Artificial Intelligence and Machine Learning

Instructor: Dr. Fady Al Alami

Introduction

- In this lecture you will be exposed to different definitions of artificial intelligence (AI)
- Also, you will learn about the Turing test which measures the intelligence between man and machine
- Applications are the most important aspect of AI
- In this lecture, we looked some major applications which effects the future of AI
- Some of these applications are considered as a turning point of AI

Why taking this course?

- Science and technology are changing rapidly. (Mobile phones, Computers, Web pages).
- “old” sciences such as physics are relatively well-understood.
- Computers & Mobile phones are widespread.
- Grand Challenges in Science and Technology. (iPhone, Samsung, Facebook, Instagram, etc.). i.e. Pattern challenge.
- Understanding the brain, Logic, knowledge, creativity.
- Creating intelligent machines, is this possible? what are the technical and philosophical challenges? (Huge amount of data, Fast processors)

What is Intelligence?

The capacity to learn and solve problems" (Websters dictionary)

in particular,

- ✓ The ability to solve novel problems
- ✓ The ability to act logically
- ✓ The ability to act like humans

- 2 main approaches: "engineering" versus "cognitive modeling" i.e. (Numbers vs Fuzzy algorithm)

What is Artificial Intelligence? (John McCarthy, Stanford University)

- 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.
- Yes, but what is intelligence?

Intelligence is 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.

- Isn't there a solid definition of intelligence that doesn't depend on relating it to human intelligence?

Not yet. The problem is that we cannot yet characterize in general what kinds of computational procedures we want to call intelligent. We understand some of the mechanisms of intelligence and not others.

- Machine intelligence came from gathering human experience.

Artificial intelligence: Some definitions

- "The automation of activities that we associate with human thinking, activities such as decision-making, problem solving, learning …"(Human experience come from learning)

Bellman, 1978

- "... the science of making machines do things that would require Intelligence if done by humans" (Chess game)

Marvin Minsky

Turing test

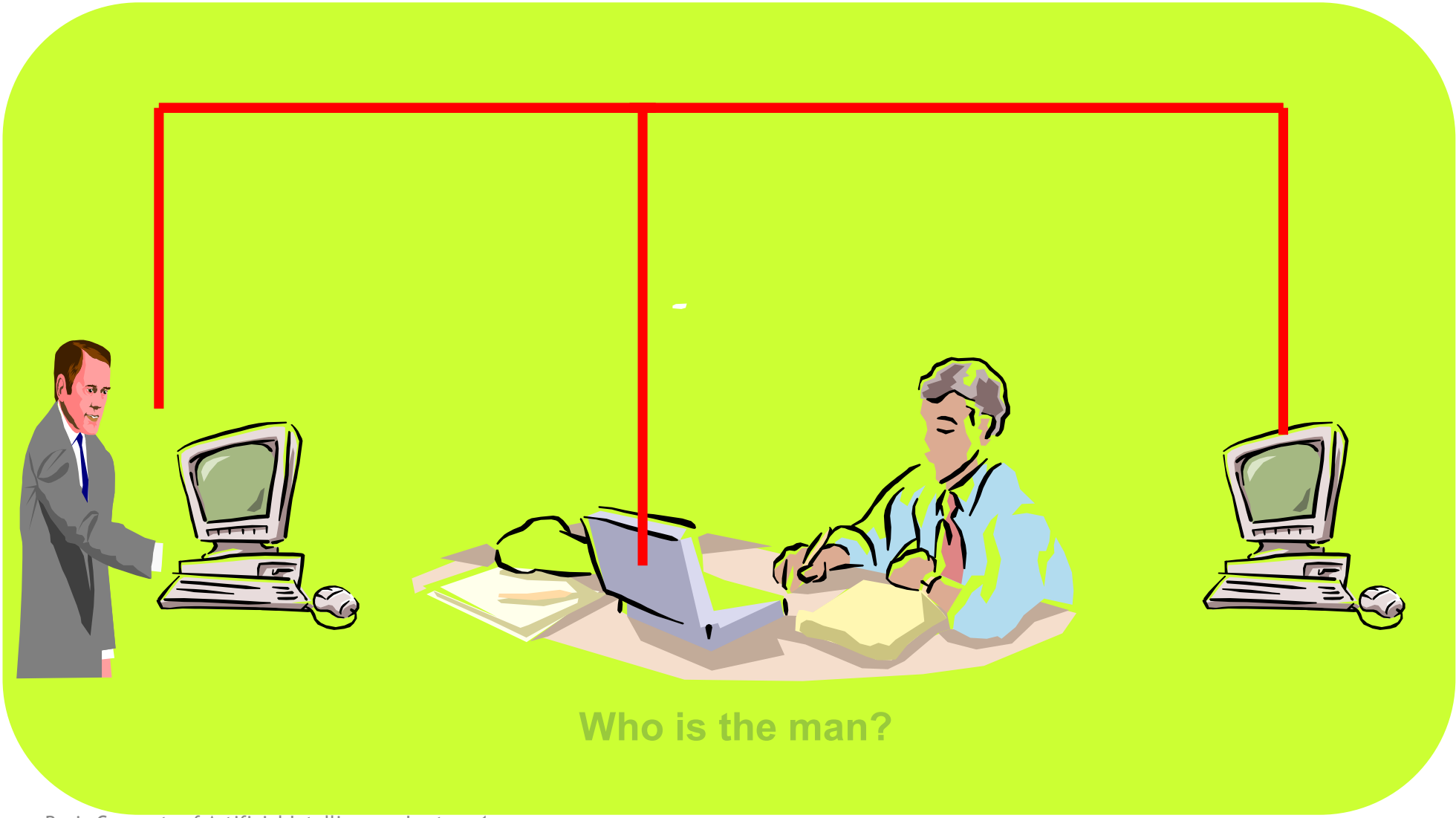
- In 1950 Alan Turing published his paper "*Computing Machinery and Intelligence*" in which he described a method for testing an intelligent system
- He predicted that by the year 2000, a machine could have 30% of chance to fool a normal person for 5 minutes (Facebook Pages)

