Artificial Intelligence (CSC261)

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Nature of Course, Evaluation Scheme and Credit Hours:

- Nature of Course: Theory + lab
- Evaluation scheme: 60+20+20 (need to score 40% in each section to pass)
- Credit Hours: 3

Course Description

CSC261 Description

- The course introduces the concepts and techniques that comprise the principles and design of intelligent systems.
- It covers AI fundamentals and applications such as intelligent agent design, problem-solving, searching, probabilistic reasoning, etc.
- Moreover, this course also covers fundamental concepts regarding knowledge representation systems, concepts of ANN and ML, and NPL.

Course Objectives

CSC261 Objectives

- To introduce the fundamental concepts of AI.
- The general goals are to learn about intelligent systems, design intelligent agents, identify and solve fundamental AI problems, etc.
- Furthermore, it also covers how to design knowledge representation and expert systems, and design neural networks for problem-solving, etc.
- To enable learners to identify different machine learning paradigms and their practical applications.

Laboratory Works

Students are highly encouraged to implement the following as a part of the programming assignment using LISP, PROLOG, or another high-level language preferably Python.

- Design and implementation of intelligent agents and expert systems.
- Implementation of searching techniques, and knowledge representation systems.
- Design and implementation of ANN, Genetic algorithms, and machine learning techniques for solving some fundamental problems.

Introduction (3 Lecture Hours)

Outline

- Background
- Introduction to AI
- AI Perspectives:
  - Acting humanly
  - Thinking humanly
  - Acting rationally
  - Thinking rationally
- History of AI
- Foundations of AI
- Applications of AI

Background

- We call ourselves Homo sapiens.
  - The wise human: because of our intelligence.
- For thousands of years, people (especially: cognitive scientists) have tried to figure out
  - how we think, or
  - how a tiny matter can perceive, comprehend, predict, and manipulate a world far larger and more complex than itself.
- The domain of AI, goes even further, attempting not only to understand but also to build intelligent entities.

Background

- AI is one of the most recent interdisciplinary scientific and engineering fields.
- Work began in earnest shortly after World War II, and the name was coined in 1956.
- The motivation behind AI is like a physics student might reasonably believe that all of the good ideas have already been taken by Galileo, Newton, Einstein, and others.
- However, AI is still looking for full-time Einsteins and Newtons which might be "YOU".

Background

- AI now includes a wide range of subfields,
  - from the general (learning and perception)
  - to the specific (playing chess, proving mathematical theorems, writing poetry, driving a car on a crowded street, and diagnosing diseases, etc.)
- AI is applicable to any intellectual task; it is truly a multidisciplinary domain.

Background

- Artificial Intelligence is concerned with the design of intelligence in an artificial device.
- The term was coined by McCarthy in 1956.
- There are two ideas in the definition:
  - first one is "Intelligence" and
  - second is "Artificial device"
- AI is applicable to any intellectual task; it is truly a multidisciplinary domain.

What is intelligence?

- Is it that which characterizes humans?
- Or is there an absolute standard of judgment?
- Accordingly there are two possibilities:
  - A system with intelligence is expected to behave as intelligently as a human.
  - A system with intelligence is expected to behave in the best possible manner.

What is intelligence?

- Secondly, what type of behavior are we talking about?
  - Are we looking at the system's thought process or reasoning ability?
  - Or are we only interested in the system's final indications in terms of its actions?
- Intelligence is:
  - the ability to reason, understand, create, Learn from the experience, and plan and execute complex tasks.
- AI can be defined as "Giving machines the ability to perform tasks normally associated with human intelligence."

What is Artificial Intelligence?

- Giving machines the ability to perform tasks normally associated with human intelligence.
- AI is the part of CS concerned with designing intelligent systems.
  - systems that exhibit the characteristic associated with intelligence in human behavior.
- AI is machine intelligence and the branch of computer science that aims to create it.
- AI is the design of intelligent agents, which are programs that perceive their surroundings and take actions that maximize their chances of success.
- The deduction, reasoning, problem-solving, knowledge representation, planning, learning, natural language processing, perceptron, and other issues are associated with AI.

