**News Generation** – Did you know that artificial intelligence programs can write news stories? According to Wired, the AP, Fox, and Yahoo! all use AI to write simple stories like financial summaries, sports recaps, and fantasy sports reports. AI isn't writing in-depth investigative articles, but it has no problem with very simple articles that don't require a lot of synthesis. Automated Insights, the company behind the Wordsmith software, says that e-commerce, financial services, real estate, and other “data-driven” industries are already benefitting from the app.

## AI applications

- ❑ **Machine Learning(ML):** Is a type of artificial intelligence (AI) that allows software applications to become more accurate in predicting outcomes without being explicitly programmed. The basic premise of machine learning is to build algorithms that can receive input data and use statistical analysis to predict an output value within an acceptable range.
- ❑ **Automatic Programming:**

Is the generation of programs by computer, usually based on specifications that are higher-level and easier for humans to specify than ordinary programming languages. Automatic programming might be summarized as "Artificial Intelligence meets Compilers:"



# AI applications

## ❑ Human Performance Modeling

(HPM) is a method of quantifying human behavior, cognition, and processes; a tool used by human factors researchers and practitioners for both the analysis of human function and for the development of systems designed for optimal user experience and interaction .

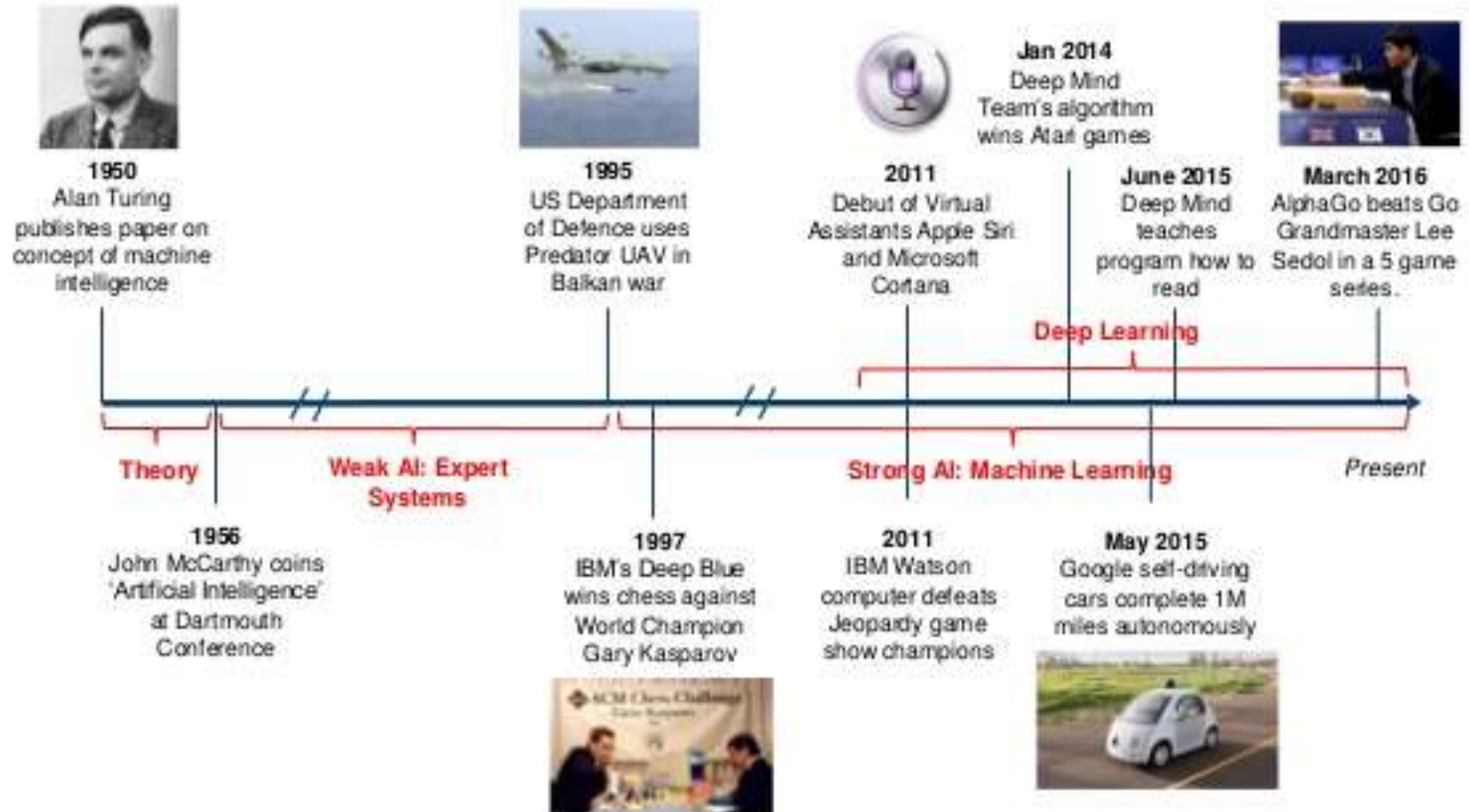
## ❑ Data Mining and Data warehousing (Big –Data)