Turing test

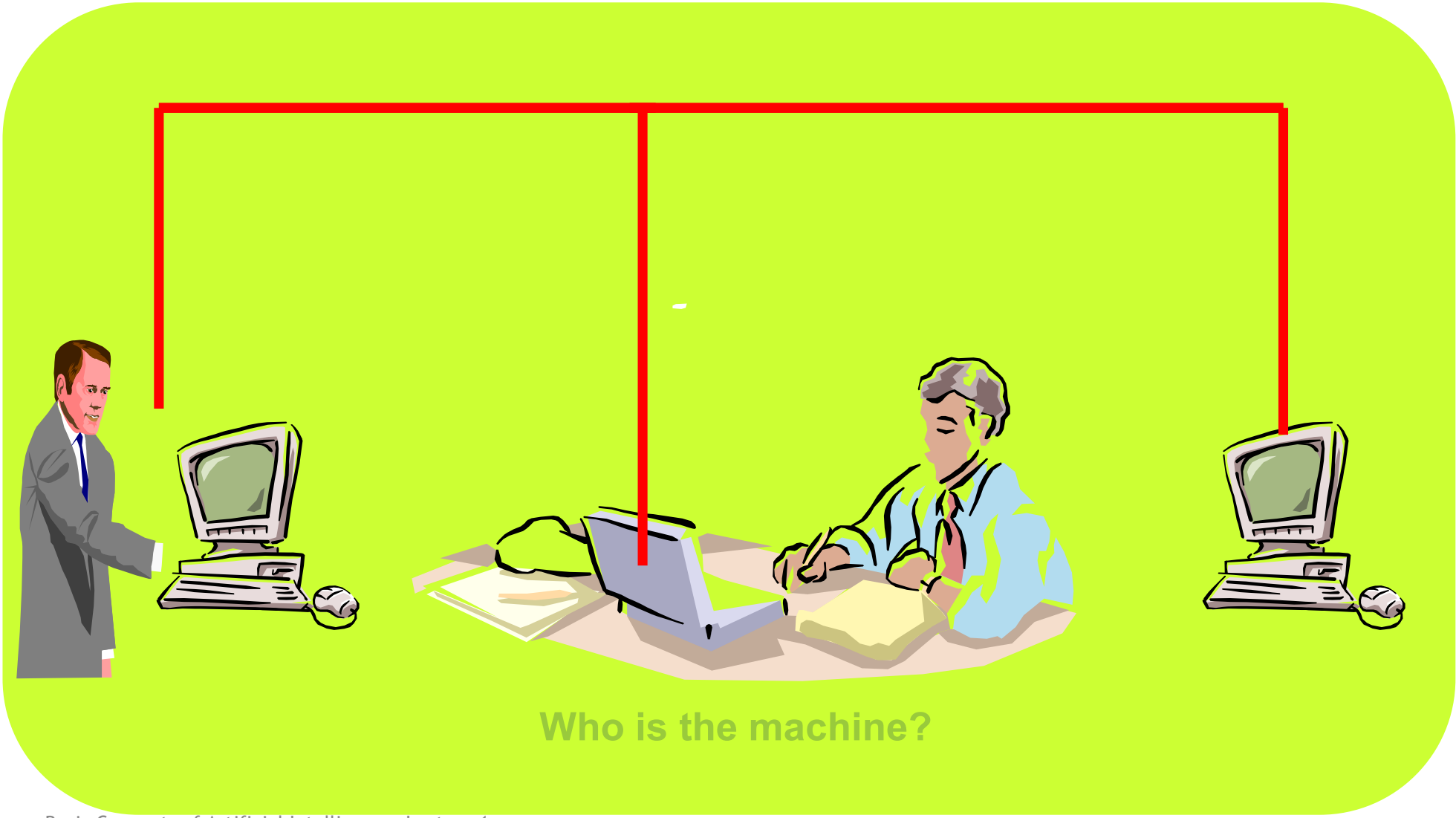
- Put a person behind one machine, and a machine behind another screen.
- A judge can examine both via a teletype for 5 minutes.
- Machine passes the test if the judge cannot distinguish which is the machine and which is the person.

Turing test

Turing test



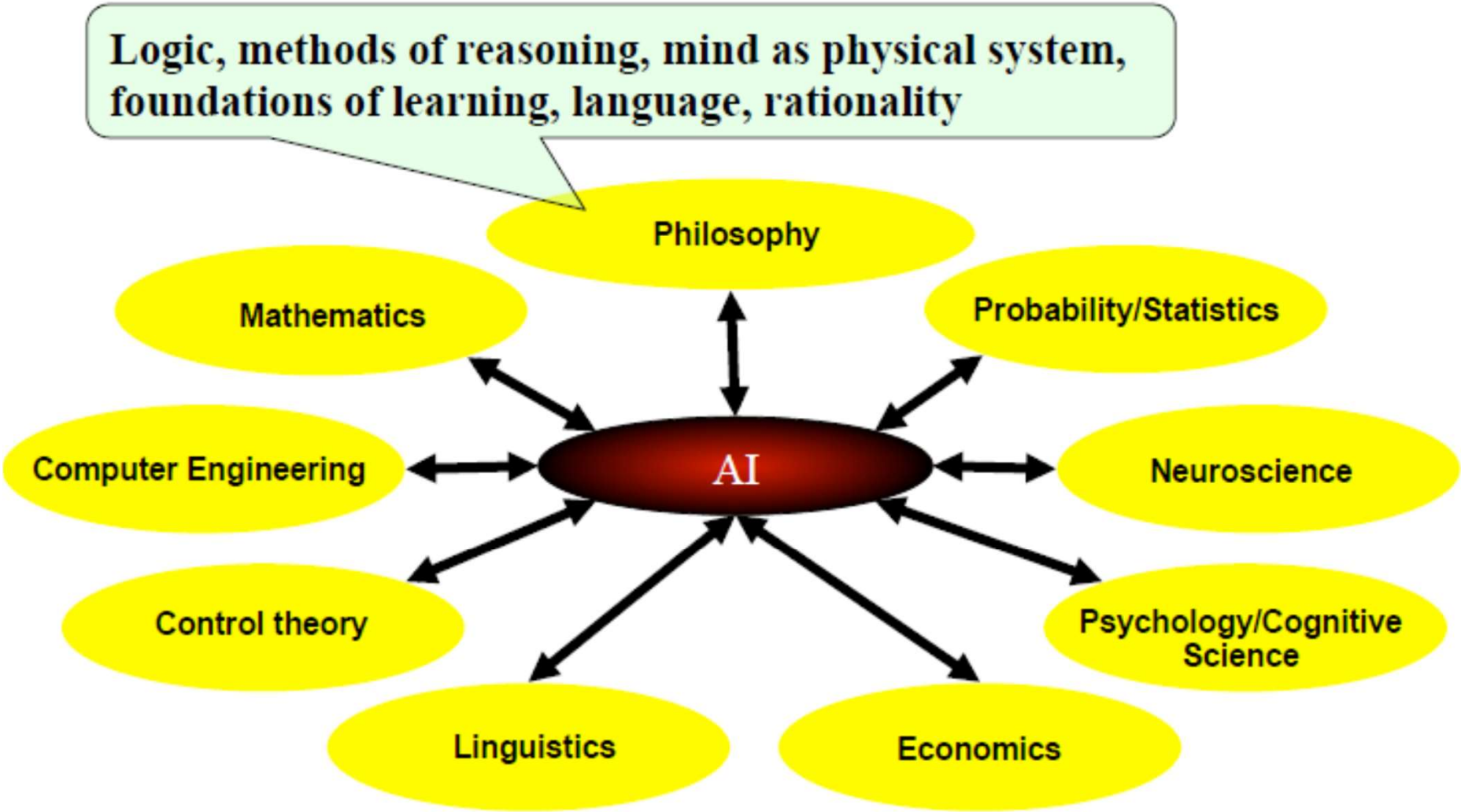
Turing test



Turing test

- The Turing test measures the performance of a claimed intelligent machine against that human being.
- The intelligence to distinguish the computer from the human being examiner.
- Comparing machine performance on a given set of problems to that of a human expert.

