

Playing chess with a philosopher

Turing and Wittgenstein

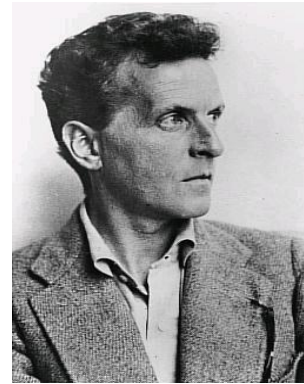
Stéphane Massonet

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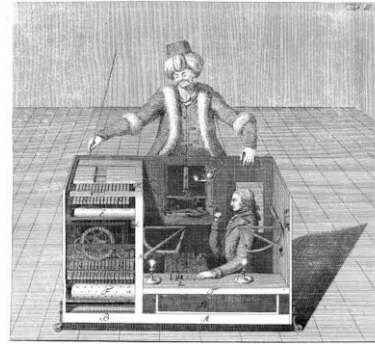
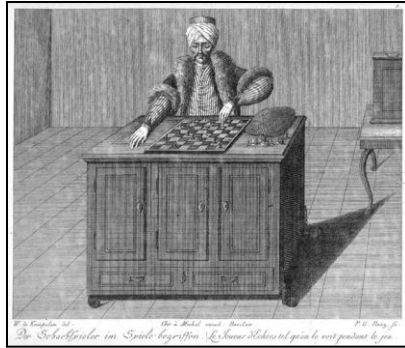
TURING IN CONTEXT II

Royal Flemish Academy of Belgium for Science and the Arts

Brussels, Belgium



A metaphor for a philosophical encounter



- Wittgenstein's critique of the Mechanical Thesis or the man behind the machine
- Discussions on the Foundation of Mathematics
 - Chess as a formal mathematical model (Turing)
 - Chess as a linguistic model (Wittgenstein)
- Chess and gaming theory in the inception of early digital computers and in AI (or Chess playing machine as a sign of intelligence)
- Chess and the Turing Test as the illusion / blindness of not looking inside the machine that has passed the imitation game

Lectures on The Foundations of Mathematics

- 1939 – Turing and Wittgenstein both lectured at the University of Cambridge on the topic of the Foundations of Mathematics.
- Alan Turing attending the philosopher's seminars.
- Pointing out the differences in their approach to mathematics and philosophy of the mind.

“Turing’s metaphysics of mental states and persons is mechanistic; Turing was in this respect fundamentally opposed to Wittgenstein, implicitly or explicitly a focus of his criticisms”

P.M.S. Hacker, Wittgenstein’s Place in Twentieth Century Analytic Philosophy(1996)

Re-evaluating the Lectures

- Understand how they established a philosophical dialogue between the mathematician and the philosopher.
- Considers that Turing was “exactly the kind of logician / mathematician Wittgenstein approved of” (Juliet Floyd).
- Wittgenstein was himself an engineer who turned to mathematics, then logic...
- Wittgenstein has always worked surrounded by mathematicians such as Frank Ramsey, Alister Watson and Alan Turing.

Wittgenstein & Turing encounter

- **1937- Alister Watson introduced Wittgenstein to Turing.**
- **Letter of February 11th 1937, Turing sends a copy of “On Computable Numbers” to Wittgenstein.**
- **Wittgenstein was said to be deeply impressed by the idea of the Turing Machine.**
- **Summer 1937, discussions in the botanical gardens of Cambridge University:**
 - **Incompleteness theorem of Gödel / Halting problem**
 - **The Foundation of Mathematics**
 - **Watson, Mathematics and it's Foundations, *Mind* (1938)**

Lectures on the Foundation of Mathematics

“What does mathematics need a foundation for? It no more needs one, I believe, than propositions about physical objects – or about sense impressions, need an analysis. What mathematical propositions do stand in need of is a clarification of their grammar, just as those other propositions”. (Wittgenstein, R.F.M., VII-16 : 378.)

