ARTIFICIAL INTELLIGENCE

Week 1-2

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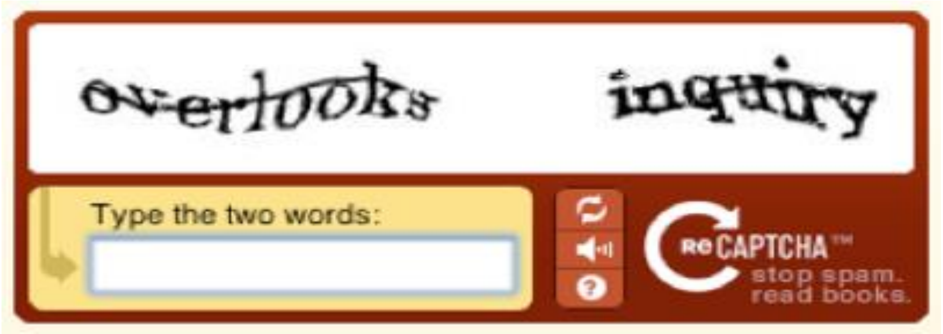
Classical Test of (Human) Intelligence

• **<u>The Turing Test: –</u>**

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.

• Weak Turing type tests:



See Luis von Ahn, Manuel Blum, Nicholas Hopper, and John Langford. CAPTCHA: Using Hard AI Problems for Security. In Eurocrypt

Human Intelligence

- Turing provided some very convincing arguments that a system passing the Turing test is intelligent.
  - We can only really say it **behaves like a human**
  - Nothing guarantees that it **thinks like a human**

- The Turing test does not provide much traction on the question of how to actually build an intelligent system.

Human Intelligence

• In general there are various reasons why trying to mimic humans might not be the best approach to AI:

– Computers and Humans have a very different architecture with quite different abilities.
– Numerical computations
– Visual and sensory processing
– Massively and slow parallel vs. fast serial Computer

	Computer	Human Brain
Computational Units	8 CPUs, 10^{10} gates	10^{11} neurons
Storage Units	10^{10} bits RAM 10^{13} bits disk	10^{11} neurons 10^{14} synapses
Cycle time	10^{-9} sec	10^{-3} sec
Bandwidth	10^{10} bits/sec	10^{14} bits/sec
Memory updates/sec	10^{10}	10^{14}

Human Intelligence

- More importantly, we know very little about how the human brain performs its higher level processes. Hence, this point of view provides very little information from which a scientific understanding of these processes can be built.

- Neuroscience has been very influential in some areas of AI. For example, in robotic sensing, vision processing, etc.

- Humans might not be best comparison?
  - Don't always make the best decisions
  - Computer intelligence can aid in our decision making

Rationality

- The alternative approach relies on the notion of **rationality**.

- Typically this is a precise formal notion of what it means to **do the right thing in any particular circumstance.** Provides

  – A precise mechanism for analyzing and understanding the properties of this ideal behavior we are trying to achieve.

  – A precise benchmark against which we can measure the behavior the systems we build.

Rationality

- Formal characterizations of rationality have come from diverse areas like **logic (laws of thought)** and **economics (utility theory—how best to act under uncertainty)**, **game theory (how self-interested agents interact).**

- There is no universal agreement about which notion of rationality is best, but since these notions are precise we can study them and give exact characterizations of their properties, good and bad.

- **We'll focus on acting rationally – this has implications for thinking/reasoning**

Computational Intelligence

- AI tries to understand and model intelligence as a computational process.

- Thus we try to construct systems whose computation achieves or approximates the desired notion of rationality.

- Hence AI is part of Computer Science.
  - Other areas interested in the study of intelligence lie in other areas or study, e.g., cognitive science which focuses on human intelligence. Such areas are very related, but their central focus tends to be different.