Academic Specialties relevant to AI



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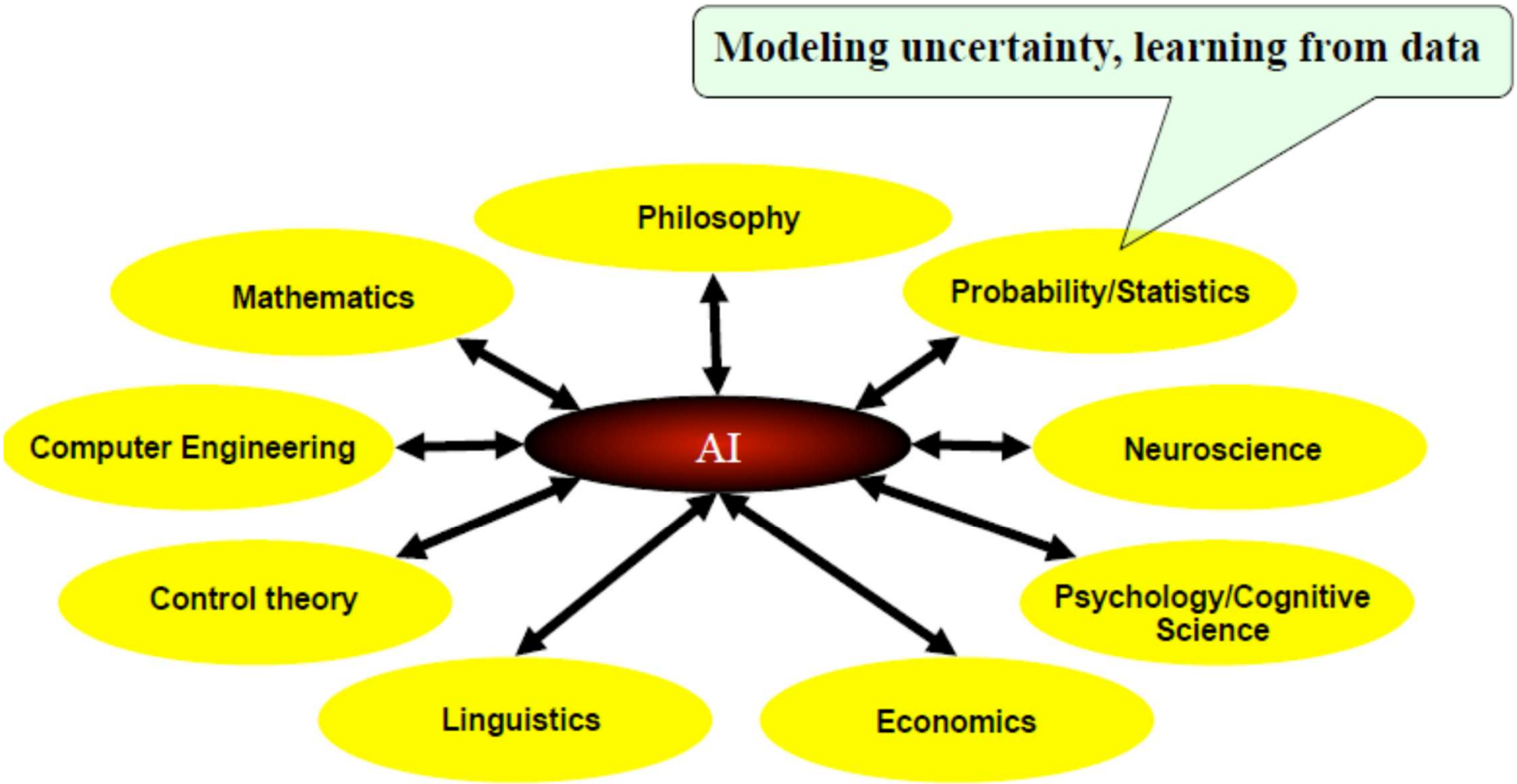

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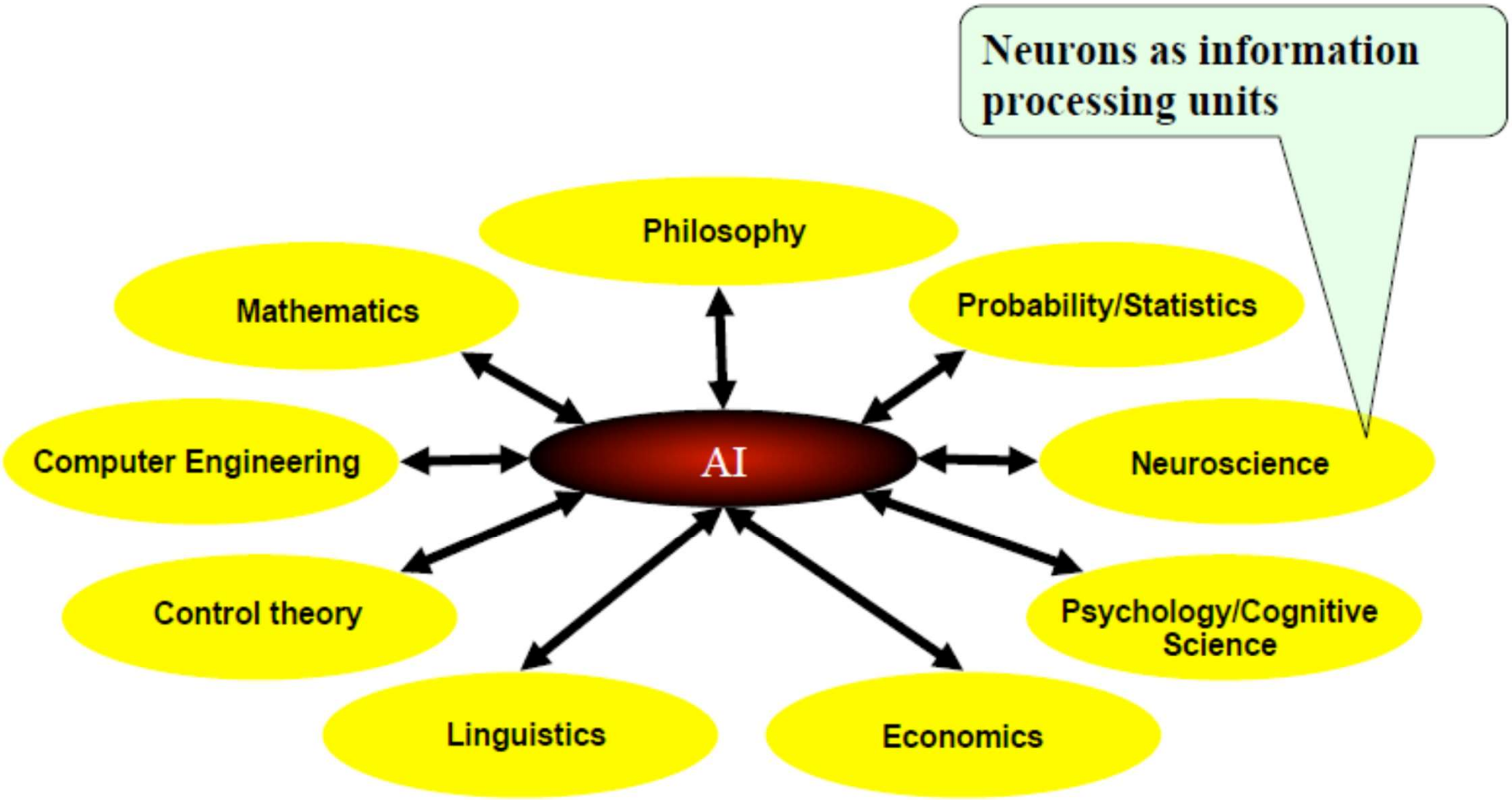

