Study of AI

Mimic life: build artificial versions

Understand principles and build devices that embody them

Can machines fly?

Can machines think?

Animals, Machines and Humans

Goals of Artificial Intelligence Research

- **Scientific:** Understand the Principles that make intelligent behaviour possible in natural or artificial systems
  - analysis of natural and artificial agents
  - testing hypotheses about the construction of intelligent agents
  - building and experimenting with intelligent agents
- **Engineering:** Design and build useful intelligent artifacts

Alan Turing and the Turing Test

Alan Turing: 1912-1954
Can machines think? - the imitation game

The interrogator is connected to one person and one machine via a terminal, therefore can’t see her counterparts. Her task is to find out which of the two candidates is the machine, and which is the human only by asking them questions. If the machine can "fool" the interrogator, it is intelligent.

Conversations

**ELIZA - (1966 Joseph Weizembaum, Lisp)**

**ME:** Hi
**ELIZA:** How do you do? What brings you to see me?
**ME:** I’m thinking of taking a course in artificial intelligence.
**ELIZA:** Why do you say that?
**ME:** I’m worried about it
**ELIZA:** Are you worried often?
**ME:** when I take AI courses
**ELIZA:** What happened when you take AI courses?
**ME:** I usually spend long nights doing assignments
**ELIZA:** Earlier you said you felt worried?
**ME:** about AI courses
**ELIZA:** Maybe your plans have something to do with this.
**ME:** no
**ELIZA:** Why not?
**ME:** because I think you are a computer
**ELIZA:** Is it because you think I am a computer that you came to me?

**CONFEDERATE:** Hello, my name is Sam and I am the human
**JUDGE:** Hi Sam, tell me which is larger, a TV screen or Belgium.
**CONFEDERATE:** Belgium is a little bit larger.
**JUDGE:** Which is further away from this apartment, Queens or the Queen of England?
**CONFEDERATE:** If the Queen is visiting Manhattan, she is closer.
**JUDGE:** If the Queen is visiting Manhattan, won’t she want to abdicate?
**CONFEDERATE:** I would.
**JUDGE:** You would rather not be Queen, then, right?
**CONFEDERATE:** I’d like to be Queen, but England’s damp. How about you?

Blocks World - SHRDLU - Winograd 1968

**Pick up a big red block**
**OK**
**grasp the pyramid**
**I DON’T UNDERSTAND WHICH PYRAMID YOU MEAN**
**What does the box contain?**
**THE BLUE PYRAMID AND THE BLUE BLOCK.**
**What is the pyramid supported by?**
**THE BOX.**
**How many blocks are not in the box?**
**FOUR OF THEM.**

movie: https://www.youtube.com/watch?v=QAJz4YKUwqw
### Game Playing

**Two person, Zero-Sum games (competitive)**

**Game tree:**

- 500 billion billion nodes ($5 \times 10^{20}$)
- Samuel 1950
- Jonathan Schaeffer, U. of Alberta (1992)
- Heuristic search
- "solved" checkers - no search program could do any better
- World champion man-machine player

---

### Checkers

- 500 billion billion nodes ($5 \times 10^{20}$)
- Samuel 1950
- Jonathan Schaeffer, U. of Alberta (1992)
- Heuristic search
- "solved" checkers - no search program could do any better
- World champion man-machine player

---

### TD-Gammon

- Gerald Tesauro 1992
- IBM’s Thomas J. Watson Research Center
- Neural Network
- Reinforcement Learning
- Just below human play

---

### Chess

- game tree has more than $10^{100}$ nodes
- IBM - Deep Blue
- Heuristic Search - search depth: 7-8
- Deep Blue - Kasparov, 1996, Game 1
- Kasparov won 3-2-1
- Currently Houdini 6, Stockfish 8, Komodo 11: search depths of about 20
- Human search depth: 3-4

---

### Go

- game tree has more than $10^{360}$ nodes
- Google Deep Mind : AlphaGo
- March 2016: AlphaGo beats Lee Sedol 4/5 games
- May 2017: AlphaGo beats Ke Jie 3/3 games
- doi:10.1038/nature16961

---

### Atari 2600 Games

- Almost no domain knowledge
- Deep Reinforcement learning from pixels
- Convolutional Neural Networks
- better than human on 3/7 games
- arxiv.org/pdf/1312.5602v1.pdf
- movie: [https://www.youtube.com/watch?v=V1eYniJ0Rnk](https://www.youtube.com/watch?v=V1eYniJ0Rnk)
StarCraft

- multi-agent problem
- imperfect information (partially observed map)
- large action space \(10^8\) possibilities
- large state space
- delayed credit assignment

Poker

- Michael Bowling et al.
- imperfect information
- Must model opponent
- Long-term payoff
- **Cepheus**
- CFR+: 4800 cores, 68 days: 900 core-years


Video Game AI

- IBM “Watson”
- Natural Language understanding
- Must be FAST and SPECIFIC
- Beat Jeopardy! Champs in 2011

Example questions:

- *When Columbus left spain on August 2rd, 1492, he was aboard this ship*
- *Columbus scared the locals in Jamaica when he predicted one of these*

Robotics

- **Shakey**
  - Jos´e
  - SRI
  - 1970
- **José**
  - UBC
  - 2000
- **HRP-4C**
  - AIST
  - 2010
Robotics

Robocup 2017:

Autonomous Cars

Autonomous Cars: 10 years?
Peter Stone (UT Austin)
http://www.youtube.com/watch?v=4pbAI40dK0A

More examples of AI in action

- space exploration
- disaster recovery
- web search
- advertising
- economy - predictions
- knowledge management, engineering
- circuit design, model checking, provability of systems
- air traffic control
- online selling and auctions
- social networks, computational social science and related disciplines
- ...