- **Provide clarity to the concepts we use in mathematics.**
 - **Clarify notions such as “identity”, “proof”, “rule following”, “axioms”, “contradiction”, “errors” and “mistakes” in calculation.**
- **Correct use of the grammatical rules that govern our statements about mathematics.**
- **Wittgenstein addresses mathematics from the outside, from the structure of mathematical propositions and the use of language.**

Lectures on the Foundation of Mathematics (2)

- Wittgenstein questions the status of a mathematical proposition
 - Are mathematical propositions necessary truths ?
 - Can they be explained wholly in terms of logic ?
- Investigation of language games, meaning and knowledge.
- Turing will show it is possible to consider mathematics as an “experiment” : what if something goes wrong...
- Turing paper of 1940 “Reform of mathematical notation and phraseology”: examine the listing of all commonly used forms of notation and see what they really mean.

The man in the machine

“Turing's Machine: These machines are humans who calculate. And one might express what he says also in the form of games. And the interesting games would be such as brought one via certain rules to nonsensical instructions. I am thinking of games like the 'racing games'. One has received the order 'Go on in the same way' when this makes no sense, say because one has gotten in a circle. For any order makes sense only in certain positions (Watson)”. (RPP I : § 1096)

- **Wittgenstein wide interest for machines and mechanical calculation.**

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A. M. TURING

[Nov. 12,

ON COMPUTABLE NUMBERS, WITH AN APPLICATION TO
THE ENTSCHEIDUNGSPROBLEM

By A. M. TURING.

[Received 28 May, 1936.—Read 12 November, 1936.]

The “computable” numbers may be described briefly as the real numbers whose expressions as a decimal are calculable by finite means. Although the subject of this paper is ostensibly the computable *numbers*,

The human calculator as a machine

- Wittgenstein warns us about the abuse of certain grammatical forms.
- Proposition such as “Can a machine think ?” or “Can a machine calculate ?” transgresses the rules of grammar.
- Analysis of Turing's use of mechanical and mind metaphors in his paper “On Computable numbers”.

“We may compare a man in the process of computing a real number to a machine which is only capable of a finite number of conditions $q^1; q^2; .. q^a;$ which will be called " m-configurations "” (Turing, 1936, 231).

The human metaphors of the Turing Machine

- **The tape that this machine uses as memory to scan and store symbols, Turing writes :**

“The “scanned” symbol” is the only one which the machine is, so to speak, “directly aware” ” (Turing, 1936, 231).

- **Abundant usage of human actions to describe his machine, that “sees”, “remembers”, “assists”, etc...**
 - **Turing bringing the machine paradigm very close to the behaviorist assumptions.**

- **Wittgenstein's reaction :**

“Could a machine think ? Could it be in pain ? - Well, it is the human body to be called such a machine It surely comes as close as possible as being such a machine.” (P.I. § 359: p. 120)

Towards intelligent machines

- **Wittgenstein's view on the mechanical thesis : “Does a calculating machine calculate ?” (V-2, p. 257).**
- **Machines only executes mechanically the procedures or the program that humans have embedded in them to solve a calculus ?**
- **Wittgenstein never wrote on Turing's later works on machine intelligence, but had a strong interest in the mechanical thesis:**
“If one thinks of thought as something specifically human and organic, one is inclined to ask “could there be a prosthetic apparatus for thinking, an inorganic substitute for thought?”. But if thinking consist only in writing or speaking, why shouldn't a machine do it? “Yes, but the machine doesn't know anything”. Certainly it is senseless to talk about a prosthetic substitute for seeing and hearing. We do talk of artificial feet, but not of artificial pains in the foot. (P.G. § 47: p. 105).

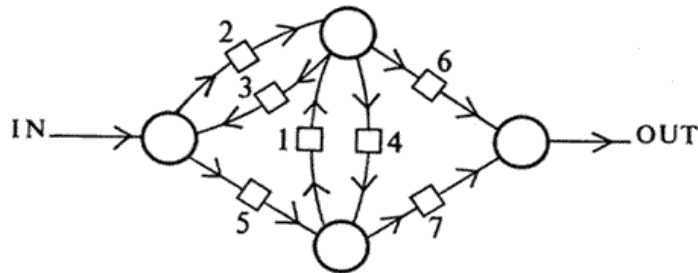
Computing Machinery and Intelligence

- 1950's Mind paper asks : “Can machines think”, questioning the meaning of the words “machine” and “think”.
- Turing put forward an influential behaviorist definition of intelligence
- Operating model of machine intelligence in the making under the form of a game : the Turing Test.
- Turing focuses on the behavior of the machine, on the way it interacts with humans, not the internal engineering.