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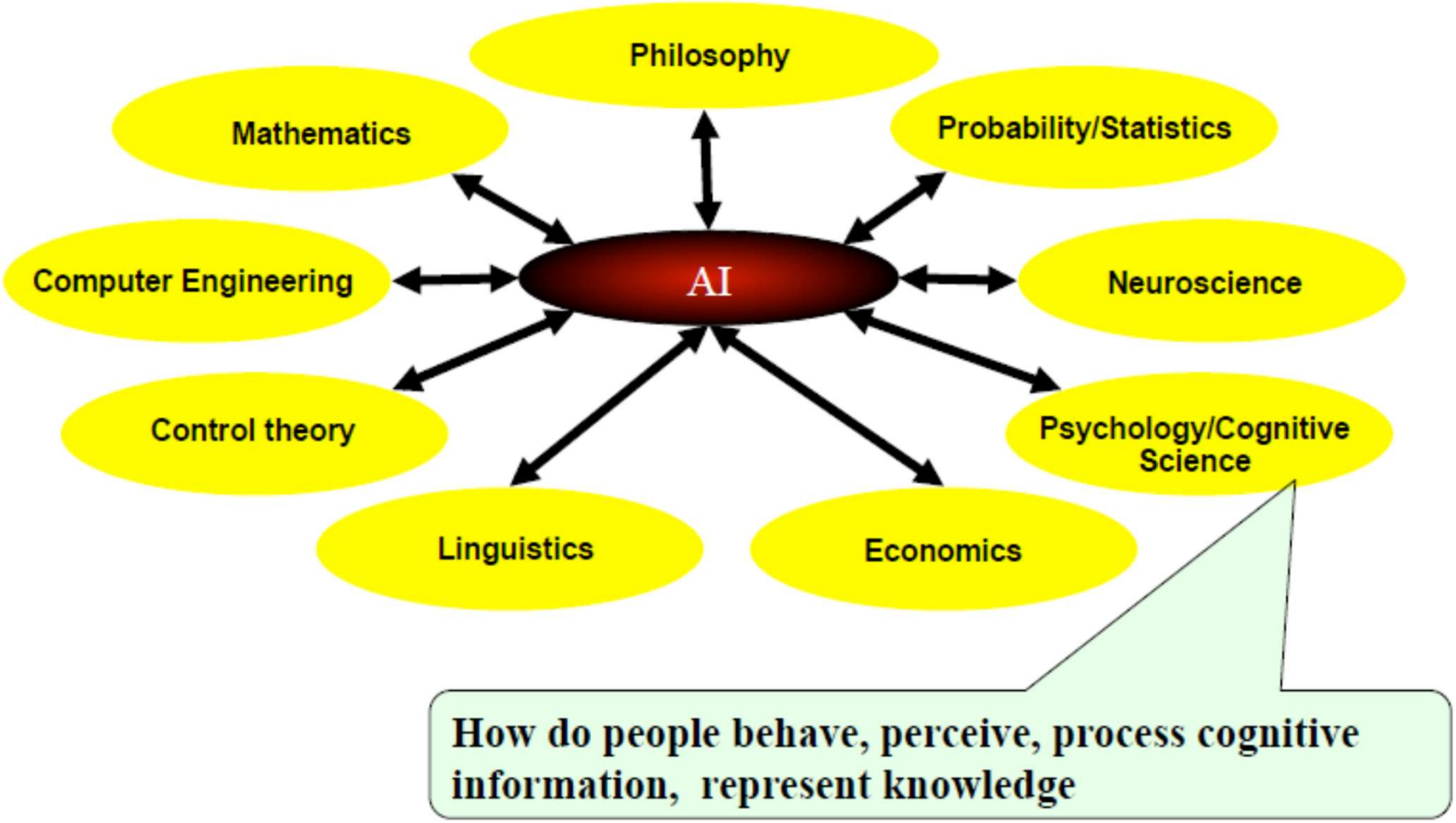

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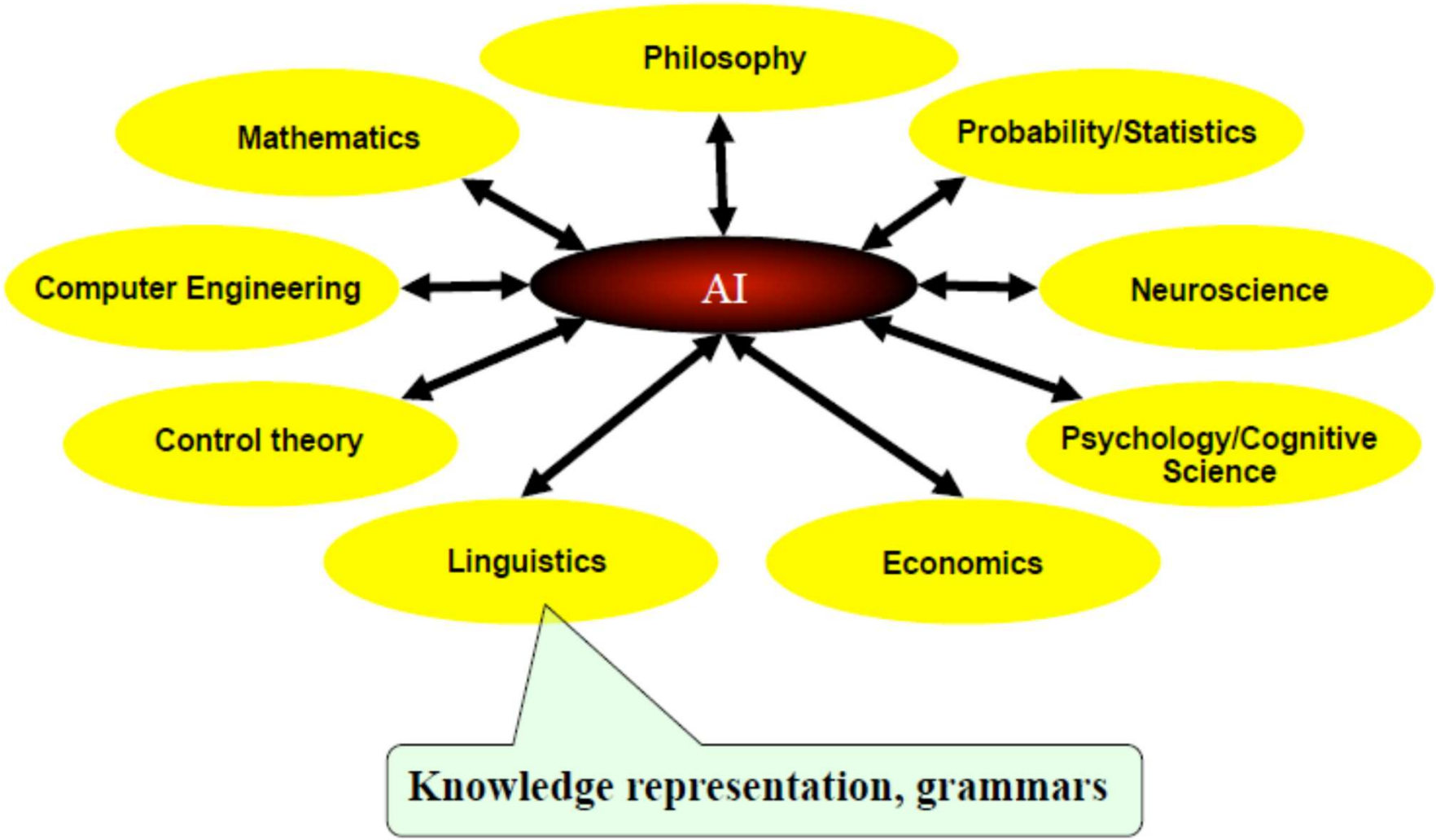

