UNIVERSITY OF DAR ES SALAAM

COLLEGE OF ICT

IS 363 / CS 433

Introduction to Artificial Intelligence

Coordination

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http://lms.udsm.ac.tz/course/view.php?id=1501

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Objectives

- Fundamental concepts of AI and intelligent systems
- knowledge representation methodologies such as propositional and predicate logic, rule-based systems, and probabilistic systems
- Various search algorithms and identify when does each algorithm is appropriate and useful
- Provides an understanding of the representation and use of knowledge in inference-based problem solving by knowledge-based agents.

Learning Outcomes

- Demonstrate good understanding of fundamental concepts
- Acquisition of analytical capabilities and problem solving skills
- Explain how heuristics offer ways to pursue goals in exponentially large search spaces
- Describe the representation and use of knowledge in inference-based problem solving by knowledge-based agents.
- Relate theories of mind and the future of AI to ethical issues raised by artificial cognitive systems.
- Identify the utility and limitations of knowledge representation methodologies such as propositional and predicate logic, rule-based systems, and probabilistic systems;
- Distinguish various uninformed and informed search algorithms and identify when each is appropriate.

Content

- Introduction to Artificial Intelligence (AI)
- Problem Solving in AI
  - Role of heuristics
  - Probability in AI
  - Probabilistic Inference
- Machine Learning
  - Planning under Uncertainty
  - Logic Representation
- Robotic Reinforcement Learning

Course Info.

- **Primary Text:**
  - Artificial Intelligence: A Modern Approach (Second Edition) by Stuart Russell and Peter Norvig; Prentice Hall, 2003. ISBN 0-13-103805-2.
- **Other References:**
  - Artificial Intelligence: A New Synthesis by Nils J. Nilsson, Morgan Kaufmann, 1998, ISBN 1-55860-467-7.
  - Artificial Intelligence: A Systems Approach by M. Tim Jones, ISBN: 978-0-9778582-3-1
  - Various Online Sources

Course Info.

- **Course Conduct**
  - 15 Lecture Hours
  - 15 Tutorial Hours
- **Course Assessment:**
  - Coursework: Accounts for 40%
    - Project: 20%
    - Mid-Term: 20% (one or two tests)
  - Final Exam: Accounts for 60%
- **N. B.:** This schedule may change as we progress

Content

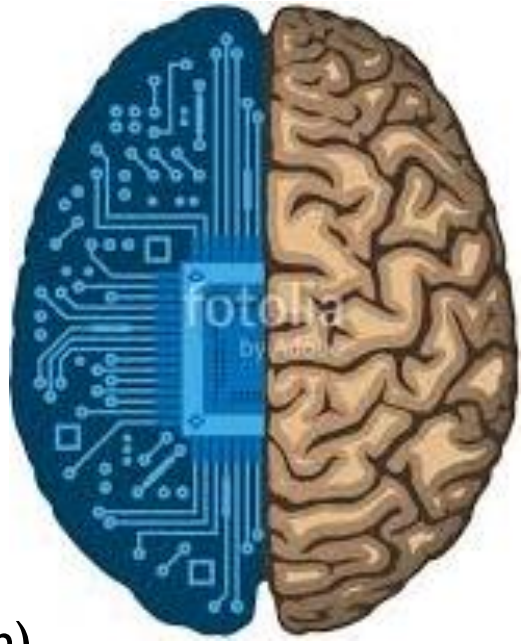
- Introduction to Artificial Intelligence (AI)
  - What is AI?
  - History of AI
  - Artificial vs. Human Intelligence
  - Assignment 1

What Does it mean by Intelligence?

- 1st part: Ability to interact with the world (speech, vision, motion, manipulation) in smart manner.
- 2nd Part: Ability of a system to learn, adapt and reason about the world.
- 3rd Part: A judgment based on observation of the system's behavior and agreed to by "most reasonable men" as intelligence.

What is AI?

- What is AI in Computer discipline:
  - AI is a model representation of algorithm that target thinking, perception and action design to solve a constraints.



