data-ppf.github.io 2021-03-09

lecture 8 of 14: AI1.0: from Bletchley to GOFAI

chris wiggins + matt jones, Columbia

context: 3 gifts of Bletchley

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- last week: computation & code-breaking

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- this week: computers & "thinking" (centered on cognition)

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- Stephanie Dick 2019, enumeration added

student reactions

student reactions

```
152 intelligence
 58 artificial
 94 turing
 31 stephanie/ dick
 11 lighthill
  8 dartmouth
  9 mccarthy
  5 "look ma, no hands"
  2 intelligence is a "moving target"
```

our money, ourselves:

- "What we call machine learning bears only a loose relationship to Lighthill's category three: computer based human CNS research. Instead, machine learning research is more invested in predictive modeling. My hunch is that there is a lot more money in producing algorithms for models that predict outcomes in policy and business decision-making."

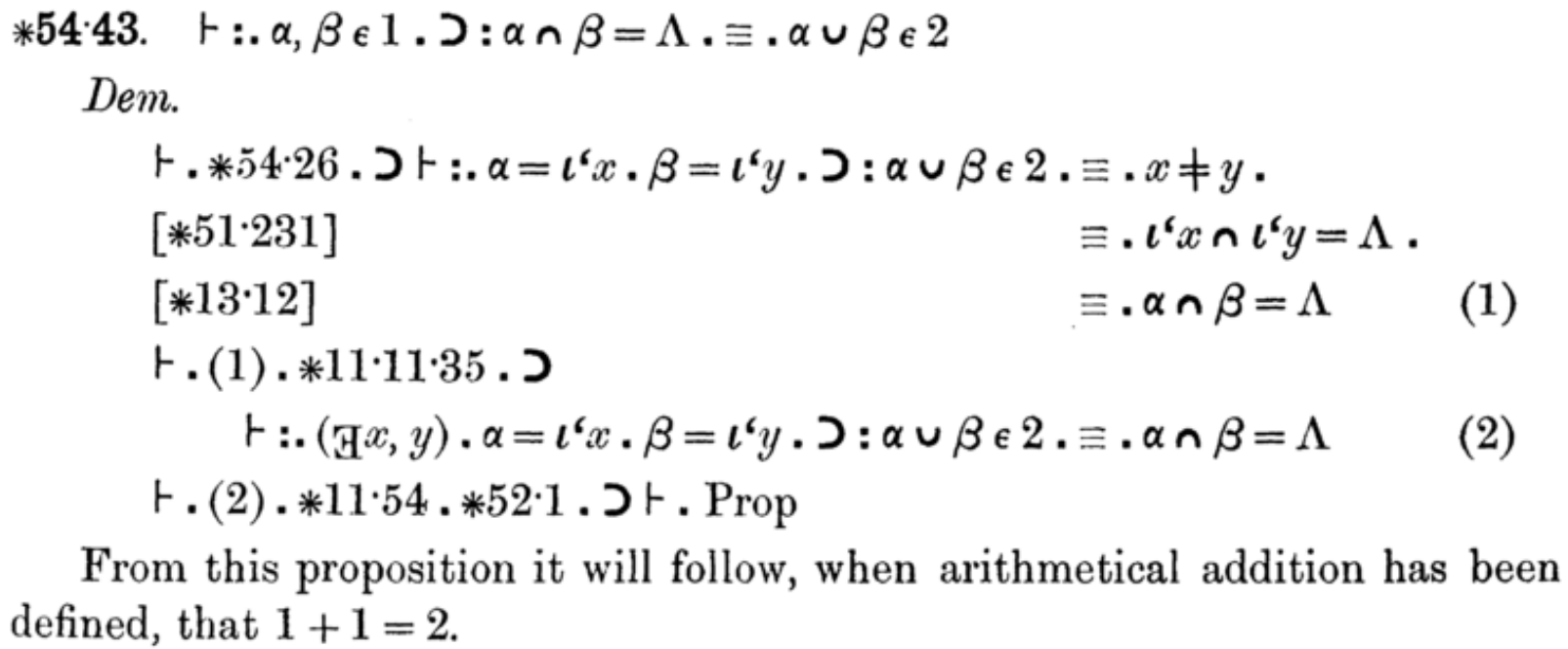
our money, ourselves:

- "What we call machine learning bears only a loose relationship to Lighthill's category three: computer based human CNS research. Instead, machine learning research is more invested in predictive modeling. My hunch is that there is a lot more money in producing algorithms for models that predict outcomes in policy and business decision-making."
- "at the time of its infancy, there was a pervading belief that AI should solve problems through human-like means. I think this reflects an ongoing obsession and even desperation to understand ourselves — if we could somehow recreate human intelligence, we could explain away behavior."

Turing 1950

Turing's professional life, < WWII

revolutionized computing theory and mathematical logic in 1936, @ age 24 "there can be no one definite method capable of deciding whether or not a given mathematical statement is provable" – Hodges



$*54{\cdot}43.\quad \vdash :. \alpha, \beta \in 1 . \supset : \alpha \cap \beta = \Lambda . \equiv . \alpha \cup \beta \in 2$

Dem.