## AI applications

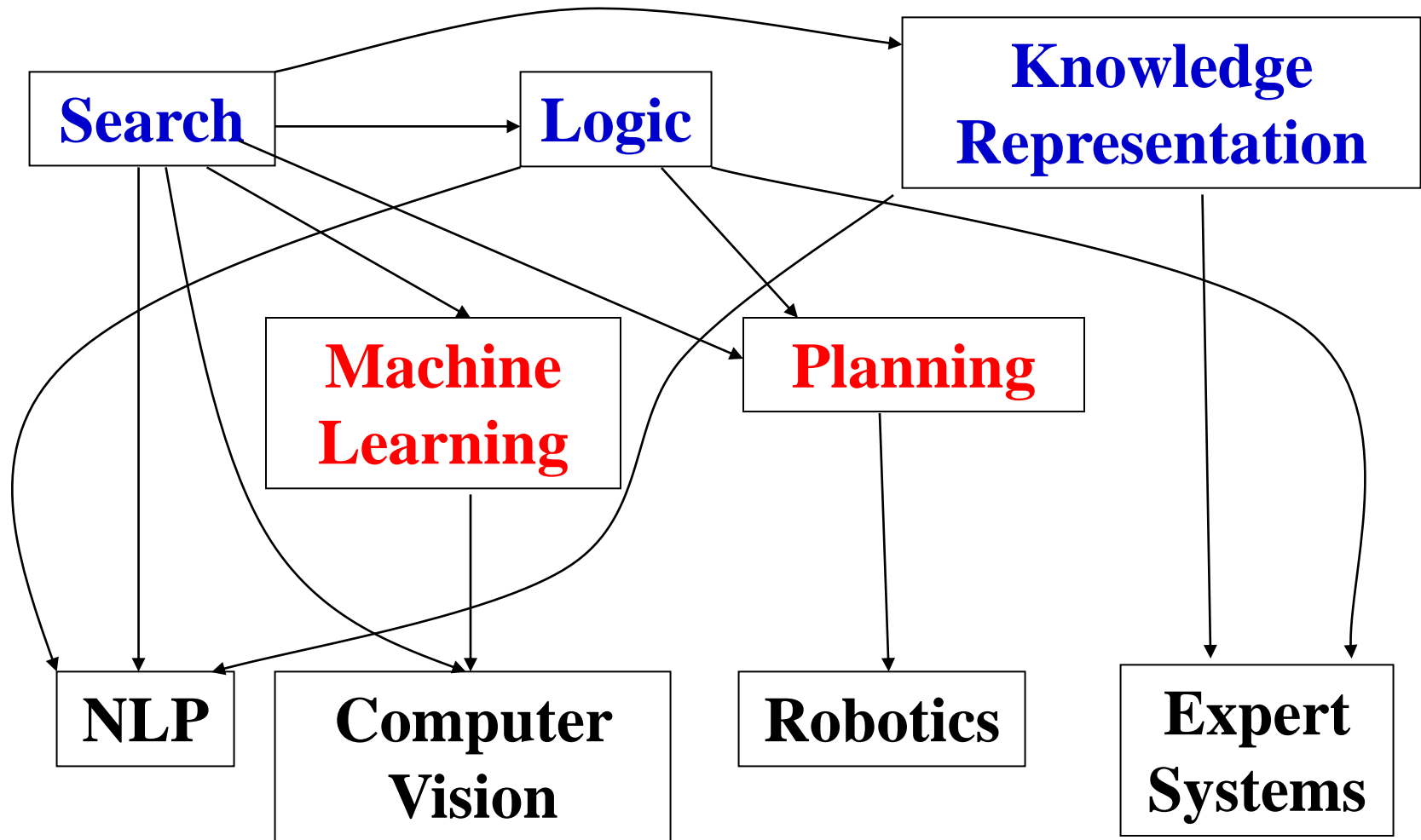
- ❑ **Handwriting Recognition** – The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus. It can recognize the shapes of the letters and convert it into editable text.
- ❑ **Vision Systems** – These systems understand, interpret, and comprehend visual input on the computer. For example,
- ❑ **A spying aero plane** – takes photographs, which are used to figure out spatial information or map of the areas.
- ❑ **Clinical expert system** – Doctors use it to diagnose the patient.
- ❑ **Face recognition** – Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.

# AI has materialised from a theory in 1950 to widespread technological applications that we use today in our daily lives

## Selected Milestones of AI



# Areas of AI and Some Dependencies



# Sub-fields of Artificial Intelligence

- ❑ **Neural Networks** – e.g. brain modeling, time series prediction, classification
- ❑ **Evolutionary Computation** – e.g. genetic algorithms, genetic programming
- ❑ **Vision** – e.g. object recognition, image understanding
- ❑ **Robotics** – e.g. intelligent control, autonomous exploration
- ❑ **Expert Systems** – e.g. decision support systems, teaching systems
- ❑ **Speech Processing** – e.g. speech recognition and production
- ❑ **Natural Language Processing** – e.g. machine translation
- ❑ **Planning** – e.g. scheduling (air line systems, railways ), game playing
- ❑ **Machine Learning** – e.g. decision tree learning, version space learning

# Importance of AI

- ❑ Game Playing
- ❑ Speech Recognition
- ❑ Understanding Natural Language
- ❑ Computer Vision
- ❑ Expert Systems
- ❑ Heuristic Classification

# Some Aspects of Artificial Intelligence

## Advantages

- ❑ More powerful and more useful computers
- ❑ New and improved interfaces
- ❑ Solving new problems
- ❑ Better handling of information
- ❑ Relieves information overload
- ❑ Conversion of information into knowledge

## Disadvantages

- ❑ Increased costs
- ❑ Difficulty with software development - slow and expensive
- ❑ Few experienced programmers
- ❑ Few practical products have reached the market as yet

# Thank You

# End

# Questions ?