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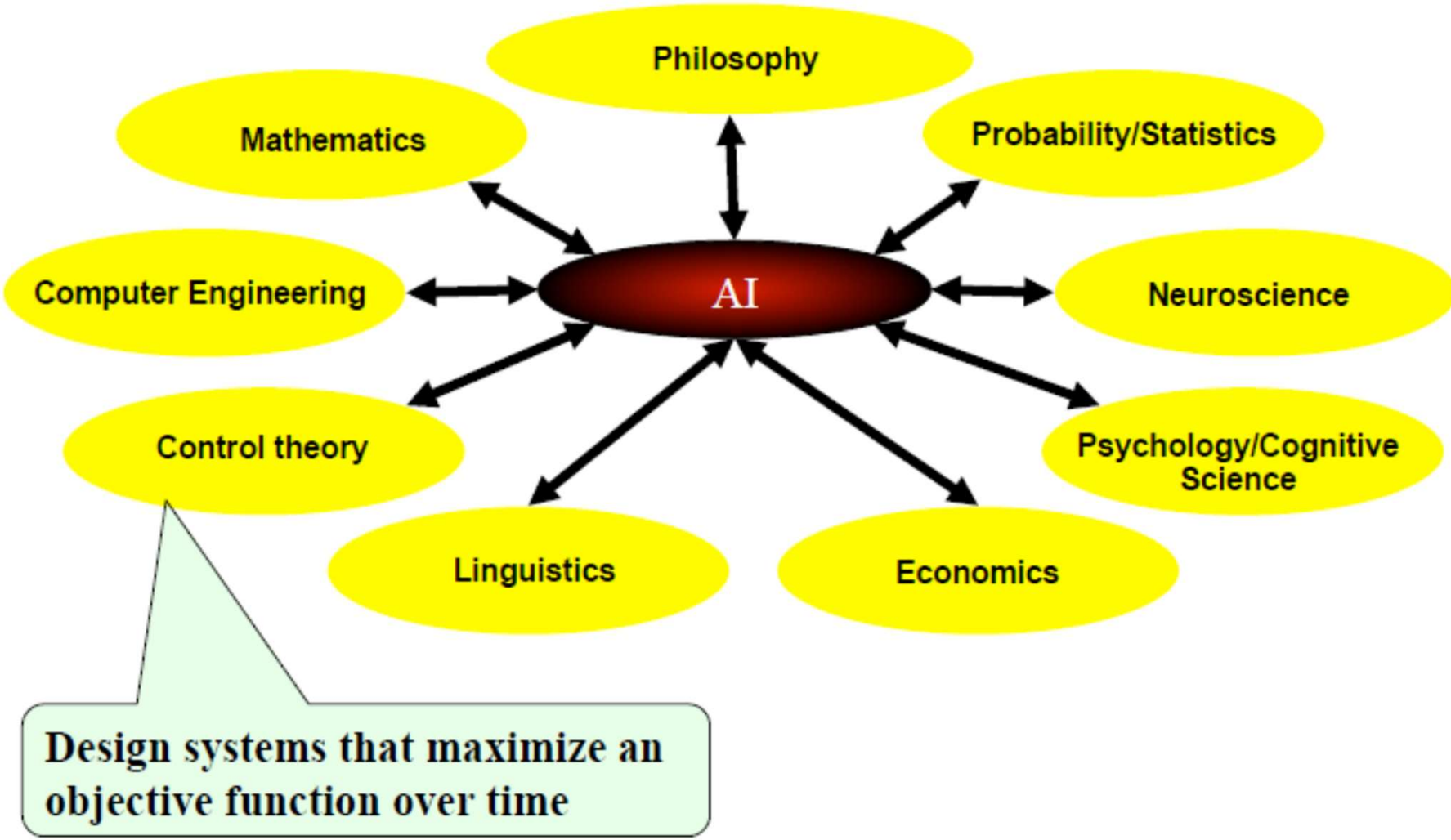

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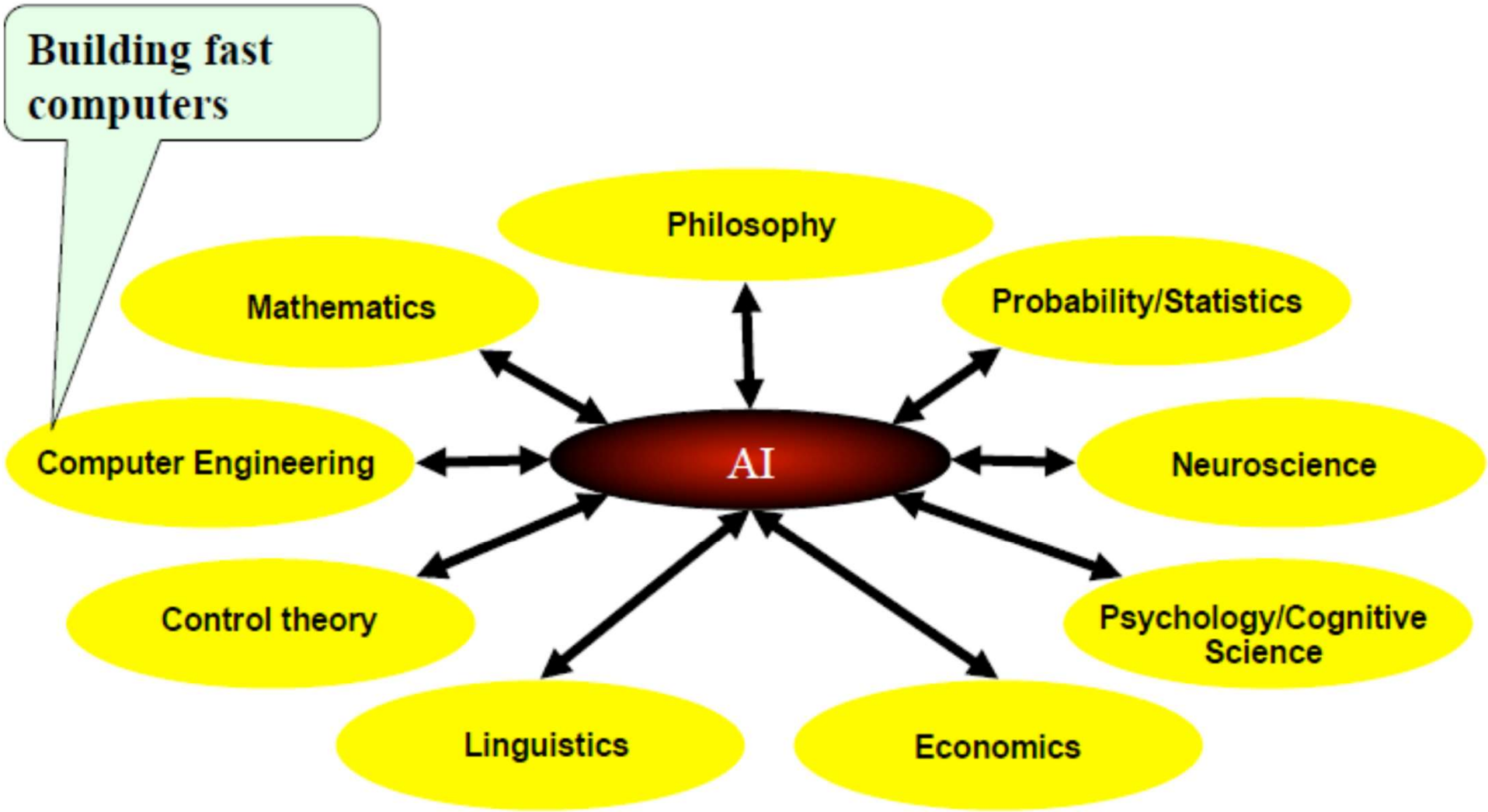