$\vdash . *54{\cdot}26 . \supset \vdash :. \alpha = \iota`x . \beta = \iota`y . \supset : \alpha \cup \beta \in 2 . \equiv . x \neq y .$

$[*51{\cdot}231] \qquad \equiv . \iota`x \cap \iota`y = \Lambda .$

$[*13{\cdot}12] \qquad \equiv . \alpha \cap \beta = \Lambda \qquad (1)$

$\vdash . (1) . *11{\cdot}11{\cdot}35 . \supset$

$\vdash :. (\exists x, y) . \alpha = \iota`x . \beta = \iota`y . \supset : \alpha \cup \beta \in 2 . \equiv . \alpha \cap \beta = \Lambda \qquad (2)$

$\vdash . (2) . *11{\cdot}54 . *52{\cdot}1 . \supset \vdash . \text{Prop}$

From this proposition it will follow, when arithmetical addition has been defined, that $1 + 1 = 2$.

Figure 1: 1+1=2 in Principia, 1910

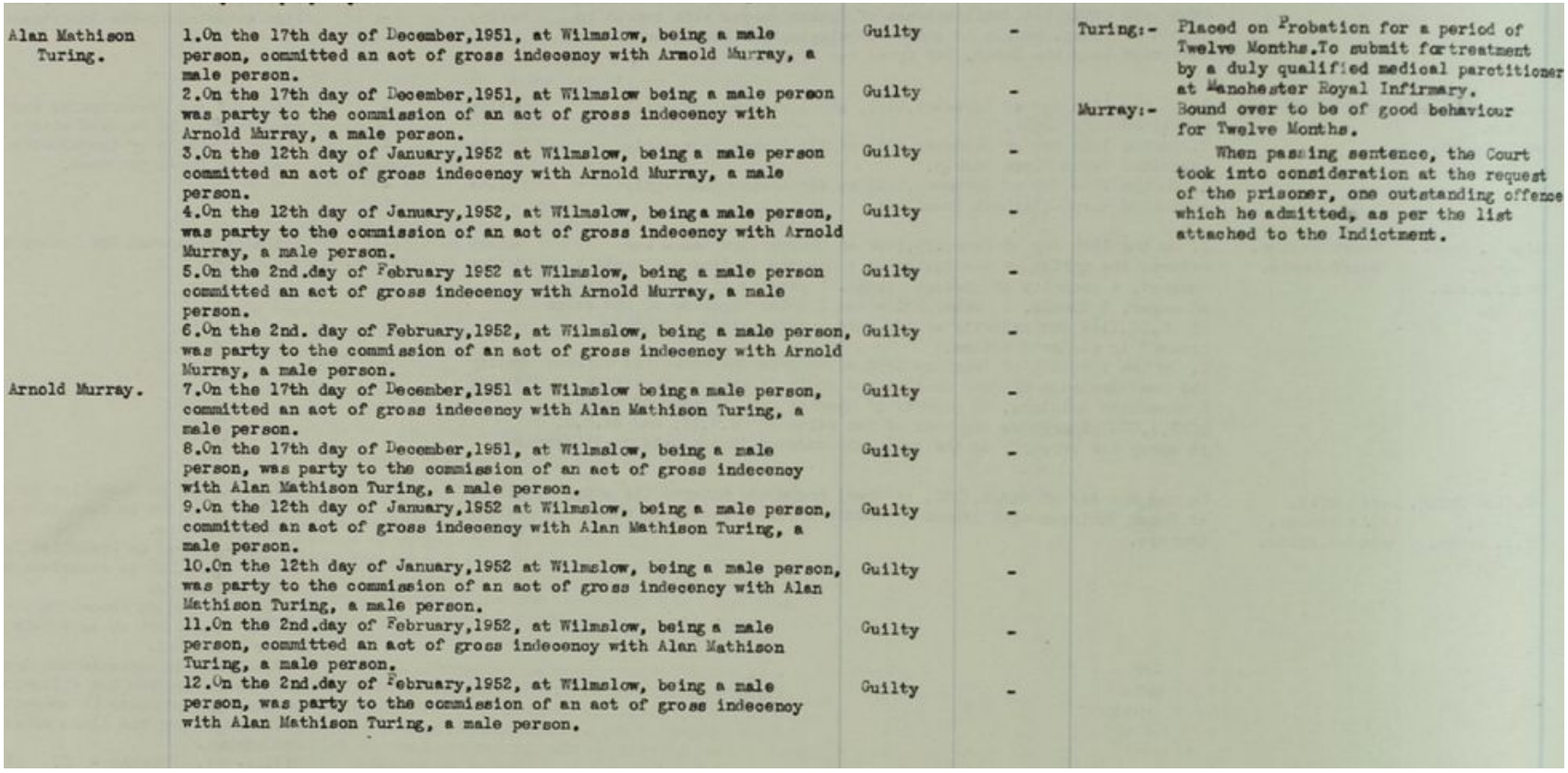
Turing impact pre WWII: M & P 1943

One more thing is to be remarked in conclusion. It is easily shown: first, that every net, if furnished with a tape, scanners connected to afferents, and suitable efferents to perform the necessary motor-operations, can compute only such numbers as can a Turing machine;
This is of interest as affording a psychological justification of the Turing definition of computability and its equivalents, Church's 4 — definability and Kleene's primitive recursiveness: If any number can be computed by an organism, it is computable by these definitions, and conversely.