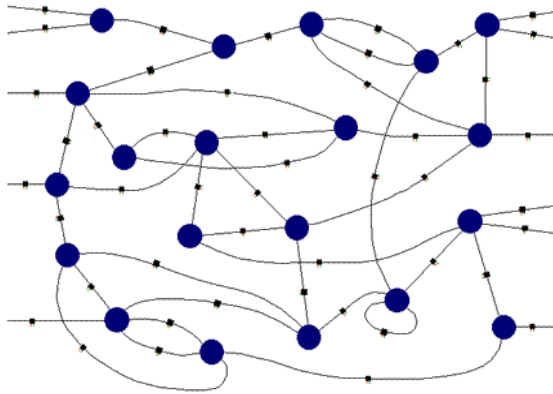
Intelligent Machinery

- **Paper of 1948 addresses the architecture for machine intelligence based on connections in a neural network called “unorganized machines”.**
 - **Self modifying in order to change it's own set of instruction**
 - **Self learning**
- **Turing pushed further the human/machine metaphor entqiled in the critique of the Mechaniat thesis**
 - **Machine learning involving a tutor / teacher**
 - **Machine is a child cortex that needs to learn how to learn**

Turing's B Type machine



B-type network

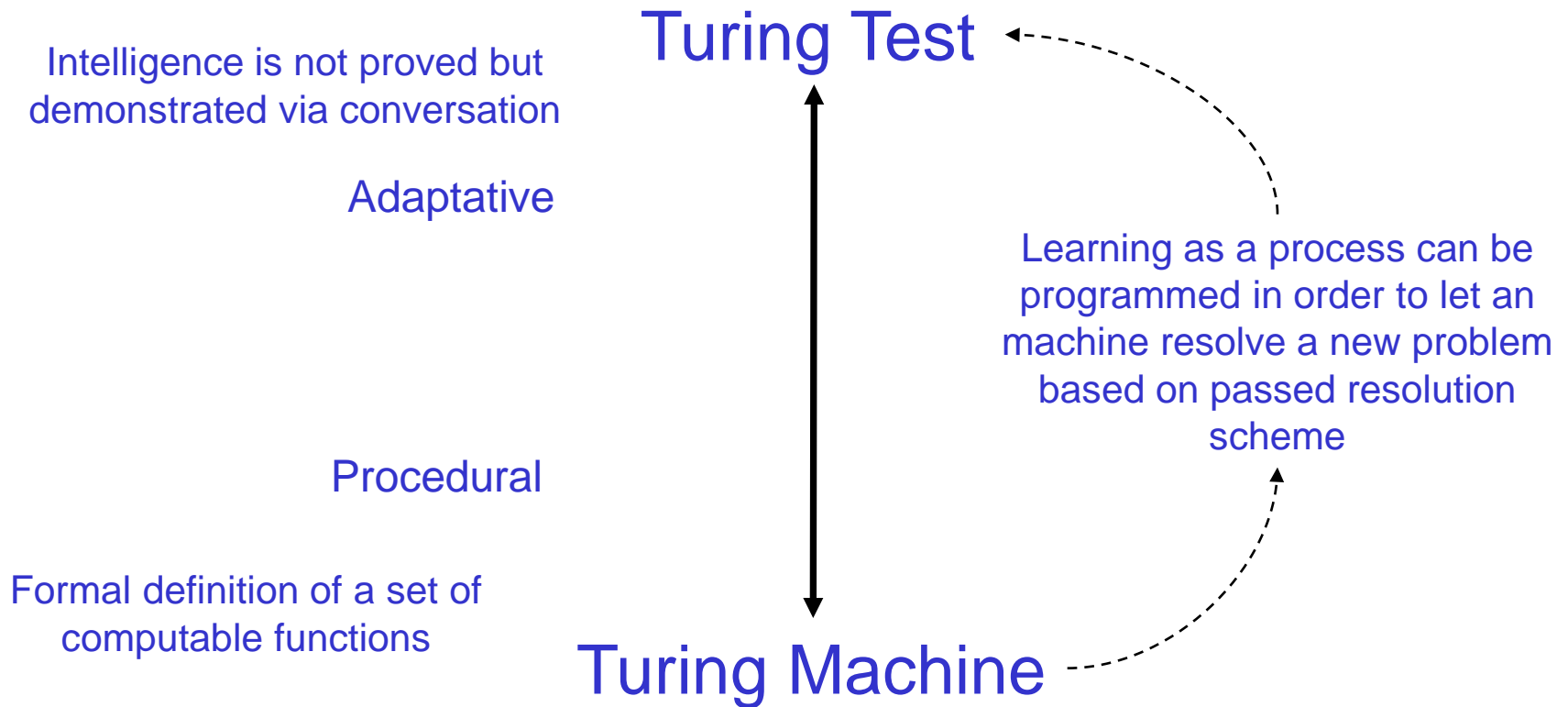


Random B-type network

- Turing statement were bold for that time: first manifesto of AI.
- Sees use in chess, language learning & translation, mathematics and cryptography.
- Language learning would be the most impressive challenge for unorganized machines.

The gap from Machine to Intelligence

*Macro level test simulating human intelligence
With no formal definition but an empirical test*



*Micro Level specification of a device from which
computable functions can be derived from*

From brute force algorithms to machine learning

Machine learning



Brute Force

- Discussion around chess enabled the paradigm shift from brute force to machine learning
- Turing departed from a more formal and mathematical approach of chess as a rule based system that can predict game winning strategies