Are Self-Driving Cars (or AlphaGo/Deep Blue/etc...) Intelligent?

The synthesis and analysis of computational agents that act intelligently.

An agent acts intelligently when
- what it does is appropriate for its circumstances and its goals, taking into account the short-term and long-term consequences of its actions
- it is flexible to changing environments and changing goals
- it learns from experience
- it makes appropriate choices given its perceptual and computational limitations

"They have to learn to be aggressive in the right amount, and the right amount depends on the culture."

- Donald Norman, Design Lab, UCSD


Autonomous Cars: Flexible enough?
Autonomous Cars: Flexible enough?

theoatmeal.com/blog/google_self_driving_car

Cognition and Affect (Dualism)

- Plato 440BC
  - reason: mind, purity, god
  - emotions: body, sin, devil
- Descartes 1600AD

The Dawn of A.I. (1940s-50s)

- Turing 1950
- von Neumann 1944
- Simon 1967

Artificial Intelligence: Rationalistic

Enlightenment, Phenomenology and Social Behaviourism

- Smith 1759
- Heidegger 1927
- Mead 1934

Smith:
- "Nay, it is chiefly from this regard to the sentiments of mankind, that we pursue riches and avoid poverty."

Mead:
- "Mind arises through communication [...] in a social process [...], not communication through mind."
Morality: Sentiment or Reason?

Hume 1777

Kant 1785

Hume: Without sentiment, there can be no moral action
→ social-intuitionist rationality (Haidt 2001)
Kant: Categorical Imperative
→ Super-rationality (Hofstadter 1983)

Limbic/Cortical Systems

- Paul MacLean’s Triune Brain 1960s
- Limbic ≈ hypothalamus, hippocampus, amygdala
- But these “systems” are really very mixed up in the brain

Neurophysiologically...

The same idea ...

<table>
<thead>
<tr>
<th>Who</th>
<th>When</th>
<th>Affective</th>
<th>Cognitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>William James</td>
<td>1890</td>
<td>associative reasoning</td>
<td>true reasoning</td>
</tr>
<tr>
<td>Heidegger</td>
<td>1927</td>
<td>ready-to-hand</td>
<td>present-at-hand</td>
</tr>
<tr>
<td>Dreyfus/Ryle</td>
<td>1950</td>
<td>knowing-how</td>
<td>knowing-that</td>
</tr>
<tr>
<td>Gene Rodenberry</td>
<td>1966</td>
<td>Captain Kirk</td>
<td>Spock</td>
</tr>
<tr>
<td>George Lucas</td>
<td>1977</td>
<td>Han Solo</td>
<td>C3PO</td>
</tr>
<tr>
<td>Joseph LeDoux</td>
<td>1998</td>
<td>Low Road</td>
<td>High Road</td>
</tr>
<tr>
<td>Stanovich/West</td>
<td>2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Kahneman)</td>
<td>2011</td>
<td>System I</td>
<td>System II</td>
</tr>
<tr>
<td>Jonathan Haidt</td>
<td>2001</td>
<td>intuitive</td>
<td>reasoning</td>
</tr>
<tr>
<td>Paul Thagard</td>
<td>2006</td>
<td>hot thought</td>
<td>cold thought</td>
</tr>
</tbody>
</table>

Why do we need a “low road”?

Emotions and Intelligent Computers

1997: Rosalind Picard in Affective Computing

This book proposes that we give computers the ability to recognize, express and in some case “have” emotions. Is this not absurd?

Now:
- IEEE Transactions on Affective Computing
- International Conference on Affective Computing and Intelligent Interaction (ACII)
  → acii2017.org
- Increasing awareness that emotions play a significant role in human intelligence
- but, still don’t have “emotional machines” - why not?

Robots have feelings too..

Darmstadt Dribblers:

Traditional Affective Computing

- Herbert A. Simon Motivational and emotional controls of cognition
- Emotions as “interrupts” to cognitive processing
- Coping strategies to “deal with” emotional interrupts
- Increased complexity of interaction → increased “emotionality”
- Increased “emotionality” → increased cognitive explanations and coping strategies
- Increased cognitive burden → increased interrupts
- Increased interrupts → increased complexity of interaction ...

Artificial Intelligence - Cognitive and Emotional

Traditional AI:

- perception
- cognition
- action
Artificial Intelligence - Cognitive and Emotional

Traditional AI:
- Environment
- Action
- Perception
- Cognition
- Emotion

Socio-Cultural (Two-System) views:
- Environment
- Action
- Perception
- Cognition
- Affect

Osgood's Semantic Differential
- Group I (N: 20) -- "polite"
- Group II (N: 20) -- "polite"

Fundamental Sentiments
- Good
- Bad
- Hyper
- Abusive
- Serene
- Polite

Affect Control Theory

- **Shared sentiments**
- **Shared emotional dynamics**
- **Shared consistency → Cooperation**

Artificial Intelligence: Affect Control Theoretic

Emotions: the new AI

- Artificial Intelligence: 
  \[ \text{intelligence} = \text{rationality} \]
- We now know that \textit{emotions} are \textit{necessary} for intelligence
- A \textit{low road} gives \textit{“heuristic”} social intelligence
- Encode a \textit{social order} that allows us to work in a society

With infinite resources, are emotions necessary?
I'm sorry Dad, but Siri made me do it......