T'50 Imitation Game

The new form of the problem can be described in terms of a game which we call the 'imitation game'. It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman.

Imitation Game and Turing's personal life



Alan Mathison Turing.	1.On the 17th day of December,1951, at Wilmslow, being a male person, committed an act of gross indecency with Arnold Murray, a male person.	Guilty	-	Turing:-	Placed on Probation for a period of Twelve Months.To submit for treatment by a duly qualified medical paretitioner at Manchester Royal Infirmary.
	2.On the 17th day of December,1951, at Wilmslow being a male person was party to the commission of an act of gross indecency with Arnold Murray, a male person.	Guilty	-	Murray:-	Bound over to be of good behaviour for Twelve Months.
	3.On the 12th day of January,1952 at Wilmslow, being a male person committed an act of gross indecency with Arnold Murray, a male person.	Guilty	-		When passing sentence, the Court took into consideration at the request of the prisoner, one outstanding offence which he admitted, as per the list attached to the Indictment.
	4.On the 12th day of January,1952, at Wilmslow, being a male person, was party to the commission of an act of gross indecency with Arnold Murray, a male person.	Guilty	-		
	5.On the 2nd.day of February 1952 at Wilmslow, being a male person committed an act of gross indecency with Arnold Murray, a male person.	Guilty	-		
	6.On the 2nd. day of February,1952, at Wilmslow, being a male person, was party to the commission of an act of gross indecency with Arnold Murray, a male person.	Guilty	-		
Arnold Murray.	7.On the 17th day of December,1951 at Wilmslow being a male person, committed an act of gross indecency with Alan Mathison Turing, a male person.	Guilty	-		
	8.On the 17th day of December,1951, at Wilmslow, being a male person, was party to the commission of an act of gross indecency with Alan Mathison Turing, a male person.	Guilty	-		
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	12.On the 2nd.day of February,1952, at Wilmslow, being a male person, was party to the commission of an act of gross indecency with Alan Mathison Turing, a male person.	Guilty	-		

Figure 2: Guilty under 1885 legislation, repealed 1967

Imitation Game/“Turing Test”/“Imitation Game” (2014)

- gendered nature replaced by human/bot in lore

From Wikip

Imitation Game/“Turing Test”/“Imitation Game” (2014)

- gendered nature replaced by human/bot in lore
- “shoe-horning the incredible complexity of the Enigma machine and cryptography in general was never going to be easy. But this film just rips the historical records to shreds”

From Wikip

Turing 1950: "intelligence", revisited

> *We now ask the question, 'What will happen when a machine takes the part of A in this game ?' Will the interrogator decide wrongly as often when the game is played like this as he does when the game is played between a man and a woman ? These questions replace our original, 'Can machines think?'*
> *May not machines carry out something which ought to be described as thinking but which is very different from what a man does ? This objection is a very strong one, but at least we can say that if, nevertheless, a machine can be constructed to play the imitation game satisfactorily, we need not be troubled by this objection.*

- how does this compare to Spearman?

Turing 1950: prescient objections: memory

The criticism that a machine cannot have much diversity of behaviour is just a way of saying that it cannot have much storage capacity. Until fairly recently a storage capacity of even a thousand digits was very rare.

- hidden background of massive data analysis at Bletchley

Turing 1950: prescient objections: but can it. . . ?

(5). . . Be kind, resourceful, beautiful, friendly, have initiative, have a sense of humour, tell right from wrong, make mistakes, fall in love, enjoy strawberries and cream, make some one fall in love with it, learn from experience, use words properly, be the subject of its own thought, have as much diversity of behaviour as a man, do something really

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- (9) The Argument from Extra-Sensory Perception. (!)

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Turing 1950: the Manchester machine

The reader must accept it as a fact that digital computers can be constructed, and indeed have been constructed, according to the principles we have described, and that they can in fact mimic the actions of a human computer very closely.

Turing and prescience

- so-called “Turing Test”: operationalize “intelligence”

Turing and prescience

- so-called “Turing Test”: operationalize “intelligence”
- 2 paths to intelligence

Turing and prescience

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Turing and prescience

- so-called “Turing Test”: operationalize “intelligence”
- 2 paths to intelligence
  - learning
  - “just program it” – Simon

Turing and learning, Sec 7

a machine undoubtedly can be its own subject matter. It may be used to help in making up its own programmes, or to predict the effect of alterations in its own structure. By observing the results of its own behaviour it can modify its own programmes so as to achieve some purpose more effectively. These are possibilities of the near future, rather than Utopian dreams.

