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)
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.

Find the cues Doctor uses
Artificial 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
Does Deep Blue’s performance show that a computer can be intelligent?

• No -- it repeats its designers 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
Being Creative

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  Audience Thought: Bach Prof EPI
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):

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

C is nonsense, so L_C can’t exist.
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
Robotics

What tasks would you want a robot to do?