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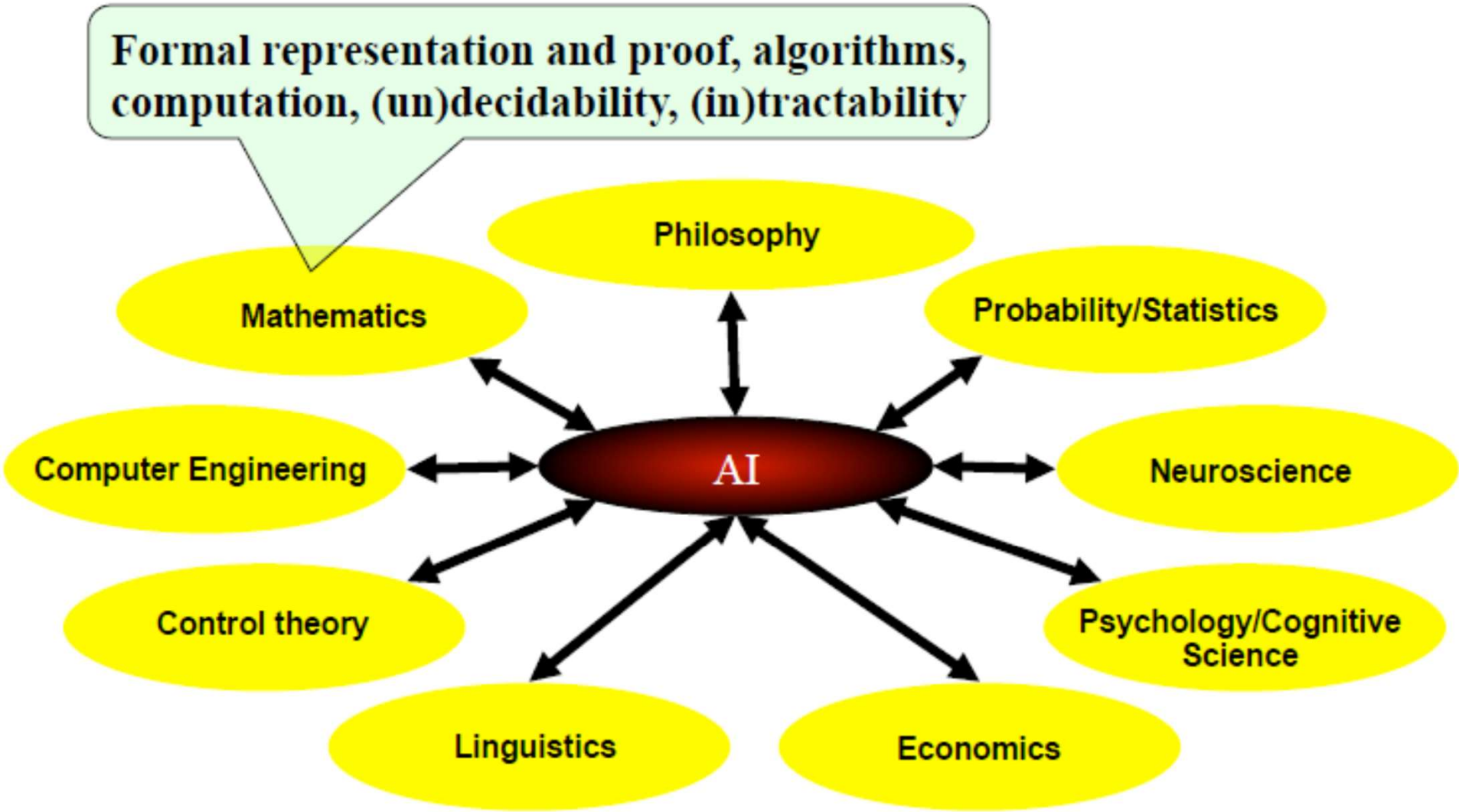


AI Applications (Overview)

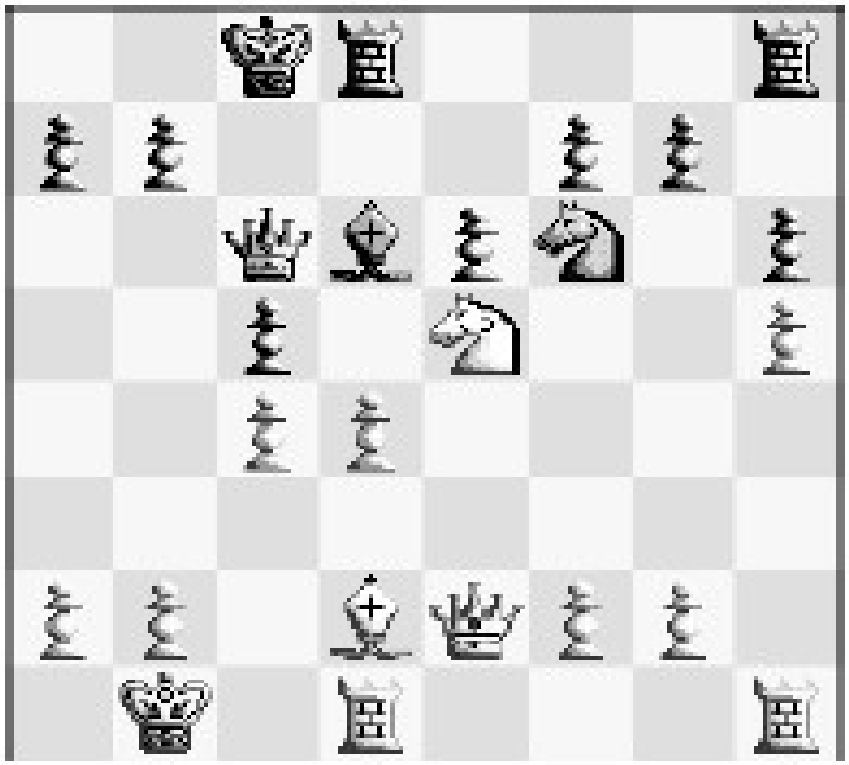
- AI techniques can be applied to a wide range of problems :
  - Game playing
  - Expert Systems
  - Automated reasoning
  - Natural language understanding
  - Modelling human performance
  - Planning and Robotics
  - Machine learning

Overview of AI Applications

- Many applications reach to a level of emulating human being capabilities in dealing with complex tasks
- Also AI has a good interaction with engineering aspects. Such interactions leads to productions of many applications in the areas of:
  - Speech Recognition and Synthesis (Hey Google, Hey Siri, etc.)
  - Computer Vision
  - Pattern Recognition

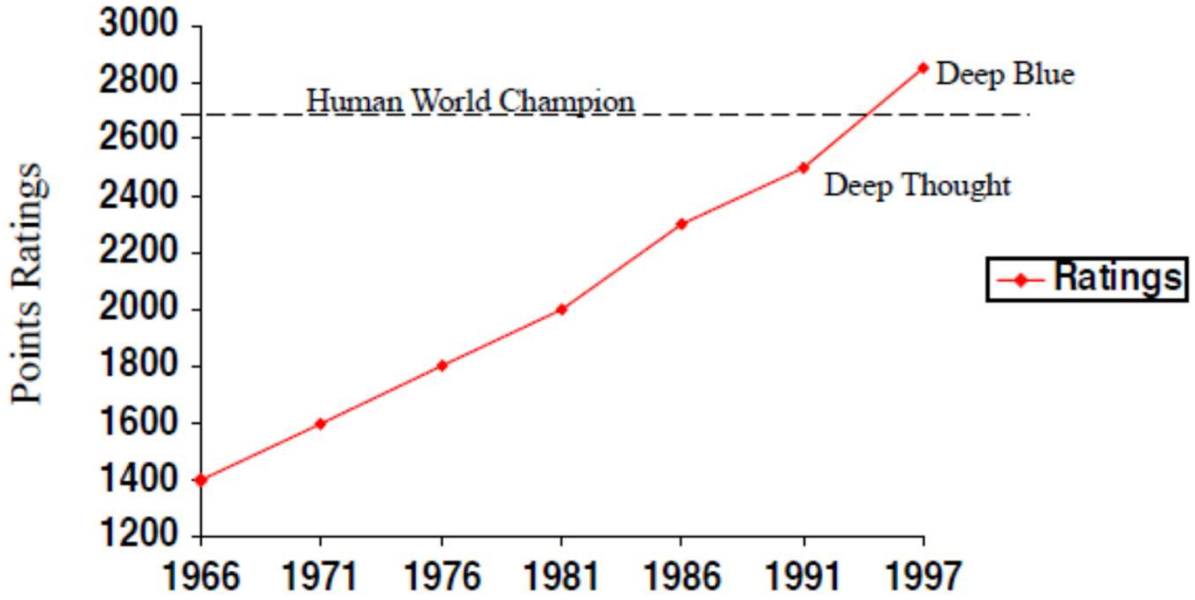
Game Playing

- Chess playing
- Computers chess playing games now can beat a human champion in chess playing



Game Playing

- Can Computers beat Humans at Chess?
  - Chess Playing is a classic AI problem
  - Well-defined problem
  - Very complex: difficult for humans to play well