Turing impact: UK

influenced many UK "machine intelligence" researchers, e.g., Strachey, who wrote programs to

- play checkers (1951, before Arthur Samuel at IBM coins "machine learning" to play checkers in 1959)

Figure 3: Strachey "discouraged"

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- play checkers (1951, before Arthur Samuel at IBM coins "machine learning" to play checkers in 1959)
- write love poems (try it at home! www.gingerbeardman.com/loveletter)

Figure 3: Strachey "discouraged"

Turing impact: “toy” AI

consider Chess vs NLP: both are done by humans, but Chess is a game:

- mechanized

In some ways, getting mechanical devices to imitate human intelligence first succeeds in arenas when humans have allowed themselves to behave like machines (e.g., with algorithmic rules of production (e.g., robots) or games (e.g., chess))

Turing impact: “toy” AI

consider Chess vs NLP: both are done by humans, but Chess is a game:

- mechanized
- abstracted

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Turing impact: across the Atlantic, e.g., @Bell

Dartmouth 1956

Dartmouth 1956

Figure 4: partial attendee photo

D'56: Authors & mission

J. McCarthy, M. L. Minsky, N. Rochester, and C.E. Shannon. August 31, 1955.

> *We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it.*

- dream of precise description *programmed* into computers

Shannon (b. 1916), Bell Labs

- @MIT: V. Bush's analog computer "differential analyzer" (funded by W. Weaver @RF)

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- (NB: Dartmouth didn't even make his Wikip page)

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- LISP & GOFAI
- DARPA largess, esp via J.C.R. Licklider and IPTO (of 'Internet' fame) & "Machine-Aided Cognition" (MAC)
- "raised as a Communist but eventually became a conservative Republican"

Figure 5: JCM

McCarthy (b. 1927), Dartmouth/MIT

- PhD Princeton (Mathematics): PDE
- @Bell (along w/Minsky) under Shannon 1953
- interest in logic
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- NB: D'56 team all militarily funded directly or indirectly

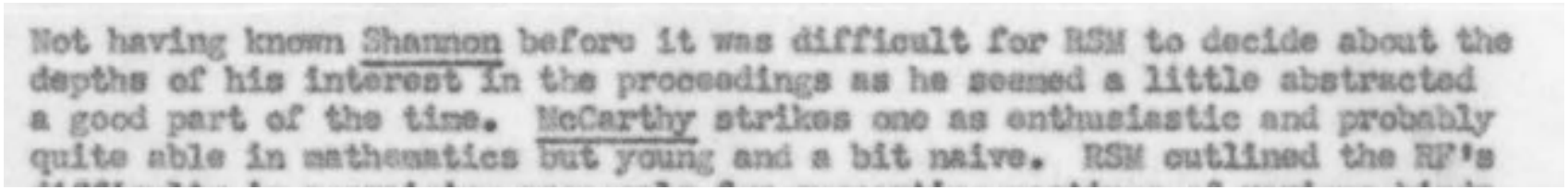
Figure 5: JCM

D'56: "AI" born, explicitly, as "flashy" brand move

– Excuse me. I invented the term artificial intelligence. I invented it because... when we were trying to get money for a summer study and I had a previous bad experience ... in 1952 when Claude Shannon and I decided to collect a batch of studies which we hoped would contribute to launching this field and Shannon thought that artificial intelligence was too flashy a term and might attract unfavorable notice and so we agreed to call it Automata studies and I was terribly disappointed when the papers we received were about Automata and very few of them had anything to do with the goal that at least I was interested in. So I decided not to fly any false flags anymore but to say that this is study aimed at the long term goal of achieving human level intelligence.

- From the Lighthill debate on artificial intelligence, 1973 D'56 funded by RF (Weaver hand-off)

D'56: NB Shannon's level of commitment



Not having known Shannon before it was difficult for RSM to decide about the depths of his interest in the proceedings as he seemed a little abstracted a good part of the time. McCarthy strikes one as enthusiastic and probably quite able in mathematics but young and a bit naive. RSM outlined the RF's

- RF asked to add other organizers. They added Minsky and Rochester, "chief designer of IBM's (NSA-funded) 701"

D'56: 7 prescient goals

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- NB: no 1 "method", just an aspiration

historical context on this aspiration

not a new aspiration; NB longstanding dreams of machines as servants or partners

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- NB both *literary* and *engineering* (since Vaucanson's 18th c duck) aspiration

D'56: outcome?

anybody who was there was pretty stubborn about pursuing the ideas that he had before he came, nor was there, as far as I could see, any real exchange of ideas

- JCM from Pamela McCorduck, 2004
  Newell and Simon seemed. . . to be addressing psychologists. . . Minsky wasn't. . . necessarily convinced that human and artificial intelligence needed to resemble each other. This last was a very strong theme in AI research in the early years.

D'56: "brains"?

brain modelers–how thought *embodied*

mind modelers–how thought doesn't require *body* (cf. the "U" in AMT's UTM 1936, of which JCM was well-aware)

> *The physical machine became little more than an arbitrary vehicle for the interactions of pure information.*

- Edwards

D'56: split on methods

- Simon

One vision was that AI means to "take symbolic information as input, manipulate it according to a set of formal rules, and in so doing can solve problems. . .

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GOFAI, 1956-1973

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"programmed instructions operating on formal symbolic representations... From the mid 1950s to the mid 1980s, it was the dominant (though not the only) approach in AI."

