Computer Science 1400: Part #8:

Where We Are: Artificial Intelligence

# WHAT IS ARTIFICIAL INTELLIGENCE (AI)? AI IN SOCIETY RELATING WITH AI

### What is Artificial Intelligence (AI)?



#### WALL-E (2008)

# What is Artificial Intelligence (AI)? (Cont'd)



The Terminator (1984)

What is Artificial Intelligence (AI)? (Cont'd)

Artificial Intelligence (Merriam-Webster): 1. a branch of computer science dealing with the simulation of intelligent behavior by computers. 2. the capability of a machine to imitate intelligent human behavior.

- Two flavors of AI:
  - Strong AI: Design computer systems that demonstrate full human-level intelligence using "same" mechanisms.
  - Weak AI: Design computer systems that demonstrate human-like abilities using any mechanisms.

### Artificial Intelligence: Beginnings



• First AI artifacts are mechanical automata which simulate various intelligent processes, *e.g.*, movement, reasoning.

#### Artificial Intelligence: The 1940s





Warren McCulloch and Walter Pitts Norbert Wiener (1898–1969 / 1923-1969) (1894–1964)

 Initial focus on natural models of neural (McCulloch-Pitts) and homeostatic (Wiener) processes.

#### Artificial Intelligence: The 1950s





John McCarthy (1927–2011)

Allen Newell and Herb Simon (1927–1992 / 1916-2001)

- Al born at Dartmouth Conference in 1956 (McCarthy).
- Focus shifts to abstract information-processing models (*e.g.*, General Problem Solver (GPS) (Newell-Simon)).

#### Artificial Intelligence: The 1960s





Joe Weizenbaum (1923–2008)

Marvin Minsky and Seymour Papert (1927–2016 / 1928–2016)

 Information-processing-based AI systems proliferate (*e.g.*, ELIZA (Weizenbaum)); first rule-based expert system created (*e.g.*, MYCIN); first-generation neural network research (Perceptrons) killed off by Minsky and Papert.

# Artificial Intelligence: The 1960s (Cont'd)



PUMA (Programmable Universal Machine for Assembly) (1969)

### Artificial Intelligence: The 1960s (Cont'd)



The LOGO Turtle (1969)

## Artificial Intelligence: The 1960s (Cont'd)



Shakey (1969)

### Artificial Intelligence: The 1970s



SHRDLU (1970)



Hubert Dreyfus (1929–2017)

• Retreat to "toy" micro-world systems (*e.g.*, SHRDLU); emergence of AI critics into popular culture (*What Computers Can't Do* (1972) (Dreyfus); *Computer Power and Human Reason* (1976) (Weizenbaum)).

### Artificial Intelligence: The 1980s



Rodney Brooks (1954–) Genghis (1989)

- Second-generation neural network research begins; rise of reactive systems (*e.g.*, Genghis (Brooks)); massive governmental (Fifth Generation Project (MITI: Japan) / Strategic Computing Initiative (DARPA: USA)) and industrial start-up funding
- Over-selling leads to crash and late 1980s "AI Winter".

### Artificial Intelligence: The 1990s



Gary Kasparov vs. IBM's Deep Blue (1997)

# Artificial Intelligence: The State of the Art Overview

- Four general types of AI techniques:
  - 1. State-space search
  - 2. Expert systems
  - 3. Response frames
  - 4. Neural networks
- Original goal in 1956 was Strong AI, which is very hard; is now usually Weak AI in which brute-force processing or heuristics are used to get human-level speed if not accuracy.
- Notable successes in certain applications.

# Artificial Intelligence: The State of the Art (Cont'd) Techniques: State-space Search

- View problem as space of interlinked states, e.g., configurations of puzzle or game.
- Solving the problem corresponds to finding a **solution path** through this space from the start state, i.e., what we know initially, to a **goal state**, i.e., what we want.



# Artificial Intelligence: The State of the Art (Cont'd) Techniques: Expert Systems

- Perform logical inference and deductions in particular domains using **expert systems**.
- An expert system consists of (1) a **knowledge base** (assertions + IF-THEN rules) coded from human experts and (2) an **inference engine**.



Artificial Intelligence: The State of the Art (Cont'd) Techniques: Expert Systems (Cont'd)

Assertions: A1. Lincoln was president during the Civil War. A2. Kennedy was president before Nixon. A3. FDR was president before Kennedy.

#### +

Rules: R1. If X was president before Y then X precedes Y.

R2. If *X* was president before *Z* and *Z* precedes *Y* then *X* precedes *Y*.

#### ∜

Inferences: I1. A2 AND R1  $\Rightarrow$  Kennedy precedes Nixon. I2. A3 AND I1 AND R2  $\Rightarrow$  FDR precedes Nixon.

# Artificial Intelligence: The State of the Art (Cont'd) Techniques: Response Frames

 Response frames derive output by matching handcoded patterns on input and substituting matched entities into handcoded templates, e.g.,

"It's about <b>X1</b> ."		"Tell me more about ( <b>X1,X2</b> )."
"X2 drives me crazy."	$\Rightarrow$	"Why do you <b>Y1 X3</b> ?"
"I <b>Y1 X3</b> ."		"Why does <b>X2</b> drive you crazy?"
"X4 hates me."		"You care about ( <b>X1,X2,X4</b> )'s opinion."

• Key technology for implementing chatbots.

# Artificial Intelligence: The State of the Art (Cont'd) Techniques: Neural Networks

- Based on abstract model of biological neurons.
- An **artificial neuron** produces an output 1 if the sum of its inputs times the weight on each input line exceeds a neuron-specific threshold value and 0 otherwise.
- Implement complex functions with an artificial neural networks (ANN) = input layer + one or more hidden layers + output layer + between-layer connections.
- Given **training set** of correct input-output pairs, can learn ANN connection weights by various algorithms, e.g., backpropagation.