  - You face a problem?!?!
  - Think of solution
  - Reasoning on perception of your thinking
  - Create models of different perceptions
  - Act to optimize model solution (algorithm)

What is AI?

- Views of AI fall into four categories:
  - Thinking: the process of considering or reasoning about something for judgement
  - Perceive: become aware or conscious of (something) i.e. come to realize or understand by use one of the senses.

Thinking	Perceive
Acting	Acting rationally

What is AI?

- Views of AI fall into four categories:
  - Act: take action to fulfil the function or serve the purpose based on initial understanding.
  - Rational: The understanding should based on or in accordance with reason or logic.

Thinking	Perceive
Acting	Acting rationally

Goals in AI

- To understand intelligence in order to model it
- To build systems that exhibit intelligent behavior
- Sometimes we want AI systems to be better and smarter than what we are!
- We investigate other living organisms and adopt their intelligence to model systems

AI – The History

- AI is as old as computing, whose theory started in the 1930 with Alan Turing, Alonzo Church, and others
- 1941 Konrad Zuse, Germany, general purpose computer
- 1943 Britain (Turing and others) Colossus, for decoding
- 1945 ENIAC, US. John von Neumann a consultant
- 1956 Dartmouth Conference organized by John McCarthy (inventor of LISP)
- The term Artificial Intelligence was coined at Dartmouth, which was intended as a two month study.

AI – The Achievements

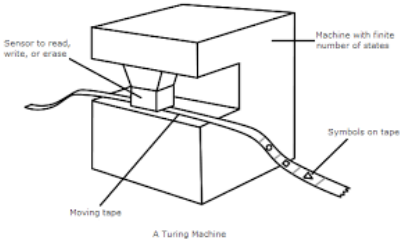
- Computers land 200 ton jumbo jets unaided every few minutes.
- Search systems like Google are not perfect but provide very effective information retrieval.
- Robots cut slots for hip joints better than surgeons.
- The chess program Deep Blue beat world champion Kasparov in 1997.
- Medical expert systems can outperform doctors in many areas of diagnosis
- Self-driving cars are beginning to enter the market.

Artificial vs. Human Intelligence

- Today's computers can do well-defined tasks (e.g. arithmetic operations), much faster and accurate than human.
- However, computers' interaction with their environment is not very sophisticated yet.
- How can we test whether a computer has reached the general intelligence level of a human being?
- **Turing Test:** Can a computer convince a human interrogator that it is a human?
- Let's start developing our own extremely simple "intelligent" machine.

Paradigms of Computation

- **Turing machine** was conceived by Alan Turing as a theoretical Model of automatic computation.



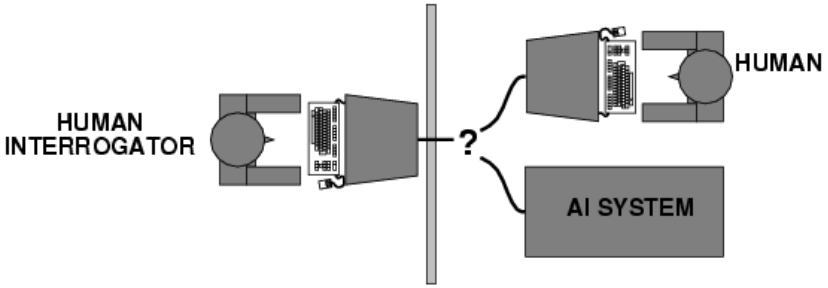
- It uses a tape head that reads and writes symbols on an infinite tape.
- Based on the machine's current **state**, the head moves to the left or right or writes a new symbol, and the state is updated.
- These state transition rules constitute the **program**.
- It is believed (but has not been proven) that this machine can compute all functions that can be computed in principle.

Turing Machines

- Turing machines inspired construction of first computers, which were based on the **von-Neumann architecture**.
- Therein, **digital memory** was storing the program and data, including the machine state.
- A **Central Processing Unit (CPU)** sequentially executes individual instructions in program through memory read and write operations.
- This fundamental architecture is still shared by most of today's computers.