– Margaret A. Boden, GOFAI

in GOFAI, knowledge » data

> *In this approach, 'knowledge engineers' would interview human experts, observe their problem-solving practices, and so on, in hopes of eliciting and making explicit what they knew such that it could be encoded for automated use (Feigenbaum, 1977, p. 4). Expert systems offered a different explanation of human intelligence, and their own theory of knowledge, revealing that both were moving targets in this early research.*

- SD2019

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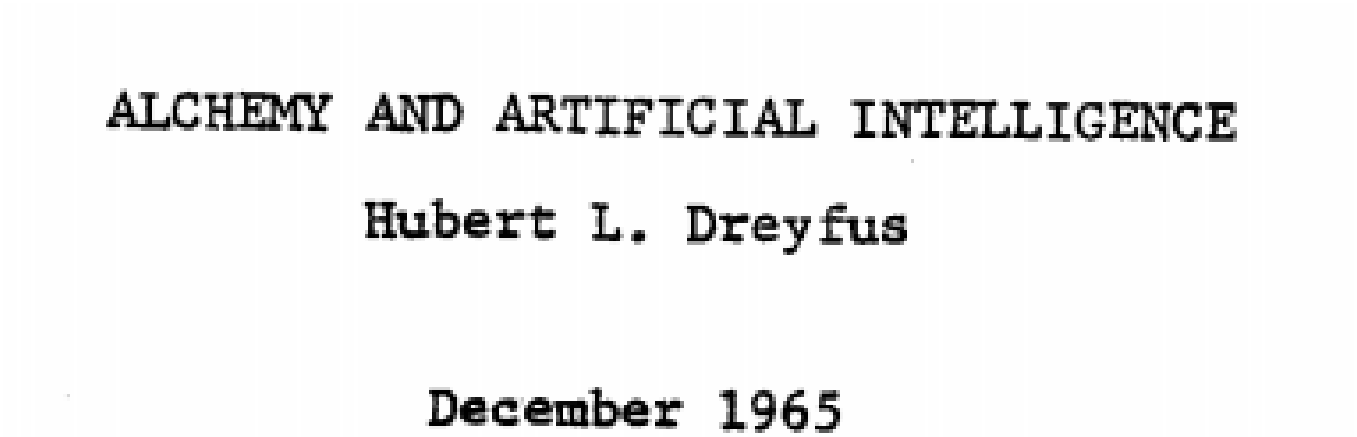
GOFAI claims

"Within ten years, they claimed,

- a computer would be world chess champion,



ALCHEMY AND ARTIFICIAL INTELLIGENCE

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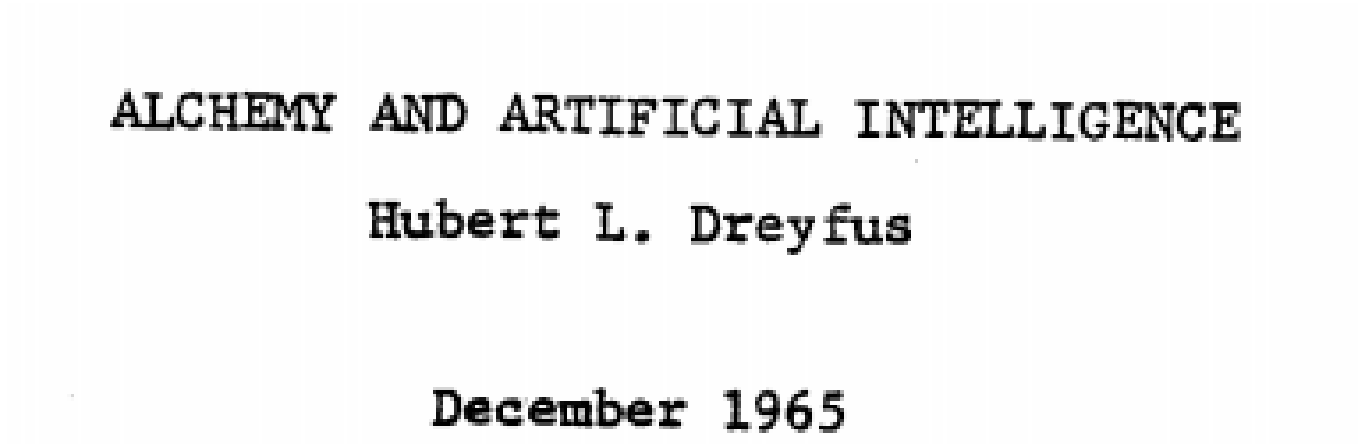

