The Second Machine Age

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The Second Machine Age

• Lecture 3 preview
  • Background – software
  • What is Artificial Intelligence (AI)?
  • History of AI
  • What AI is not / what deserves to be called AI
  • AI research areas
  • Big players in AI
  • Impact of AI (part 1)
The Second Machine Age

• **Background**
  
  • Software is instructions that execute in processors
  
  • How software is developed
  
  • How to program a process that “learns”
Computer logic

Output = \overline{ABC} + \overline{ABC} + \overline{AB} + \overline{ABC}
8085 microprocessor - 1976
Background technology

• **Software**
  
  • Machine-language instructions
  
  • Programming languages
    
    • Compiled into machine-language instructions

  • A compiler is another program for translating

• Programs often have “bugs”
Background technology

- **Software development** process (a human activity)
  - Write / edit “source code” in a high-level language
  - Compile source code (into machine instructions)
  - Test the code, find bugs
  - Rewrite / edit “source code” and repeat

- When it works OK, *integrate* it with other code
Sample source code (in C++) part 1

#include <CkMailMan.h>
#include <CkEmail.h>

void ChilkatSample(void)
{
    // Create a MailMan for the purpose
    // of unlocking the component.
    CkMailMan mailman;
    bool success = mailman.UnlockComponent("anything for 30-day trial");
    CkEmail email;
    // Adding attachments, HTML/plain-text bodies, etc can be done
    // in any order:
Sample source code (in C++)  part 2

    // Add an attachment
    const char *contentType = email.addFileAttachment("hamlet.zip");
    if (email.get_LastMethodSuccess() != true) {
        std::cout << email.lastErrorText() << "\n"; return; }

    // Add some headers:
    email.put_Subject("This is a complex email");
    success = email.AddTo("Chilkat Support","support@chilkatsoft.com");
    email.put_From("Matt <matt@chilkatsoft.com>");

    // Add a plain-text body:
    success = email.AddPlainTextAlternativeBody("This is the plain-text body");

    // Add an image that will be embedded in the HTML body.
    const char *contentIdDude = email.addRelatedFile("dude.gif");
    if (email.get_LastMethodSuccess() != true) {
        std::cout << email.lastErrorText() << "\n"; return; }
        ...
Software design decisions

• Data representation
• Data structures
• **Algorithms**
• Modules
• Inputs & Outputs
• Testing / validation
  • Test data
  • Test results
Designing Software for AI

“Learning” algorithms

feedback from previous results

calculating the accuracy of results
History of Artificial Intelligence
History of Artificial Intelligence (1)

• Storytelling devices / ethical questions:
  • Mary Shelley – *Frankenstein* (1817/1823)
  • Karel Capek – *R.U.R* (1920/1921) – “Robot”
History of Artificial Intelligence (2)

• Storytelling devices / ethical questions:
  • Mary Shelley – Frankenstein (1817/1823)
  • Karel Capek – R.U.R (1920/1921) – “Robot”

• Formal logic & reasoning – philosophers, mathematicians
  • Turing & Church (1937)– a machine can simulate any mathematical deductive system using only 0 and 1 (and a “finite-state machine”)

History – Alan Turing

• Turing Machine

• Alan Turing 1912-1954

Turing Machine Model

- Are there computations that no “reasonable” computing machine can perform?
  - the machine should not store the answer to all possible problems
  - it should process information (execute instructions) at a finite speed
  - it is capable of performing a particular computation only if it can generate the answer in a finite number of steps
History – Alan Turing

- Turing Machine
  - https://youtu.be/E3keLeMwfHY
History – Alan Turing

• Turing Machine
  • Important result (from Turing & Church) –
    • some functions are not computable
History of Artificial Intelligence (3.1)

• Storytelling devices / ethical questions:
  • Mary Shelley – Frankenstein (1817/1823)
  • Karel Capek – R.U.R (1920/1921) – “Robot”

• Formal logic & reasoning – philosophers, mathematicians
  • Turing & Church – a machine can simulate any mathematical deductive system using only 0 and 1 (and a “finite-state machine”)

• Turing’s Test –
  • "if a human could not distinguish between responses from a machine and a human, the machine could be considered “intelligent"
History of Artificial Intelligence (3.2)

• Storytelling devices / ethical questions:
  • Mary Shelley – Frankenstein (1817/1823)
  • Karel Capek – R.U.R (1920/1921) – “Robot”

• Formal logic & reasoning – philosophers, mathematicians
  • Turing & Church – a machine can simulate any mathematical deductive system using only 0 and 1 (and a “finite-state machine”)

• Turing’s Test –
  • "if a human could not distinguish between responses from a machine and a human, the machine could be considered “intelligent”

• The Imitation Game
History of Artificial Intelligence (4)

• **AI research beginnings**
  
  • 1950 paper by Alan Turing – Computing Machinery and Intelligence
    
    • Can machines do what we can do?
  
  • 1956 – Allen Newell (CMU), Herbert Simon (CMU), John McCarthy (MIT), Marvin Minsky (MIT), Arthur Samuel (IBM)
  
  • 1959 – Art Samuel - checkers
  
  • 1961 – Frank Rosenblatt – “perceptron”
  
  • 1963 -- AI Labs founded at MIT & Stanford
    
    • ELIZA, checkers & chess, robots (Shaky), locomotion (vehicle)
History of Artificial Intelligence (5)

• **AI research**
  
  • in 1980s -- “AI Winter” for funding
    
    • No dramatic successes in AI applications

  • 2010s – AI is rescued by
    
    • Moore’s Law
    
    • Breakthrough algorithms

• Use of graphics processors for “machine learning” algorithms
Artificial Intelligence Research areas

- bioinformatics
- cognition
- computational geometry
- computer vision
- decision theory
- distributed systems
- game theory
- general game playing
- image processing
- information retrieval
- knowledge systems
- logic
- machine learning
- multi-agent systems
- natural language
- neural networks
- planning
- probabilistic inference
- sensor networks
- robotics
What deserves to be called AI? (part 1)

- **Pattern recognition** (faces, map features, radar blips & sonar echoes, ...)
- **Language**: speech to text, speech recognition, speech understanding
- **Language translation**
- **Human interaction**: “Turing’s Test”, Chatbots
- **Simulation**: artificial worlds; 3D modeling & design; engineering testing
- **Gaming**: Chess, Go, Jeopardy; game-playing bots
What deserves to be called AI? (part 2)

• **Recommendation engines** (Amazon, Netflix, ...)
• **Autonomous vehicles & aircraft** (drones/UAVs)
• **Robots**, industrial and domestic
• **Medical applications** – public health; clinical diagnoses; research aides
• **Virtual reality** applications
  • Jaron Lanier: *Dawn of the New Everything*
Who are the big players in AI?
Who are the big players in AI? (part 1)

• **Commercial**
  • Facebook
  • Google/Alphabet
  • Microsoft
  • IBM
  • Apple
  • Amazon
  • Nvidia
  • (OpenAI consortium)

• Baidu
• Alibaba
• Tencent
• Uber
• Tesla
Who are the big players in AI? (part 2)

• National
  • China
  • USA
  • France
  • Canada
  • U.K.
  • …

• Academic
  • MIT
  • CMU
  • Stanford
  • UC Berkeley
  • …
  • Waterloo
  • Toronto
  • …
  • Tsinghua
  • Peking
AI in 2018

• Artificial General Intelligence
  • IKEA furniture assembly?
  • Common sense?
  • the Singularity

• Impact of AI on employment and work
  • The jobs shift
To be considered in future lectures

• **Machine Learning** – software underlying “A.I.”

• AI for **autonomous vehicles**?