Acting humanly: Turing Test

- Turing (1950) starts a journey towards "intelligent“ machine:-
  - "Can machines think?" → "Can machines behave intelligently?"
  - Set imitation Game to test intelligent behavior:



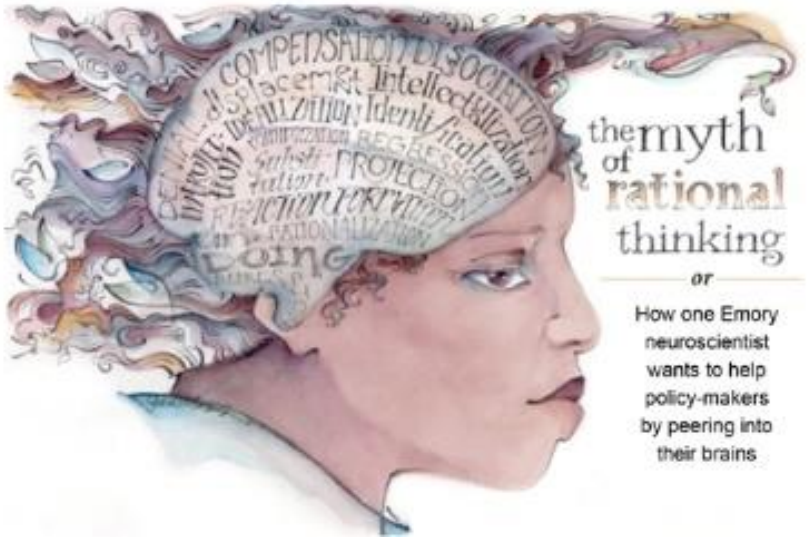
- Turin predicted by Year 2000, a machine might have 30% chance of fooling a lay-person for 5 minutes
- Anticipated all major arguments against AI in following 50 years
- Turin suggested major components of AI: knowledge, reasoning, language understanding, learning

Thinking humanly: cognitive modeling

- 1960s "cognitive revolution": information-processing psychology
- Requires scientific theories of internal activities of the brain
- How to validate? Requires:-
  1. Predicting and testing behavior of human subjects (top-down) or
  2. Direct identification from neurological data (bottom-up)
- Both approaches (roughly, Cognitive Science and Cognitive Neuroscience) are now distinct from AI

Acting rationally: rational agent

- Rational behavior: doing the right thing
- The right thing: that expected to maximize goal achievement, given the available information
- Acting doesn't necessarily involve thinking – e. g. blinking reflex
  - but thinking should be in the service of rational action



Rational agents

- An agent is an entity that perceives and acts
- This course is about designing rational agents
- Abstractly, an agent is a function from perceived histories to actions:

$$[f: \mathcal{P}^{\star} \rightarrow \mathcal{A}]$$

- For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance

→ design best program for given machine resource

AI Application

Philosophy	Logic, methods of reasoning, mind as physical system foundations of learning, language, rationality
Mathematics	Formal representation and proof algorithms, computation, (un)decidability, (in)tractability, probability
Economics	utility, decision theory
Neuroscience	physical substrate for mental activity
Psychology	phenomena of perception and motor control, experimental techniques
Computer engineering	building fast computers

AI Application

- Control theory — design systems that maximize an objective function over time
- Linguistics — knowledge representation, grammar

AI Project – Assignment 1

- Swarm intelligence is heuristic approach that tries to model the population of entities able to self – organize and interact and broadly speaking.
- It refers to the problem-solving method that origins from the interaction of individuals in population with ability to self-organize.
- The computational swarm intelligence could be defined as algorithmic models of intelligence behavior between such individuals.
- Many heuristic solution methods have been developed and applied for solving the mathematical models by mimic Swarm intelligence
- Explain Swarm Intelligence algorithm of your choice and give details of its heuristics approach.