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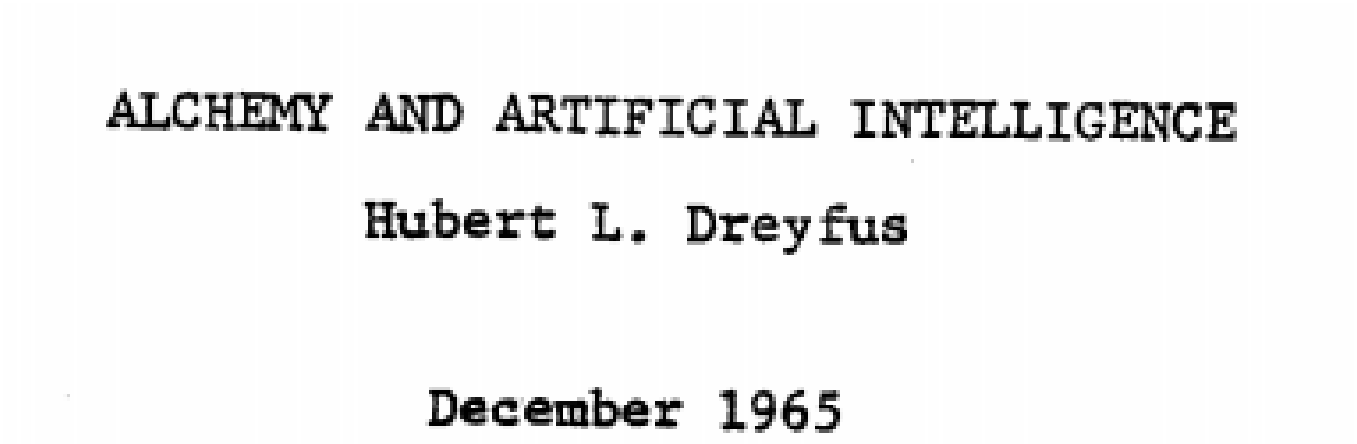

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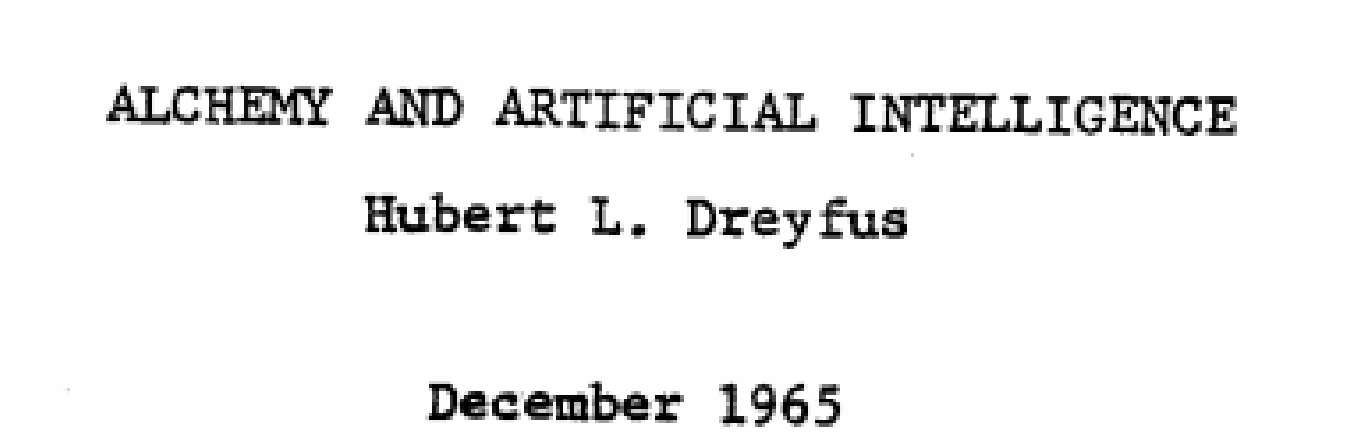
- see also: Strong/AGI vs Weak/narrow AI



