Goals of AI

COMPSCI 570
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What is a Computation?

- **Alonso Church**: Anything that can be expressed in a formal language (not entirely unlike today’s programming languages)
- **Alan Turing**: Anything that can be computed by a specific type of machine (more on this later)
- **Stephen Kleene**: Anything that can be computed by a recursive function

- It turns out that all of these are equivalent

Church-Turing Thesis

- C-T thesis is a hypothesis, not a provable statement
- Paraphrased: “Every effectively calculable function is computable by a machine”
- Effectively calculable = has some reasonable set of rules describing the computation

Tangent: Not everything is computable

- Church-Turing thesis is not vacuous
- It turns out that some things you might want to do are not computable in any finite amount of time
- **Halting problem**: Is there a general procedure for determining if another program will terminate for a particular input?
- **Proofs in first order logic**: Is there a general mechanism that will prove any logical statement (with quantification) true or false?
- The above problems are “semi-decidable”
- We can write a program that will search for answers, but if the answer doesn’t exist, the program may run forever.
What is a Turing Machine?

• Ingredients of a Turing Machine
  – An infinite tape
  – A “head” that reads symbols on the tape
  – A finite program:
    • Program has a finite number of states
    • Each state can inspect symbols on the tape
    • (Conditionally) rewrite symbols on the tape
    • Move the head

• Turing machines are abstractions of every modern computer, except that actual computers have finite tapes (finite memory)

Who Was Alan Turing?

• British mathematician
• Code breaker who developed machines for breaking the famous German “enigma” code in WWII, providing allies with key strategic advantage, e.g., locating u-boats
• Considered a father of the modern notion of computation, and of AI
• Committed suicide (at 41) after being prosecuted for being homosexual and forced to endure hormone treatment (or face imprisonment)

Turing’s Straw Men(?)

• Theological Argument – untestable
• Head in the Sand – wishes != reality
• Mathematical (completeness) – not relevant
• Consciousness – untestable
• Arguments from disabilities – disguised form of earlier arguments, or just begs the question
• Originality/creativity (Lovelace’s argument) – Applies to people too?
• Analog/digital distinction – not relevant
• Informality of behavior – begs the question
• ESP – given more credibility than it deserved

Tangent: What are Reason and Science?

• A key element of scientific/rational behavior is that it make testable claims about the world
• Subjective claims may still have some value:
  – “Roses are beautiful.”
  – “Chicken is delicious.”
• Untestable claims may have personal value to the speaker, e.g., “My deity forbids the consumption of bananas.”
• Untestable claims cannot be a rational basis for resolving disputes, e.g., “This box is not intelligent because XXX,” where XXX is untestable is not a rational way to convince somebody of your position.
• Why? If both parties offer untestable claims to support their position, there is no basis for choosing one over the other!
Behavior and Testability

• What are some other objective criteria that might be relevant for assessing intelligence aside from behavior? (For example, would it matter if a machine that randomly combined words coincidentally passed the test?)

• Do the inner workings of the machine matter?

Why Is NLP Hard?

• Inherent ambiguity of language
• Headline: “Police help dog bite victim”
• “One morning I shot an elephant in my pajamas. How he got in my pajamas, I don't know.” (Fodor)
• “Time Flies Like and arrow; Fruit flies like a banana.” (Groucho Marx)

Watson

• Arose as a “challenge problem”
• Jeopardy viewed as requiring intelligence
• Question answering:
  – Viewed as an independently useful task
  – Previous work existed but was weak
  – Partly embodied in google (now), Siri today
  – See Wolfram alpha
  – Watson is now used to help doctors

• Previous work was promising but weak

Watson Hardware

• Massively parallel cluster of machines

• Not quite a top 500 supercomputer

• Arguably, less computational ability than a brain
Why Didn’t This Happen Sooner?

- Availability of the internet
- Advances in statistical parsing
- Move away from monolithic knowledge bases
- Advances in machine learning

- Speed, memory

Lessons Learned From Watson

- Know what you don’t know!
- Value of ensembles
- Value of ontologies
- Deep and shallow knowledge both have roles