AI Perspectives

- AI Perspectives:
  - Acting humanly
  - Thinking humanly
  - Acting rationally
  - Thinking rationally

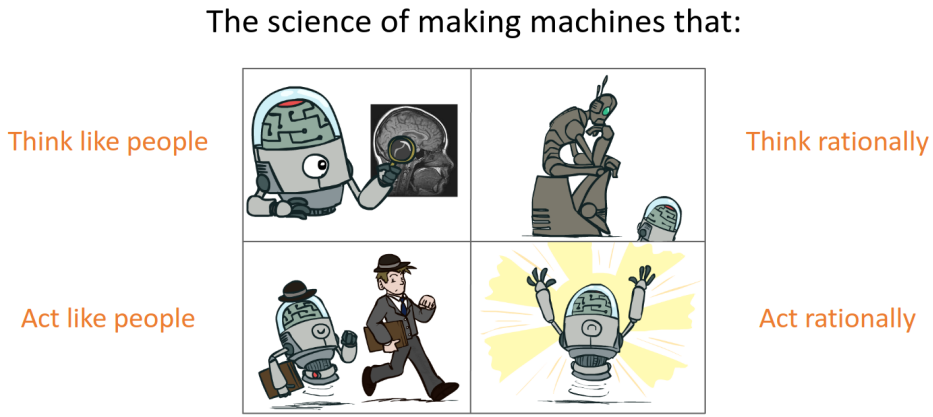

Figure 1:

AI Perspectives

- Historically, all four approaches to AI have been followed, each by different people with different methods.
- An empirical science that focuses on a human-centered approach, involves observations and hypotheses about human behavior.
- A rationalist approach involves a combination of mathematics and engineering.
- The definitions on top are concerned with thought processes and reasoning, whereas the ones on the bottom address behavior.

AI Perspectives

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)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "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) "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) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Figure 2: Some definitions of artificial intelligence, organized into four categories.

Acting humanly: The Turing Test approach

- Alan Turing's (1950) Turing test was designed to persuade people whether a particular machine can think or not.
- He proposed a test based on indistinguishability from undeniably intelligent entities such as humans.
- An interrogator interacts with one human and one machine during the test.

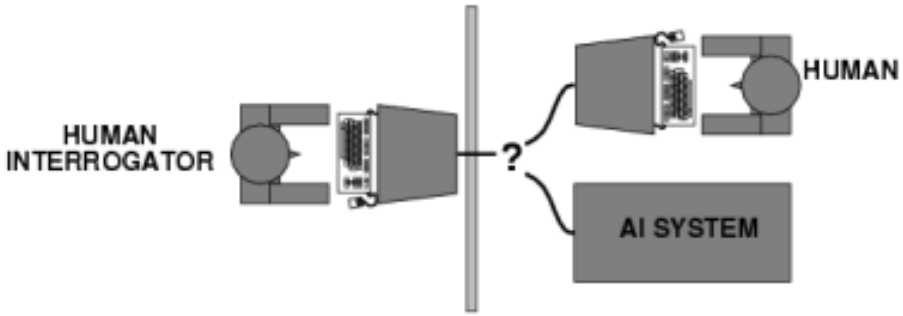

Figure 3: The Turing Test Approach.[1]

[1] https://slideplayer.com/slide/6911551/

Acting humanly: The Turing Test approach

- Within a certain amount of time, the interrogator must determine which of the two is a human and which is a machine.
- The computer passes the test if a human interrogator cannot tell whether the written response came from a human or not after presenting some written questions.
- To pass a Turing test, a computer must have the following capabilities:
  - Natural Language Processing: Must be able to communicate successfully in English
  - Knowledge representation: To store what it knows and hears.
  - Automated reasoning: Answer the Questions based on the stored information.
  - Machine learning: Must be able to adapt in new circumstances.

