# Lighthill's Anti Formalist Falsification of AI in Philosophical Context

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Slides will be posted on my web page www.tdl.com/~smeyer

# Overview

- Argument starts with discussion of how the best chess players now defeat the best computer programs - player methods. Al will never succeed in chess.
- New results from cold atom experimental physics (Chris Monroe from Maryland and IonQ Corp.) ion trap quantum computers (QCs). QCs are no better than analog computers with 1-2 percent inherent error implied by Bohr's complementarity.
- Slide on importance of history for philosophy of CS. One reason AI is believed is that philosophy of CS stops in the late 1920s. Accepts Hilbert's programme: knowledge is predicate logic formulas. Falsified by Godel and abandoned in the 1950s.
- Next, two slides that illustrate John von Neumann's criticism of Al.

#### ... overview continued - philosophy

- Lighthill's argument from 1972. Al is nothing more than data processing so why limit methods to attributes of human intelligence and why limit methods to big data search (see my preprint arXiv:1208.3739v1 [cs.OH]).
- Francis Bacon's inductive philosophy (collect facts) used by current AI is compared to Karl Popper's science as falsification following Donald Gillies 1996 book "Artificial Intelligence and Scientific Method."
- Discussion of Neumann's thinking in designing his architecture (VNCs). Rejected Turing Machine (TM) model of computation for VNC MRAM model because TMs are slow from lack of table look up indexing.
- Solving problems with computers is just injecting human understanding into programs. A good way to accomplish tasks. No reason to attribute human properties to such programs. Maybe distributed computing with humans as nodes (info computationalism?).

#### Best chess players can now defeat computers

- Financial Times chess columnist Leonard Barton Dec. 31, 2016 edition referring to Fabian Caruana wrote: "The US champion and world No. 2 unleashed a brilliant opening novelty, which incidently showed the limitations of the most powerful computers."
- More Barton: the best chess players are using inferior openings such as Magnus Carlson's A3 (left rook pawn one square) because "Carlsons message is clear. Offbeat openings can save a lot of wasted preparation."
- It has taken two decades but chess masters now are beating computers because they have good chess position analysis data processing programs. Donors such as Rex Sinquefield has led to development of chess position analysis programs to counter IBM's huge Deep Blue project budget.

#### ... chess continued

- Garry Kasperov in "Deep Thinking: Where Machine Intelligence Ends and Human Creativity Begins" (2017) argues that he lost because of harassment and team effort of many good chess players not to Deep Blue.
- The situation illustrates a common pattern of application computer program's solving problems. Human knowledge injected into data processing programs by means of writing computer code.
- This is what Lighthill's means by combinatorial explosion (Lighthill, J. "Artificial Intelligence: A General Survey" prepared for UK Science Research Council, 1972).

# New results from ion trap quantum computers - just analog computers

- Arguments for coming AI intelligence rely on exponentially faster computers. AI can not expect QCs to be such faster computers over coming combinatorial explosion.
- Best introduction to actual QC properties is to listen to one of Chris Monroe's physics colloquia (such as https://www.youtube.com/watch?v=9aOLwjUZLm0).
- I claim lonQ's measured 1-2 percent error rate is inherent because of Niels Bohr's quantum mechanics complementarity. Inside the atom quantum calculation rules apply. Machines at the macro scale require Newton plus relativity rules.
- Monroe argues quantum error correction will not help because it will either require an exponential number of qbits or it will make QCs same speed as VNCs. QCs are conceptually a row of coupled harmonic oscillators.
- I think lonQ is looking for people to send them QC algorithms to run on its tiny low teens gbit machines.

## History important but philosophy of CS stops in late 1920s

- Imre Lakatos famous paraphrase of Kant. "Philosophy of science without history of science is empty; history of science without philosophy of science is blind."
- Hilbert's programme that all knowledge can be expressed as predicate formulas and reasoning is just formula manipulation was abandoned in the 1950s.
- In the 1960s AI restarted Hilbert's programme and claimed logic will lead to computer programs more intelligent than humans.

#### Neumann on language as formulas

"The insight that a formal neuron network can do anything which you can describe in words is a very important insight and simplifies matters enormously at low complication levels. It is by no means certain that it is a simplification on high complication levels. It is perfectly possible that on high complication levels the value of the theorem is in the reverse direction, namely, that you can express logics in terms of these efforts and the converse may not be true (Aspray, John von Neumann and the Origins of Modern Computing, note 94, p. 321, 1990)."

