CS324-Artificial Intelligence

Lecture 1: Introduction

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Outline

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Artificial Intelligence (3-0)

Rationale

Artificial intelligence (AI) provides tools and techniques for the automation of intelligent behavior. This course exposes students to the paradigms and techniques necessary for study and research in AI. Emphasis is placed on the historical evolution and the emerging trends in (AI) technology.

In this course:

- Concentrate on theoretical aspects of AI and its applications.
- Learn basic knowledge representation, problem solving, and learning methods of AI.
- Assignments after each unit. (Late assignments will not be accepted.)
- Plagiarism is an academic offense, zero marks will be given if found in your assignments.
- Random Quiz any day any time during class.

AI Books and Awards

Books & Materials

- Artificial Intelligence: A Modern Approach, Pearson Education by [1]
- Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Addison Wesley, by [2]
- Web Resources: Hundreds of links to different resources can be found on `http://aima.cs.berkeley.edu/ai.html`

Awards and Prizes in AI[3]

- The Machine Intelligence Prize
- Loebner prize
- Herbrand Award

Outline

Artificial Intelligence

Definition

The study and design of intelligent agents where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success.

Definition (John McCarthy)

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.

Intelligence

What is Intelligence

- It is related to task involving higher mental process
- For example: Creativity, problem solving, pattern recognition, language processing, learning, classification etc.
- Intelligence is actually the computational part of the ability to achieve goal, and varies among humans and animals.

Intelligent Behavior

Intelligent Behavior

- Percieving the environment
- Acting in complex environment
- Learning and understanding from experience
- Reasoning to solve problems and discover hidden knowledge
- Responding in new situation by applying knowledge successfully
- Thinking abstractly, and using analogies
- Communication

Outline

Historical Development: Basis for AI I

- Philosophy: intelligence can be achieved via mechanical computation

Example

Aristotle's (450 B.C.) informal system to consider the mind as a physical system, and that the conclusion are generated mechanically given initial premises (proper reasoning).

- Mathematics: George Boole (1847) proposed formal language for logical inference.

Historical Development: Basis for AI II

- Decision Theory: John Von-Neumann and Oskar Morgenstern (1944) Mathematical successor to utility theory that combines both the utility theory and probability theory to identify good actions vs bad actions.

- Psychology: Much of the AI is based on human psychology such as human vision, human behavior in different circumstances, cognitive psychology.

- Kenneth Craik (1943) explained three important steps for knowledge-based agent

  1. The stimulus[1] must be translated into an internal representation.
  2. New internal representation derived by cognitive processes[2] by manipulating existing representation.

Historical Development: Basis for AI III

3. The internal representations are then translated to actions.

- Computer Engineering: AI is based on intelligence and artifact.

- Linguistic: Languages are ambiguous, context dependent, and leave much unsaid. I.e., Knowledge of context, and subject matter has importance to understand language. Knowledge representation (1960s) knowledge in the form so that the computer can reason with.

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[1]Stimulus is energy pattern(sound, light) that is identified by senses and constitute behavior or perception

[2]mental processes of perception, memory, judgment, and reasoning

Outline

Sub-Areas of AI

- Computer Vision
- Speech Recognition
- Machine Learning
- Neural Networks
- Natural Language Processing
- *Reasoning and Decision Making*

What we will be learning

Searching, Planning, and decision theory (Decision making)
Knowledge Representation
Reasoning (Logically and Probabilistic)

Outline

Goals of AI

There are four possible goals of AI

- Systems that think like human (Cognitive Science Approach)
- Systems that think rationally (Laws of Thoughts Approach)*
- Systems that acts like human (Turning Test Approach)
- Systems that act rationally (Rational Agent Approach)*

Cognitive Science

Definition
Aims to develop, explore and evaluate theories of how mind works through the use of computational model.

How it is important
It is more important to know how things are done rather than what has done. i.e., the intelligent behavior is not enough but the agent should operate in intelligent manner. E.g, Chess playing

Example
In 1957, Allen Newell and Herbert Simon developed the General Problem Solver (GPS) that can solve equations. The authors were actually more concerned to compare its reasoning steps to the human subjects solving the same problems.

Turing Test

Alan Turing (1950)

A human interrogator communicates with a hidden subject that is either a computer system or a human. If the human interrogator cannot reliably decide whether or not the subject is a computer, the computer is said to have passed the Turing test.

- Turing provided some very persuasive arguments that a system passing the Turing test is intelligent.
- However, the test does not provide much on the question of how to actually build an intelligent system.

Short Question!

What sub-areas of AI may be important for a system to pass Turing test?

Rationality

Definition (Aristotle idea)

This is a precise mathematical notion of what it means to do the right thing in any particular circumstance. i.e., to codify the right thinking.

It will give us

- A precise mechanism for understanding and analyzing the properties of the ideal behavior we are trying to achieve.
- A precise benchmark for validating and evaluating the behavior of the system we build.

- Rooted from diverse fields of Logic (Laws of thoughts), and
- Economics (Utility theory[3], and game theory [4])

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[3]deals with best to act under uncertainty.

[4]deals with modeling interaction of self-interested agents.

Some more on rationality

Laws of Thoughts

- Inspired by mental mechanism, i.e., perceive $\Rightarrow$ reason $\Rightarrow$ act.
- Inference is important that are provably correct and guarantee an optimal solution.
- Develop systems of representation to allow inferences to be like "Socrates is a man. All men are mortal. Therefore Socrates is mortal."
- Objective: Formalize the reasoning process as a system of logical rules and procedures for inference.

Issues

- Not all problems can be solved just by reasoning.
- Stating informal knowledge in the formal terms required by logical notation.
- Can not handle uncertainty, i.e., knowledge must be 100% certain.

Rational Agent

- **Agent**: an entity or something that exists in an environment and acts on that environment based on its perceptions of the environment.
- **Rational Agent**: that acts to achieve best outcome or best expected outcome in the presence of uncertainty.
- This act may be to reason logically to the conclusion (inference) that a given action will achieve one's goals and then to act on that conclusion ("Laws of Thoughts Approach").
- There may be no provably correct thing to do, but something must still be done.
- I.e, that act sufficiently if not optimally in all situations.

Readings

– Chapter 1 of the book
– Also look into the history of AI and its success.

References I

📄 Stuart Russell and Peter Norvig.
Artificial Intelligence: A Modern Approach.
Pearson Education, Inc, USA, second edition, 2003.

📄 George F. Luger.
Artificial Intelligence: Structures and Strategies for Complex Problem Solving.
Addison-Wesley Publishing Company, USA, 6th edition, 2008.

📄 AI completions and awards.