Acting humanly: The Turing Test approach

- Turing test avoids the physical interaction with the human interrogator.
- Physical simulation of human beings is not necessary for testing intelligence.
- The total Turing test includes video signals and manipulation capability so that the the interrogator can test the subject's perceptual abilities and object manipulation abilities.
- To pass the total Turing test computer must have the following additional capabilities:
  - Computer Vision: To perceive objects
  - Robotics: To manipulate objects and move

AI Perspectives

Thinking Humanly: Cognitive modeling approach

- If we are to claim that a given program thinks like a human, we must first determine how humans think.
- We must investigate the inner workings of human minds.
- There are two approaches to this:
  - through introspection: catch our thoughts while they go by
  - through psychological experiments etc.
- Once we have a precise theory of mind, we can express it as a computer program.
- Cognitive science combines computer models from AI and experimental techniques from psychology to try to build precise and testable theories of how the human mind works.

AI Perspectives

Think rationally: The laws of thought approach

- Aristotle was among the first to attempt to codify correct thinking, which is an irrefutable reasoning process.
- He presented Syllogisms that always resulted in the correct conclusion when the correct premises were given.
- For Example:
  - We are human.
  - Humans are mortal.

Think rationally: The laws of thought approach

- These thought laws were supposed to govern the operation of the mind.
- This research helped to establish the field of logic.
- The logicist AI tradition seeks to create intelligent systems through logic programming.
- This approach, however, faces two challenges.
  - First, it is difficult to take informal knowledge and express it in the formal terms required by logical notation, especially when knowledge is not completely certain.
  - Second, solving problems, in theory, differs from doing so in practice.

Acting Rationally: The rational Agent approach

- An agent is just something that acts (agent comes from the Latin agere, to do).
- A rational agent is one that acts so as to achieve the best outcome or when there is uncertainty, the best-expected outcome.
- Rational agent is expected to have the following attributes:
  - Autonomous control
  - Perceiving their environment
  - Persisting over a prolonged period of time
  - Adapting to change
  - And capable of taking on another's goal

Acting Rationally: The rational Agent approach

- Rational behavior: doing the right thing.
  - Given the available information, the right thing is that which is expected to maximize goal achievement.
  - A rational agent is one who acts in such a way that the best outcome or, in the case of uncertainty, the best-expected outcome is obtained.

Students Presentation on the topic of

Brief history of AI

- Class presentation should cover the following:
  - The gestation of AI: (1943-1955)
  - Birth of AI: (1956)
  - Early enthusiasm and great expectations: (1952-1969)
  - A Dose of Reality in AI research: (1966-1973)
  - AI revival through knowledge-based systems: (1969-1979)
  - AI becomes an industry: (1980 - present)
  - Connectionist revival (Return of Neural Network): (1986 - present)
  - AI becomes a science: (1987 - present)
  - The emergence of intelligent agents: (1995 - present)
  - The impact of AI in the day-to-day lives of human

Foundations of AI

- We provide a brief overview of the disciplines that contributed ideas, points of view, and techniques to artificial intelligence.