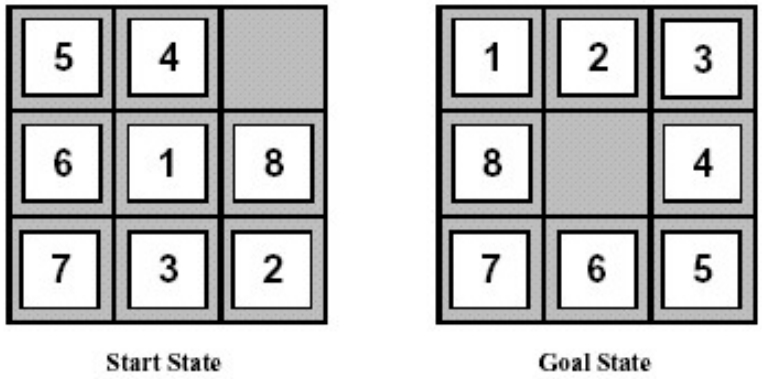


Game Playing

World chess champion Garry Kasparov playing IBM's Deep Blue computer in 1997

Game Playing

- Other board games achieved a high level of performance on computers e.g. the puzzle problem



Expert Systems

- Computer software that:
  - Emulates human expert
  - Can be applied to well defined domains of expertise
  - May be applied to solve many real-world problems
  - It can play the role of a consultant
  - Can explains its reasoning; i.e. how it finds the solution
  - Should be able to learn from experience.

Automated Reasoning

- Is the oldest branch of AI
- Automated reasoning is the area of computer science that is concerned with applying reasoning in the form of logic to computing systems. If given a set of assumptions and a goal, an automated reasoning system should be able to make logical inferences towards that goal automatically.
- It is based on formal mathematical logic
- Many modeling theorem provers functions as a human intelligent assistant

Natural Language Understanding

- Computers nowadays reach to a level of understanding human language (written and spoken)
- The major applications in this area are machine translation and dictionary construction
- Machine translation is considered as the dream of human being.
- This is because if machine can translate from one language to another it will mean that it can understand both languages and the domain

Natural Language Understanding

- Major applications now available on the market are machine translation for many pairs of languages such as: English – Russian, English – French, …
- As a spoken language is an every day human activity, computers now can take spoken human language and convert it to a computer commands and also to a text
- Computer dictionaries are now commercially available in many domains

Modeling Human Performance

- Human performance modeling has proved to be a powerful tool for formulating and testing theories of human cognition
- Many scientists have adopted the language and theory of computer science to formulate models of human intelligence
- Computer implementation of these theories offer scientists an opportunity to test, critic, and refine their ideas

Planning and Robotics

- Work in planning began as an effort to design a robot that could perform their tasks with some degree of flexibility and responsiveness to the outside work
- Planning assumes a robot that is capable of performing certain primitive actions. It attempts to find a sequence of those actions to accomplish a task
- A robot that blindly performs a sequence of actions without responding to changes in its environment could be hardly considered as intelligent. (Factory Machines)

Machine Learning

- One challenging area for AI is to make a computer learn in the same way as a human learns
- Learning is a difficult area but it is not impossible
- One program is called AM (Automated Mathematician) which is designed to discover mathematical laws
- Many expert systems can learn rules from their domain of knowledge

Introduction

- In this lecture you will be exposed to different definitions of agents and multiagent

- Also, you will learn about the behavior of agents and their performance measurements

From A.I. To Multiagent Systems

- Objectives of A.I.
  - Models a human being while solving problems and achieving complex tasks
  - Main foundation: knowledge and reasoning are centralized in a unique system (stand-alone system)
  - Results: expert systems have a great success

From A.I. To Multiagent Systems

- Limits of A.I.
  - Real applications need a big amount of knowledge
  - Knowledge may be incoherent and even contradictory
  - Observation of human being shows communication and collaboration between them to accomplish complex tasks
- Consequence
  - New approach: Distributed Artificial Intelligence (D.A.I.)

From A.I. To Multiagent Systems

- D.A.I. concerns the study and the construction of autonomous (or semi-autonomous) agents that interact between them and with their environment in order to solve a problem.
- D.A.I. can be divided in three domains
  - Distributed Problem Solving (D.P.S.)
  - Multi-Agent Systems (M.A.S.)
  - Parallel Artificial Intelligence (P.A.I.)
- Nowadays, D.A.I. is usually referring to Multi-Agent Systems

From A.I. To Multiagent Systems

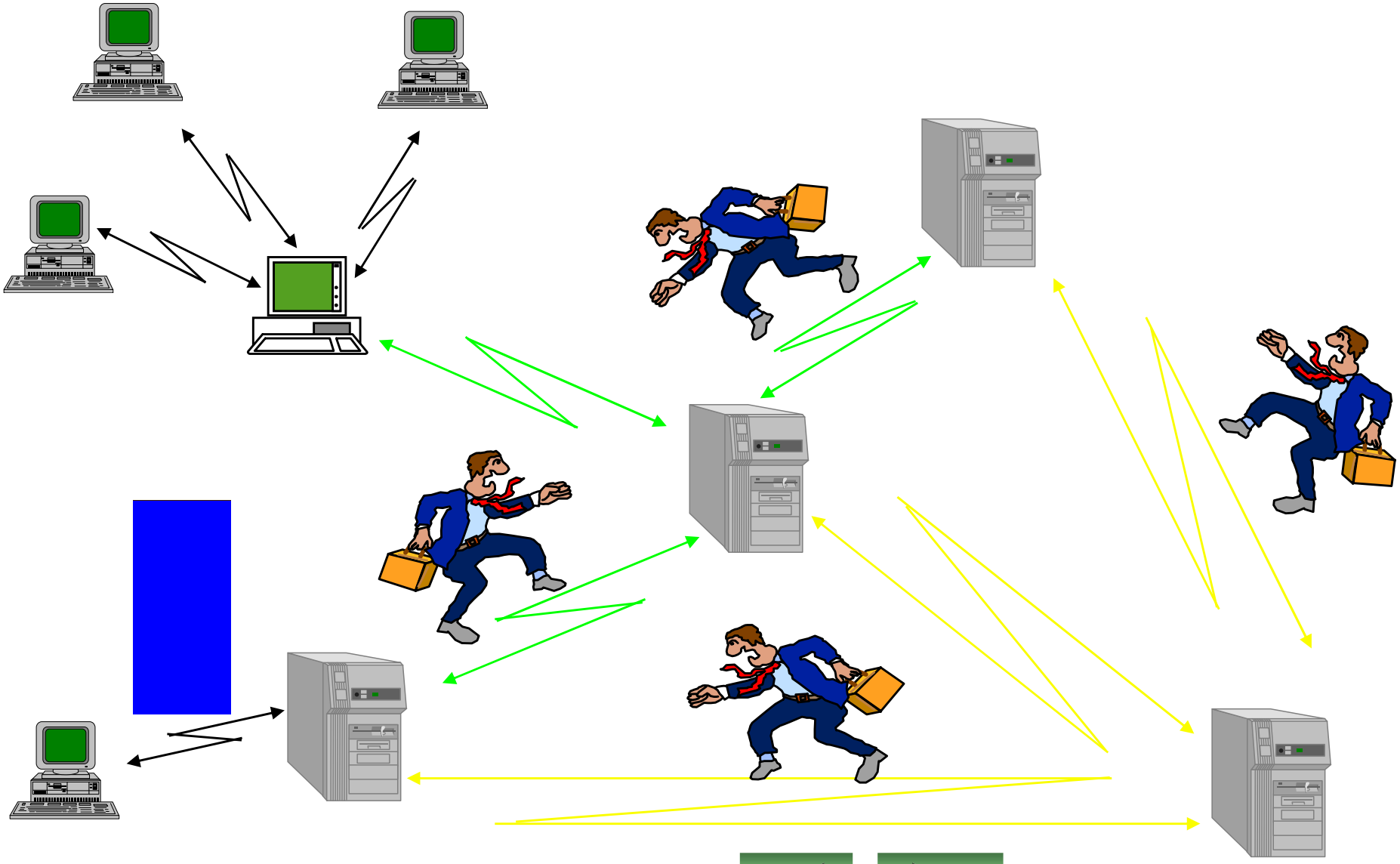
- M.A.S. Definition
  - Focuses on the coordination of a set of intelligent autonomous agents to solve a problem
  - Are computational systems in which two or more agents interact or work together to perform some set of tasks or to satisfy some set of goals