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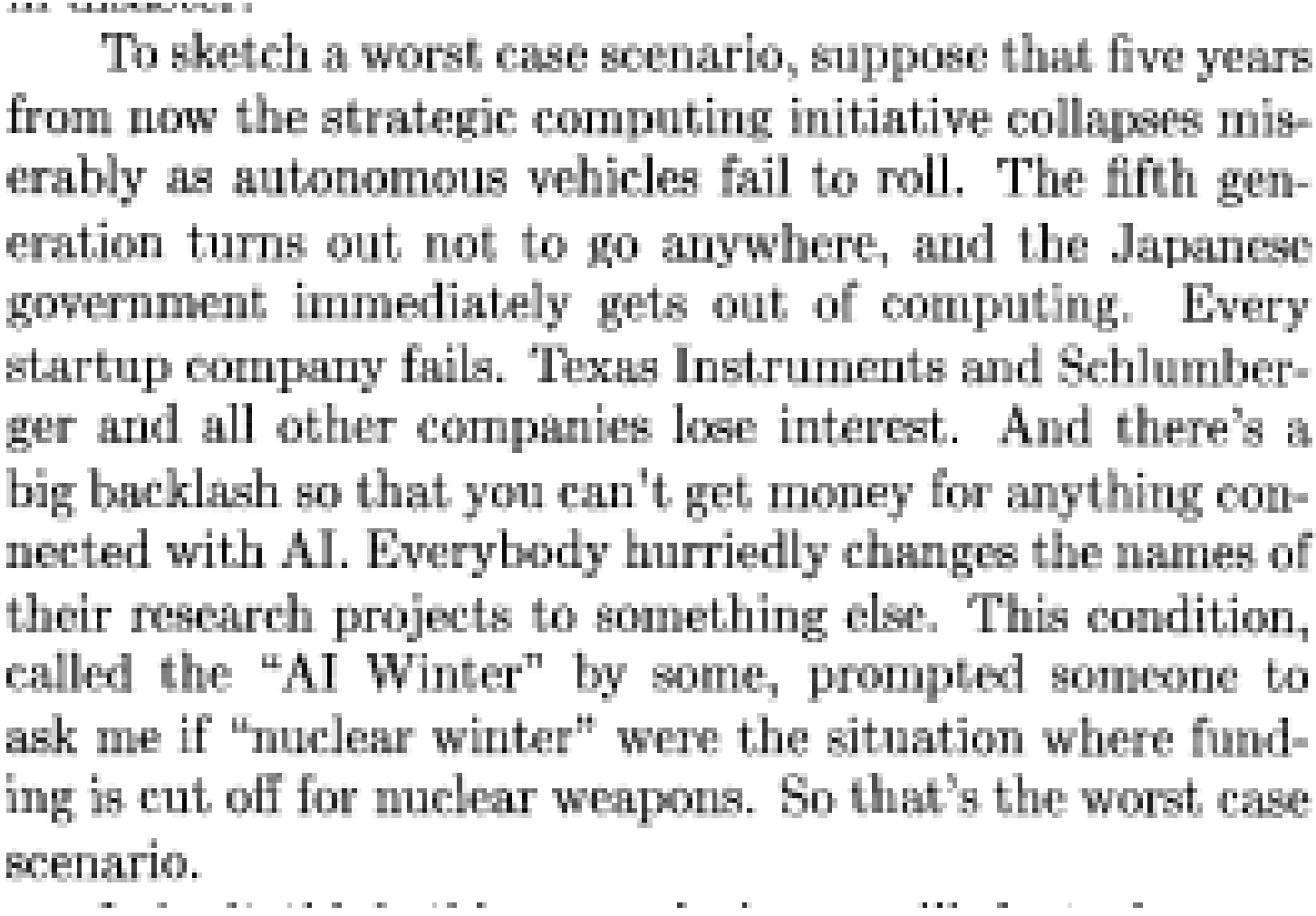

To sketch a worst case scenario, suppose that five years from now the strategic computing initiative collapses miserably as autonomous vehicles fail to roll. The fifth generation turns out not to go anywhere, and the Japanese government immediately gets out of computing. Every startup company fails. Texas Instruments and Schlumberger and all other companies lose interest. And there's a big backlash so that you can't get money for anything connected with AI. Everybody hurriedly changes the names of their research projects to something else. This condition, called the "AI Winter" by some, prompted someone to ask me if "nuclear winter" were the situation where funding is cut off for nuclear weapons. So that's the worst case scenario.

Figure 7: 1st usage

Lighthill 1973

The Category B research work on problem solving in these abstract play situations has produced many ingenious and interesting programs. A fair description of the success of these programs seems to be that they are effective when and only when the programming has taken into account a really substantial quantity of human knowledge about the particular problem domain. Just as in category A, the pure mathematical logic methods suffer defeat at the hands of the combinatorial explosion, and have to be replaced by heuristic methods. Some very interesting researches have been carried out to develop general problem-solving programs, and such work can be of research interest to psychologists, but the performance of these programs on actual problems has always been disappointing. Students of all this work have generally concluded that it is unrealistic to expect highly generalised systems that can handle a large knowledge base effectively in a learning or self-organising mode to be developed in the 20th century. (13)

in US, similar pushback (1/3)

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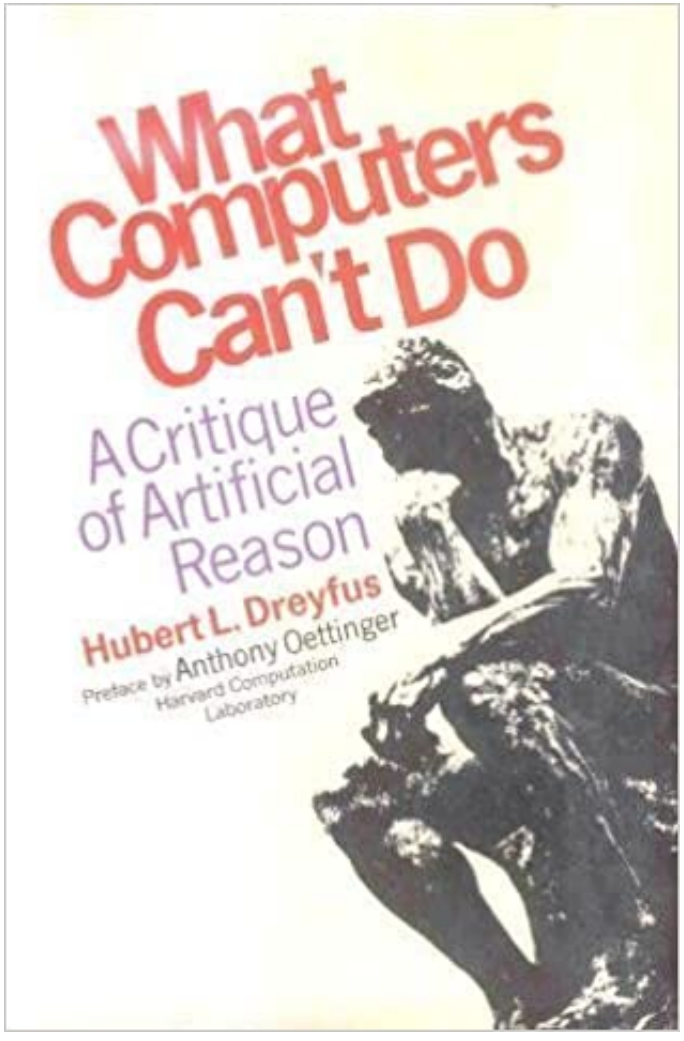
- 1965 Dreyfus' *Alchemy* (then books, '72,'79,'86,'92)

