

A Short Introduction to Artificial Intelligence

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Outline

Definitions

Artificial intelligence

- Acting rationally

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Definition of Artificial Intelligence

What is intelligence?

- Intelligence is an attribute that is exhibited by many living organisms.
- Intelligence may be defined as an attribute that enables organisms (or communities of organisms) to operate, and hence live, relatively successfully in different environments.
- Characteristics of intelligence:
 - Relies on knowledge of environment.
 - May be an attribute of an individual or a community of organisms.
 - Depends on the adaptability of the architecture — structure, function and behavior — of an organism to an environment.
 - May take many forms and rely on multiple strategies.
 - Optimizes, but does not guarantee 100% chances of success in an environment.
 - May be hierarchical, i.e. built in layers.

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What is artificial intelligence?

- Artificial intelligence (AI) is the science and engineering of intelligence.
 - As a science it deals with the study and modeling of intelligence.
 - As an engineering it deals with the design and implementation of "intelligent" systems.
- AI is a branch of computer science that deals with the analysis, synthesis and application of artifacts that rely on knowledge as a basis for solving (typically) computationally hard problems.
- AI involves:
 - **Knowledge representation:** Coding and internal storage of facts about task environments and basic rules for acting on the environments.
 - **Perception:** Sensing and interpreting states of environments.
 - **Reasoning:** Making inferences about task environments.
 - **Learning:** Acquiring (more) knowledge to facilitate the improvement of performance in task environments.
 - **Communicating:** Exchanging information with other systems.
 - **Acting:** Performing operations on, or within, task environments in response to stimuli.

Approaches to AI

Symbolic approaches to AI

- Symbolic approaches rely on the use of discrete symbols to represent subjects, information about subjects and express mechanisms for reasoning about subjects.
- Symbolic approaches have the following characteristics:
 - They rely on detailed knowledge of the domains of discourse.
 - They tend to be top-down in their implementation of systems.
- Examples of symbolic AI systems:
 - Deductive systems based on first-order and higher order types of logic.
 - Systems that rely on classical search mechanisms.

Sub-symbolic approaches to AI

- Sub-symbolic approaches rely on the use of numeric data or coded data to represent information.
- Sub-symbolic approaches are motivated by the notions of
 - Symbol grounding: Building of complex behaviors from simple behaviors without centralized control.
 - Emergent behaviors: Emergence of certain behavioral phenomena purely from interactions between components of systems and between systems and their environments.
- Examples of sub-symbolic AI systems:
 - Neural networks.
 - Genetic algorithms.
 - Systems inspired by the collective intelligence of biological organisms.

Combined symbolic and sub-symbolic approaches to AI

- Combined approaches to AI occupy the middle ground between the pure symbolic approaches and the pure sub-symbolic approaches to AI.
- Combined symbolic and sub-symbolic approaches to AI are motivated by the following notions:
 - That symbols can emerge from numeric data.
 - That mechanisms for processing symbols can be implemented by interactions between devices with simple behaviors.
 - That a high-level specification of behavior can be compiled into a low-level (or sub-symbolic) form such as a circuit that implements that behavior.
- Examples:
 - Situated automata.

The 2D approaches to AI

Russell and Norvig [?] identify two dimensions along which AI has been pursued, namely:

- The thinking versus acting dimension.
- The human versus rationality dimension.

These two dimensions give rise to four combinations of approaches to AI, namely:

- The acting humanly approach.
- The thinking humanly approach.
- The thinking rationally approach.
- The acting rationally approach.

The acting humanly approach to AI

- The acting humanly approach to AI was proposed by Allan Turing through his now famous **Turing Test** of machine intelligence.
- A machine could be adjudged as intelligent, according to Turing, if it could through its actions fool a human into thinking that it was a human.
- There are two types of Turing Tests:
 - The basic Turing Test.
 - The complete Turing Test.

The Basic Turing Test

The following is a scenario for the basic Turing Test:

- A human and a machine are placed in two different rooms.
- The human is provided with a teletext machine (or contemporary times a keyboard and a monitor) with which to interact, through text messages, with the machine.
- The human is not informed before or during the interaction that the other participant in the conversation is a machine.
- The human and the machine are made to hold a non-trivial conversation through text messages.
- After the conversation the human is supposed to declare that (s)he has interacted with either another human or a machine.

The thinking rationally approach to AI

The thinking rationally approach is the "Laws of Thought" approach to AI. It is based on the following:

- The representation of knowledge in the form of assertions:
 - Facts in the form propositions in propositional logic.
 - Predicates in first-order logic (FOL), second-order logic (SOL) and higher-order logic (HOL).
 - The manipulation of assertions using rules of inference to deduce new facts from established facts.
- Although the thinking rationally approach has proved to be a success in some areas of automated reasoning, such as theorem proving, it poses two serious challenges, namely:
- The problem of formalizing informal knowledge.
 - The problem of computational tractability.

The Total Turing Test

The total Turing Test subsumes the basic Turing Test. It comprises the following tests:

- The basic Turing Test.
- A test by the human participant of the other participant's perception capabilities, e.g. the ability to analyze a scene in a video.
- A test by the human participant of the other participant's object manipulation capabilities and mobility.

A Critique of The Turing Test Approach

The Turing Test approach to AI is an ambitious scheme. Its ultimate goal is yet to be achieved. The approach has a positive side and a negative side.

- **The positive side:** The Turing Test approach has spawned six active areas of research in AI, namely:
 - Natural language processing.
 - Knowledge representation.
 - Automated reasoning.
 - Machine learning.
 - Machine vision.
 - Robotics.
- **The negative side:** The criticisms of the approach are two-fold:
 - It confines itself to human intelligence only.
 - It fails to address the fundamental principles of intelligence.

The thinking humanly approach to AI

- The thinking humanly approach to AI is often referred to as the cognitive modeling approach to AI:
 - It is based on the notion that for machines to be adjudged intelligent, they should think like humans.
 - For the approach to be successful it has to rely on research in psychology as a basis for modeling human thought processes.
- Cognitive science is still an active area of research.
- A symbiotic relationship exists between research in cognitive science and research in AI:
 - Research in cognitive science supplies empirical evidence of processes behind the intelligence exhibited by animals.
 - Research in AI investigates possible computational models of the processes observed in cognitive science.

The acting rationally approach to AI

The acting rationally approach to AI is based on notion that intelligence manifests as the ability to *do what is right most of the time*.

- Success in an endeavor is a result of the actions that are performed by the actor.
- The most successful actors have better chances of surviving and/or maximizing their happiness.

The acting rationally approach is the basis of the rational agent paradigm of AI. An agent performs the following:

- Senses its environment.
- Makes a decision on the basis of the perceived state of its environment.
- Acts on the environment.

The rational agent approach to AI is a unifying approach to AI.

Bibliography

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