Four AI Definitions by Russell + Norvig

	Like humans	Not necessarily like humans
Think	Systems that think like humans	Systems that think rationally
Act	Systems that act like humans	Systems that act rationally Our focus

Cognitive Science

SYSTEMS THAT THINK LIKE HUMANS

"[The automation of] activities that we associate with human thinking, activities such as decision making, problem solving, learning …" (Bellman, 1978)

SYSTEMS THAT THINK LIKE HUMANS

"The exciting new effort to make computers think … machines with minds, in the full and literal sense" (Haugeland, 1985)

SYSTEMS THAT THINK LIKE HUMANS

"The study of computation that make it possible to perceive, reason and act" (Winston 1992)

SYSTEMS THAT THINK LIKE HUMANS

"The study of mental faculties through the use of computational models" (Charniak and McDermott)

SYSTEMS THAT ACT LIKE HUMANS

"The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil 1990)

SYSTEMS THAT ACT LIKE HUMANS

"A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes" (Schalkoff, 1990)

SYSTEMS THAT ACT LIKE HUMANS

"The branch of computer science that is concerned with the automation of intelligent behavior" (Luger and Stubblefield, 1993)

SYSTEMS THAT ACT LIKE HUMANS

"The study of how to make computers do things which, at the moment, people do better" (Rich and Knight, 1991)

On the face of it, this definition may appear simplistic

However, the term "at the moment" has a significant time element

SUBAREAS OF AI

- Perception: vision, speech understanding, etc.
- Machine Learning, Neural networks
- Robotics
- Natural language processing
- Reasoning and decision making ← OUR FOCUS
  - Knowledge representation
  - Reasoning (logical, probabilistic)
  - Decision making (search, planning, decision theory)

SUBAREAS OF AI

- **Many of the popular recent applications of AI in industry have been based on Machine Learning, e.g., voice recognition systems on your cell phone.**

- **We will not say much in this course about machine learning, although the last part of the course will introduce Bayes Nets a form of probabilistic graphical model.**

- **Probabilistic graphical models are fundamental in machine learning.**

WHAT WE COVER IN THIS COURSE ???

- **Search (Chapter 3, 5, 6)**
  - Uninformed Search
  - Heuristic Search
  - Game Tree Search

- **Knowledge Representation (Chapter 8, 9)**
  - First order logic for more general knowledge (8)
  - Inference in First-Order Logic (9)

WHAT WE COVER IN THIS COURSE ???

- **Classical Planning (Chapter 10)**
  - Predicate representation of states
  - Planning Algorithms

- **Quantifying Uncertainty and Probabilistic Reasoning (Chapter 13, 14, 16)**
  - Uncertainties, Probabilities
  - Probabilistic Reasoning, Bayesian Networks

AI SUCCESSES

- **Games:** chess, checkers, poker, bridge, backgammon…
  - Search
- **Physical skills:** driving a car, flying a plane or helicopter, vacuuming...
  - Sensing, machine learning, planning, search, probabilistic reasoning
- **Language:** machine translation, speech recognition, character recognition, …
  - Knowledge representation, machine learning, probabilistic reasoning
- **Vision:** face recognition, face detection, digital photographic processing, motion tracking, …
- **Commerce and industry:** page rank for searching, fraud detection, trading on financial markets…
  - Search, machine learning, probabilistic reasoning

DEGREES OF INTELLIGENCE

- **Building an intelligent system as capable as humans remains an elusive goal.**

- **However, systems have been built which exhibit various specialized degrees of intelligence.**

- **Formalisms and algorithmic ideas have been identified as being useful in the construction of these “intelligent” systems.**

- **Together these formalism and algorithms form the foundation of our attempt to understand intelligence as a computational process.**

- **In this course we will study some of these formalisms and see how they can be used to achieve various degrees of intelligence.**

READINGS

Recommended Textbook:

Artificial Intelligence: A Modern Approach Stuart Russell and Peter Norvig

Chapter No 1: Page 3 – page 28

- **1.1: What is AI?**

  Introduction to artificial intelligence, Foundations of AI

  Identifying AI systems, branches of AI

Other interesting readings:

- **1.2: Foundations**
- **1.3: History**