[Lesser 2000]

From A.I. To Multiagent Systems

Architecture for a multiagent system, indicating collaborations among users, application and resource as shown in the following figure:

From A.I. To Multiagent Systems



Definition of an Agent

- An agent is anything that can perceive its environment through sensors and act on environment through effectors
- An agent is an encapsulated computer system that is situated in some environment and that is capable of flexible, autonomous action in that environment in order to meet it's design objectives
- Agents are flexible problem solvers having partial control over the environment in which they are operating

Definition of an Agent

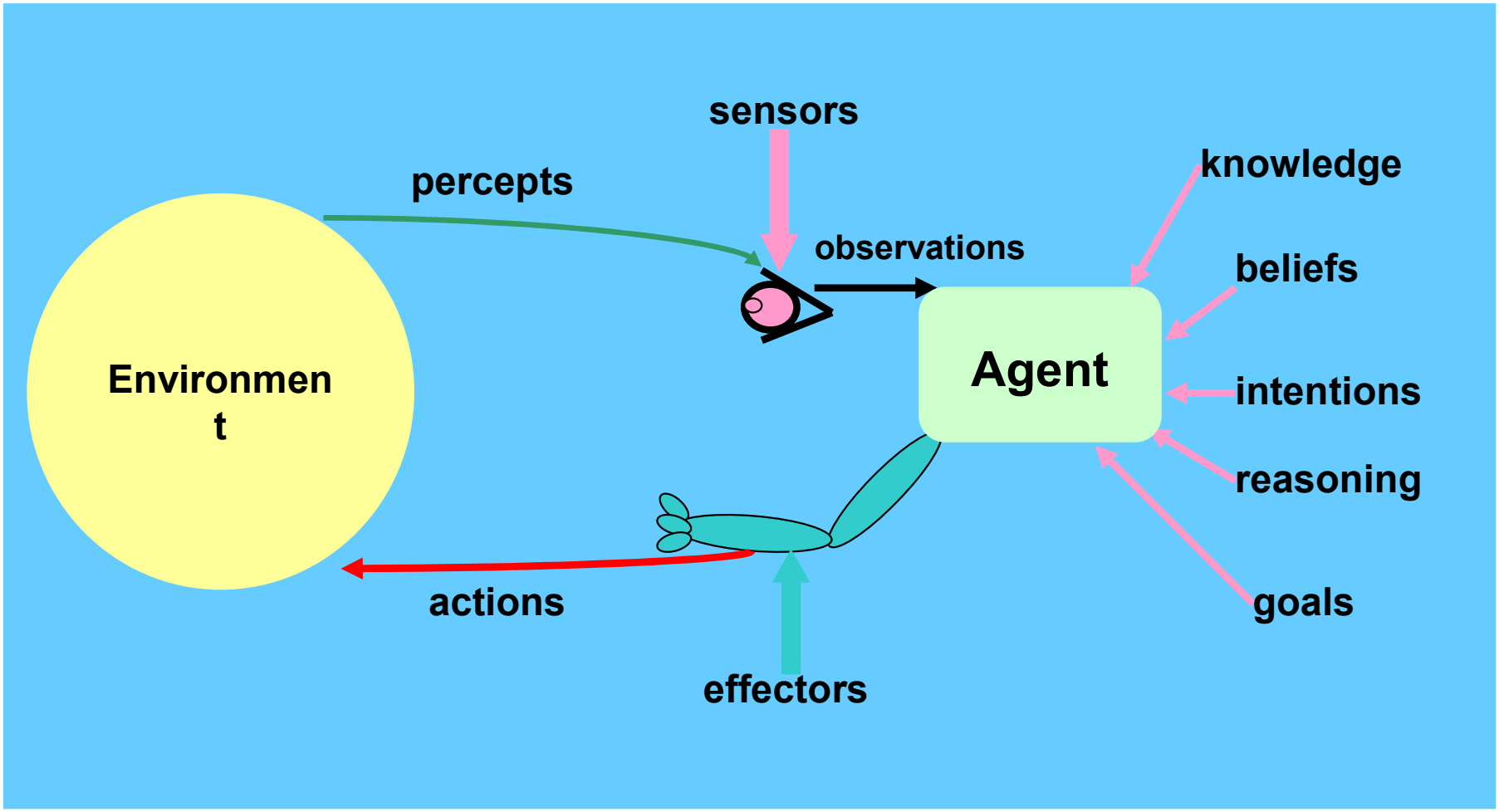
- For a human being
  - Sensors: ear, eyes, noses, skin, etc.
  - Effectors: hands, arms, legs, mouth, etc.

- For a robot
  - Sensors: camera, laser, infra-red sensors, etc.
  - Effectors: automatic arms, wheels, catchers, etc.

Definition of an Agent

- For a software agent
  - Sensors: data, chain of characters, etc. (input)
  - Effectors: data, chain of characters, etc. (output)

Schematic Diagram of an Agent



Agent's Behavior

- "For each possible percept sequence, an ideal rational agent should do whatever action is expected to maximize its performance measure, on the basis of the evidence provided by the percept sequence and whatever built-in knowledge the agent has"

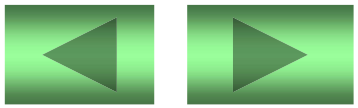
[Russel & Norvig]

Agent's Behavior

- An agent is said to be rational if it is based on reasoning
- Given options, a rational agent chooses the best actions for success
- So, a rational agent needs a performance measure to evaluate its success

Agent's Behavior

- Agents may be homogeneous or heterogeneous
- An agent operates asynchronously and has a certain level of autonomy
- Autonomy means agent's ability to make its own decisions about what activities to do, what types of information should be communicated and to whom and how to assimilate the information received



Rational agent

- Rational agent chooses the action that maximizes the value of the performance measure according to its percepts

- Rationality implies reasoning before taking actions

Measuring the Agent's Performance

- It includes the criteria for success of agents behavior
- Criteria:
  - Is agent capable of achieving the task?
  - What resources needed to achieve the task?
  - What time needed to accomplish the task?

Measuring the Agent's Performance

- Problems of measuring performance
  - It is not an easy task because it is based on measuring the average of each of the above criteria which is sometimes vague and not clear

Measuring the Agent's Performance: Examples

- Rubbish collection agent
  - Measuring its performance by the following:
    - Amount of rubbish collected
    - Quantity of electrical power used
    - Quality of cleaning the place

Measuring the Agent's Performance: Examples

- Mobile robot agent
  - Measuring its performance by the following:
    - Going to a specific destination
    - Minimize the time to reach the destination
    - Minimize the power consumption
    - Minimize the number of collisions

Summary

- At the end of this lecture, we defined together AI from different points of view
- All definitions focused on human intelligence that can be transferred to the machine.
- The expected future machines will have intelligence as it occurs in human.
- This lecture shows major applications of AI.
- It gave us some future vision of what AI can achieve.
- The ultimate goal is to make computers learn as human can learn.
- At the end of this lecture, we defined together agents and multiagent from different prospective points of view.
- All definitions focused on the agent's behavior based on human cognition