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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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

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.

What To Ask

Formulate questions a person can answer but a computer can’t
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

Intelligent?

Does Deep Blue's performance show that a computer can be intelligent?
  • No -- it repeat's 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

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  • Create designs in the style of Piet Mondrian
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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, given 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
T
F
exit
ans = no

If 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

Robotics

What tasks would you want a robot to do?