Dreyfus


What Computers Can't Do
A Critique of Artificial Reason
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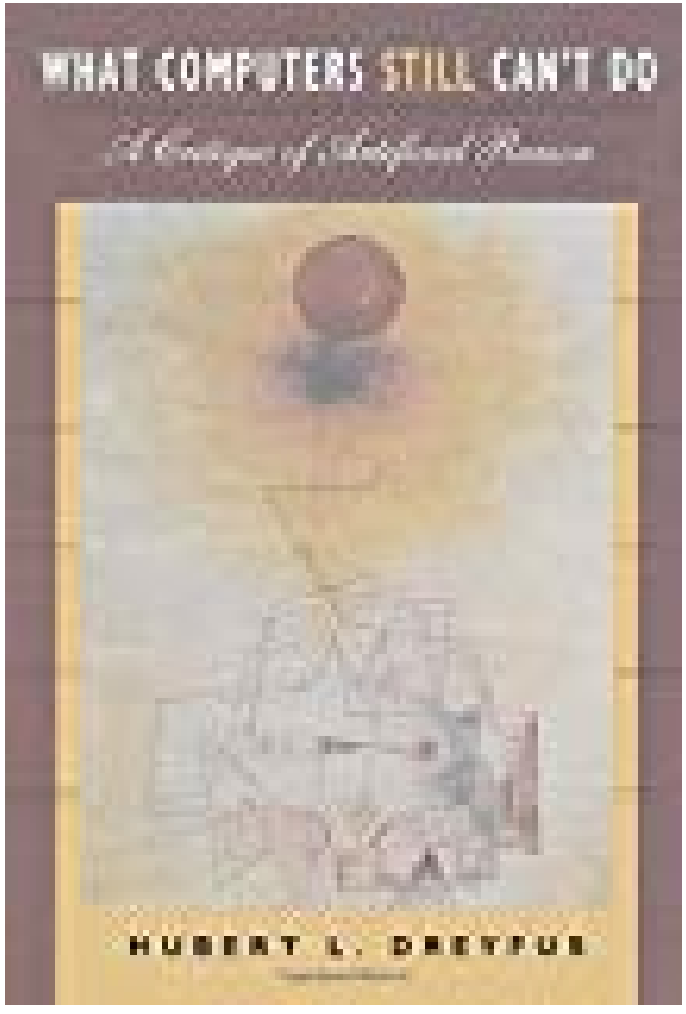
Preface by Anthony Oettinger
Harvard Computation Laboratory


WHAT COMPUTERS STILL CAN'T DO
HUBERT L. DREYFUS

in US, similar pushback (2/3)

- 1966: ALPAC report by Piece (Bell)

in machine translation: ALPAC 1964-1966

The Department of Defense, the National Science Foundation, and the Central Intelligence Agency have supported projects in the automatic processing of foreign languages for about a decade; these have been primarily projects in mechanical translation.
there is no immediate or predictable prospect of useful machine translation.

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- DARPA “American Study Group” review but. . .

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- shift to VC $$ (wait until week 13)

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- expert systems would underpin each of these applications."

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Norvig's view: from book (1995,2003,2009,2020)

Overall, the AI industry boomed from a few million dollars in 1980 to billions of dollars in 1988, including hundreds of companies building expert systems, vision systems, robots, and software and hardware specialized for these purposes. Soon after that came a period called the "AI winter," in which many companies fell by the wayside as they failed to deliver on extravagant promises. It turned out to be difficult to build and maintain expert systems for complex domains, in part because the reasoning methods used by the systems broke down in the face of uncertainty and in part because the systems could not learn from experience.

Norvig's view: pers. comm

I'm a winter skeptic as well. I haven't seen good data. there was a winter in the sense that over time not everyone automatically got a job at MIT or Stanford or Bell Labs, but everyone got good jobs throughout. So essentially, we define the winter as the death of specific companies, not a widespread drop in students or professionals,

Machine Learning as AI subaltern, the last half-century:

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- 2010s shatter this via "deep nets", an echo of ANN's from 1943
  - "Overwhelmingly, machine learning systems are oriented towards one specific task: to make accurate predictions." – SD2019

Meanwhile. . . other impacts of WWII

Meanwhile... other impacts of WWII

- next week: "big data" in the 1970s / mil-computational complex

Meanwhile... other impacts of WWII

- next week: "big data" in the 1970s / mil-computational complex
- later week: 'Pattern Recognition' becomes 'Learning' becomes 'AI 2.0'

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