Announcements
A set of review questions will be posted by the middle of the week
Final Exam 8:30-10:20 Monday
    ∗ Comprehensive, but will be weighted towards topics since the last midterm
    ∗ (Remember to set clocks ahead 1 hour for DST on Sunday!)
No Class Friday

Can Computers Think?
Dijkstra: Whether a computer can think is about as interesting as whether a submarine can swim.

Thinking with Electricity
The inventors of ENIAC, 1st computer, said it “thinks with electricity”
    • Do calculators “think”?
    • Does performing arithmetic, which is entirely algorithmic, require thinking?
    • Once, performing arithmetic, was thought to be divinely or magically conferred

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The Problem: Many human activities look like thinking until they are understood (to be algorithmic)

Turing’s Test
A.M. Turing, computer pioneer, worried about intelligence in humans & machines and proposed a test (1950)
    • Aware that it’s intelligence til it’s understood
Turing devised this experimental setup:

Room A: containing a person or machine
Room B: containing a person or machine

Judge: Asks questions via keyboard to decide which is which

What To Ask
Formulate questions a person can answer but a computer can’t
Seeming To Be Intelligent

Joel Weizenbaum’s “Doctor” was a program that appeared intelligent

User: I’m depressed.
Doctor: Why are you depressed?
User: My mother is not speaking to me.
Doctor: Tell me about your mother.
User: She doesn’t want me to major in CS.
Doctor: No?
User: No, she wants me to go into medicine.

Artifact Intelligence

The study of making computers act intelligently

- They already act intelligent… e.g. they can correct your spelling mistakes
- Is this intelligent behavior? Most AI researchers would say “no”… algorithmic
- Playing grandmaster level chess in a tournament became an AI goal (1952)
  - Minimizes real world knowledge
  - Clear goal, formal system

Playing Chess

Chess is a game, so it uses a game tree

- At each node is a ‘board’—easily digitized
- Below it are all boards created in 1 move

An objective function evaluates “goodness” of the position: go for highest… opponent goes for lowest

Deep Blue vs Kasparov

An IBM system, Deep Blue, played world champion Gary Kasparov

- In 1996 Kasparov won, but Deep Blue played 1 game well!!!
- In May 11, 1997 Deep Blue won 3.5-2.5

Deep Blue is a 32 processor parallel computer with 256 “chess processors” that can consider 200,000,000 chess positions per second + opens + ends

Intelligent?

Does Deep Blue’s performance show that a computer can be intelligent?

- No — it repeats its designer’s intelligence
- Yes — it’s better than anyone in the world at something people find interesting and fun
- Maybe — it shows intelligence in chess, but can it apply its intelligence elsewhere?

What do you think?

Being Creative

Computers can do things deemed creative in the past:

- Create designs in the style of Piet Mondrian
- Composing Bach: EPI, Bach, Professor
Definition of Creativity
Creativity has two forms: “flash out of the blue” and “incremental revision”
• “Flash,” i.e. inspiration, is rare; is it just luck?
• “Revision”, i.e. hard work, is common and to a large degree algorithmic

Advertising agencies are famous for creativity, but in a recent study, 89% of all award-winning ads were an application of one of six templates — design algorithm

Computers Can’t Debug
There are some things computers cannot do ... and we can prove it!
• No computer program can tell, give another program P, if P loops forever ... halting prob
• If possible, it would be handy for debugging
• In fact, it seems possible ... look closely at the program, check the for-statements (and other looping structures we didn’t learn)
• Suppose Loop_Check(P, Q) tests pgm P on input Q, answering “yes/no” to loops forever

Loop_Check Cannot Be
Loop_Check could not work, because if it did we’d make a new program
Contradict (P): ans = Loop_Check(P.P)

What happens when we run Contradict(Contradict)?
If L_C says C loops forever, it stops
If L_C says C stops, it loops forever
It’s nonsense, so L_C can’t exist

Intelligence & Creativity
The bottom line on the “intellectual skills” of computers...
• It has long been an interesting question
• Computers are amazing, but probably not intelligent
• When a task becomes algorithmic computers (and humans) can do it well

Maybe thinking is what people do