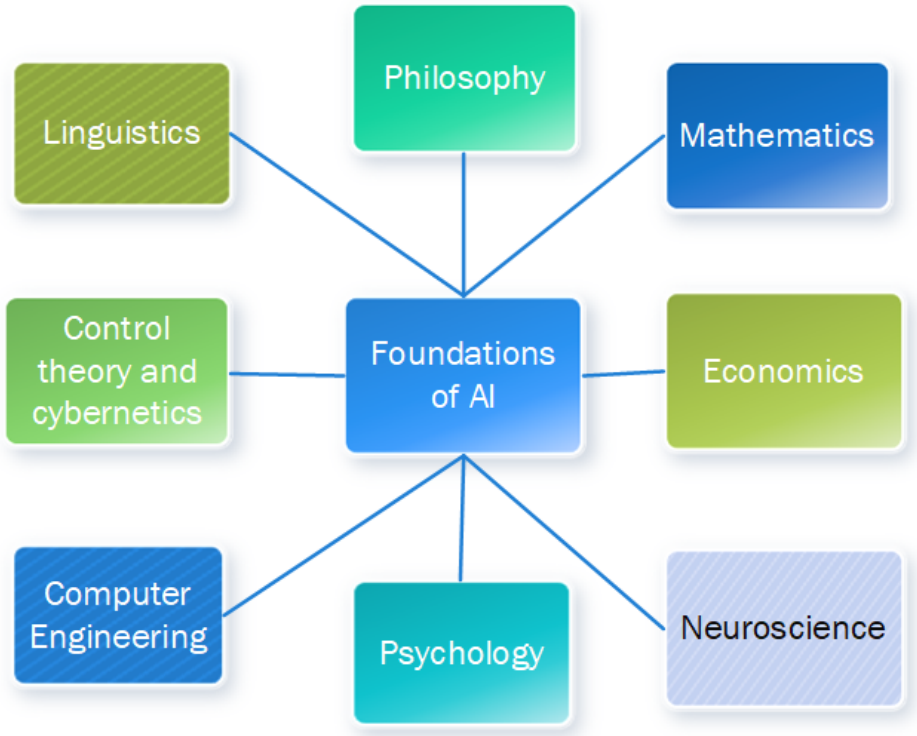

Figure 4: Foundations of AI.[2]

[2] https://www.gopichandrakesan.com/day-25-foundations-of-artificial-intelligence/

Philosophy:

- Philosophical topics include logic, reasoning, the mind as a physical system, the foundations of learning, language, and rationality.
  - Where does knowledge originate?
  - How does knowledge translate into action?
  - How does the mental mind emerge from the physical brain?
  - Can formal rules be used to reach correct conclusions?

Mathematics:

- Computation, undecidability, intractability, and probability are all examples of formal representation and proof algorithms.
  - What are the formal rules for arriving at sound conclusions?
  - What can be calculated?
  - How do we make sense of uncertain information?

Economics:

- Formal theory of rational decisions, game theory, and operation research are all examples of economics.
  - How should we make choices to maximize payoff?
  - How should we proceed when others may not agree?
  - How should we proceed when the payoff may be years away?

Foundations of AI

Psychology:

- Adaptation, perception, and motor control.
  - What do humans and animals think and do?

Linguistics:

- Grammar, knowledge representation.
  - What is the relationship between language and thought?

Foundations of AI

Neuroscience:

- The physical foundation for mental activities
  - How do our brains process data?

Control Theory and Cybernetics:

- Homeostatic systems, stability, and optimal agent design are all examples of control theory.
  - How can artifacts function independently?

Computer Science and Engineering:

- How can we build an efficient computer?

Applications of AI

- Successful AI systems today work in well-defined domains and employ narrow, specialized knowledge.
- To function in complex, open-ended worlds, common sense knowledge is required.
- A system of this type must also understand unconstrained natural language.
- These capabilities, however, are not yet fully present in today's intelligent systems.
  - How should we make choices to maximize payoff?
  - How should we proceed when others may not agree?
  - How should we proceed when the payoff may be years away?

Applications of AI

What are the capabilities of AI systems?

- Some of these tasks have seen limited success with today's AI systems.
  - In Computer vision, the systems are capable of face recognition
  - In Robotics, we have been able to make vehicles that are mostly autonomous.
  - In Natural language processing, we have systems that are capable of simple machine translation.
  - Today's Expert systems can carry out the medical diagnosis in a narrow domain
  - Speech understanding systems are capable of recognizing several thousand words of continuous speech.
  - The Learning systems are capable of doing text categorization into about a 1000 topics
  - In Games, AI systems can play at the Grand Master level in chess (world champion), checkers, etc.

Applications of AI

What can AI systems NOT do yet?

- Learn and Understand natural language robustly (e.g., read and understand articles in a newspaper)
- Create plans in dynamic real-time domains
- Demonstrate true autonomy and intelligence and so on.

Learners Should Be Able To Answer The Following:

1. What is AI? Explain the behaviors of AI.
2. Briefly discuss the four different perspectives of AI with supporting examples and statements. How they are used to evaluate the intelligence and rationality of machines?
3. Criticize the performance of the Turing test to measure the intelligence of a system.
4. Describe your own criteria for a computer program to be considered intelligent.
5. Do you agree with the development of AI has had some negative effects on the society? Why or Why not? Put your opinion.
6. How can you define AI from the dimension of rationality and thought process?
7. How do philosophy, sociology, economics, etc. influence the study of AI?
8. Discuss the state of the art in applications of AI.

References

S. J. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 3rd ed. Pearson, 2010.

Thanks