# Artificial Intelligence: The State of the Art (Cont'd) Techniques: Neural Networks (Cont'd)



Figure 15.6 Neural Network Model

# Artificial Intelligence: The State of the Art (Cont'd) Techniques: Neural Networks (Cont'd)

- Modern ANN use multiple hidden layers and sophisticated learning algorithms on very large training sets to infer input-output mappings for a wide variety of tasks.
- Such mappings have shown human-level speed, e.g., speech recognition, and in some cases better than human-level accuracy, e.g., financial advice, and once created are often much cheaper to use than humans.
- Potential problems:
  - Need enough data (and processing power).
  - Need appropriate / representative data
  - ANN may not operate correctly on new inputs.
  - ANN very difficult to understand

# Artificial Intelligence: The State of the Art (Cont'd) Applications: Computer Games



Ke Jie vs. Deepmind's AlphaGo (2017)

# Artificial Intelligence: The State of the Art (Cont'd) Applications: Intelligent Agents



IBM's Watson wins Jeopardy! (2011)

# Artificial Intelligence: The State of the Art (Cont'd) Applications: Intelligent Agents (Cont'd)



Siri (Apple; 2010)

Echo (Amazon; 2015)

# Artificial Intelligence: The State of the Art (Cont'd) Applications: Robots



Google's self-driving car (2016)

# Artificial Intelligence: The State of the Art (Cont'd) Applications: Robots (Cont'd)



#### Aiko Chihira – Robot Receptionist (2015)

# Artificial Intelligence: The State of the Art (Cont'd) Applications: Robots (Cont'd)



Real Doll Sex Robots Showcase (2017)

# The Joys of Artificial Intelligence

- Replacement of humans by AI in physically demanding / dangerous / non-rewarding situations (*e.g.*, battlefield, child / elder care).
- Easier / more natural interaction with computers on focused topics (*e.g.*, psychological / medical advice).
- Long-overdue re-assessment of the nature of humanity.





# The Perils of Artificial Intelligence

- Financial trauma from AI replacing people in jobs.
- Psychological or physical trauma from assumption of intelligence and/or understanding where none is present (*e.g.*, chatbots, battlefield robots).
- Lowering of human standards for treatment of other humans (*e.g.*, child / elder care)





### Case Study: AI in the Workplace



Flippy (2018)

# Case Study: AI in the Workplace (Cont'd)



Jaquard loom (1802)

- Debates about machines taking human jobs date back to the Industrial Revolution.
- John Maynard Keynes (1883–1946): Technology eliminates jobs, not work, e.g., blacksmiths ⇒ auto workers, and technological displacement is a temporary but necessary stepping stone for economic growth (Markoff (2015), p. 74).

#### Case Study: AI in the Workplace (Cont'd)

- 1950s debates about machines taking human jobs inspire 1964 US National Commission on Technology, Automation, and Economic Progress; the Commission's 1966 report backed traditional Keynesian view.
- Robots in factories starting in 1960s eliminate certain blue-collar jobs, and certain white-collar jobs eliminated in 1970s and 1980s by personal computer technology, e.g., typesetters ⇒ ???.
- With success of Artificial Intelligence (AI) technologies since mid-2000s, more types of jobs, e.g., taxi and truck drivers, and certain professions, e.g., lawyers, doctors, financial analysts, are under threat in the near future,

# Case Study: AI in the Workplace (Cont'd)

- Given that Weak (and maybe one day, Strong) AI systems are coming into the workplace, what can we do about it?
  - 1. Use the law to limit workplace AI, e.g., driverless cars in India.
  - 2. Keep human beings "in the loop" by focusing on Intelligence Augmentation (IA) rather than AI, e.g., driver-assisting cars.
  - 3. Make (groups of) human beings owners of AI systems, e.g., 5th Generation Project (Japan, 1980s).
  - 4. Use profits derived by using AI systems to establish universal basic incomes.
  - 5. Do nothing, e.g., Vonnegut (1952).

### Case Study: ELIZA and Other Chatbots

- Created by Joe Weizenbaum in the mid-1960's as a simulation of a Rogerian psychotherapist.
- Simulates intelligent conversation using pattern-matching and response frames (same mechanisms used by modern chatbots).
- Many human beings trust and confide in ELIZA, even when they know ELIZA does not and cannot understand them or their problems.
- Similar confusion when dealing with modern chatbots, *e.g.*, falling in love with a chatbot (Epstein (2007)).

# Case Study: ELIZA and Other Chatbots (Cont'd)

#### Talk to Eliza

```
> Hello, I am Eliza.
* I have many problems.
> Don't you ever say Hello?
* No. That's one of my problems. Rudeness.
> You are being a bit negative.
* Yes, I'm very negative most of the time. It runs in my
family.
> Did you come to me because you are very negative most
of the time. It runs in your family?
* I'm amazed by your insight. Yes, that's it. You're
amazing.
> Perhaps you would like to be amazing?
   Input:
```

# Surviving and Thriving with Artificial Intelligence

- Know actual (and do not over- or under-estimate) capabilities of AI systems.
- Beware of exaggerated claims of AI system abilities.
- Until AI systems are actually sentient and capable of being responsible for their actions, assign responsibility to the creators of these systems, not the systems themselves.
- Do not over- or under-estimate the abilities or value of human beings – we may only be mechanisms, but we are beautiful and powerful mechanisms worthy of respect.

"Don't Panic" – *The Hitchhiker's Guide to the Galaxy* "Let's be careful out there" – *Hill Street Blues*