#### Neumann on genetic algorithms

"He (Neumann) led the biologist to the window of his study and said: 'Can you see the beautiful white villa over there on the hill? It arose by pure chance. It took millions of years for the hill to be formed; trees grew, decayed and grew again, then the wind covered the top of the hill with sand, stones were probably deposited on it by a volcanic process, and accident decreed that they should come to lie on top of one another. And so it went on. I know, of course, that accidental processes through the eons generally produce quite different results. But on this one occasion they led to the appearance of this country house, and people moved in and live there at this very moment'(Heisenberg, Physics and Beyond, 1971, p. 111). "

## Lighthill's falsification of Al

- In 1972 Newton professor of physics James Lighthill prepared a report for UK science funding agency ('Artificial Intelligence: A General Survey"). Aftermath was called the AI winter by AI researchers. A Video of a Royal Society discussion is available on YouTube.
- The background of Lighthill's argument goes back to WWII operations research and Bletchley park code breaking. The book by S. Budiansky "Blackett's War the Men who Defeated the Nazi U-Boats and Brought Science to the Art of Warfare". Airplane control engineering using relays and pneumatic back then.
- It is hard to imagine now, but the UC Berkeley CS department I attended in the 1970s was almost totally skeptical of AI. All first year students were required to take Gunther Stent's (founder of molecular biology who changed to neuro-biology) skeptical minor.

## Lighthill's 3 categories

- Lighthill divides AI into three areas. Category A: Automation (feedback control engineering), Category C: computer based studies of the central nervous system, and Category B: the bridge area between A and B that provides the secret sauce of intelligence surpassing human thought.
- Lighthill is arguing that AI studies normal computer science (dataology) but rephrases problems in terms of human attributes (p. 7 paragraph 2).
- According to Lighthill it should not matter how control engineering is accomplished (p. 4 par. 4)
- Lighthill argues against logic (Church-Turing thesis) in AI by arguing AI in practice runs into combinatorial explosion. Examples people can solve instances of problem "Are two regular expressions equivalent" but searching takes exponential time in the number of terms.

### Baconian induction versus Popperian falsification

- Current AI method follows 17th century philosopher Sir Francis Bacon's inductivism. Knowledge (intelligence?) is Collecting data and analyzing it using deep learning, neural networks, etc.
- Contrast with Popper's knowledge as falsification. Scientists are duty bound to attempt to falsify knowledge. Knowledge grows by crucial experiment criticism.
- I think Gillies argument is that problems with both induction and falsification can be solved by expert systems.
- Systems that solve problems by using the methods of human experts. Rejected by current AI because such methods can not result in robots more intelligent than humans.

### ... Gillies expert systems continued

- Problem with expert systems is why limit methods humans use in developing computer programs to expert methods. As a rule of thumb, it is better to calculate instead of apply knowledge (expert systems) or search big data (current AI).
- Examples: William Tutte's linear equation algorithm for Bletchley Park Colossus ("Fish" lecture) versus Turing's Enigma enumeration.
- and autonomous vehicle innovation is better projective geometry computer algorithms and innovations in sensors (Lidar) and actuators (DSPs).

## Neumann's architecture as criticism of TMs and P?=NP

- TMs are a crucial part of the inevitability nexus of AI. AI assumes wrongly that human thinking is the same as formal logic. Peter Naur put it "all non formal ways of thinking are suppressed."
- When designing his computer architecture, Von Neumann rejected Hilbert's programme and TMs. Neumann explicitly assumed a model of computation called MRAMs.
- For MRAMs, a computer is a fixed number of unbounded size memory cells for which multiplication, indexing and bit select are unit operations.
- TMs are universal in the Church Turing sense but slow under the polynomial bounded complexity measure. TMs are inefficient because they use unary encoding and because table look up is simulated.
- For MRAMs there is no P?=NP problem and no advantage to non deterministic guessing.

# Humans as computing network nodes - info computationalism

- Chess master use of computers may be pattern for future use in task implementation and problem solving. Use chess position analysis programs to develop grand master chess play lines.
- No reason to not include humans in nodes where computer networks are used for solving problems.
- Gordona Dodig Crnkovic's info computationalism may be this.
  I think the theory with the same name for modeling human neuro-physiology is a different theory.