- Wittgenstein focused on how we learn to play chess as the game of chess was used to better understand language games and how we learn to use words and acquire concepts

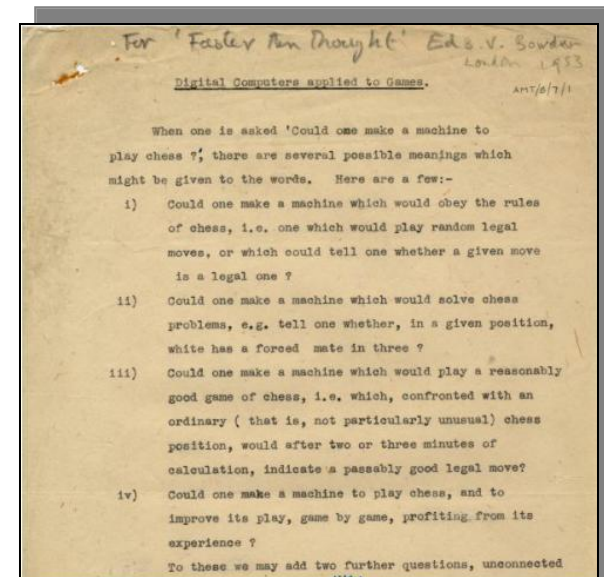
Chess & Mathematics

“It has been said very often that mathematics is a game, to be compared with chess. In a sense this is obviously false – it is not a game, in the ordinary sense. In a sense it is obviously true – there is some similarity. The thing to do is not to take sides, but to investigate”.

**Wittgenstein, Lectures on the Foundations of Mathematics, Lecture X
(C. Diamond, 1976, p. 142).**

Turing on Chess

- **1939: Formal approach to a paper based automata chess playing machine**
- **1941: Theorization the mechanization of chess with the minimax and best-first heuristics**
- **1948 : developed with David Champernowne the Turochamp routine**
- **1953 : paper on “Chess” – Digital Computers Applied to Games**
 - **develops system of rules based on his internal though process while playing**
 - **Uses heuristics to guide the search trough a “tree” structure of possible moves and countermoves**
 - **Uses a numerical evaluation rule of board configuration and weighted move in a minimax strategy**



Chess & Mathematics

- Wittgenstein's lectures discussed similarities and differences between mathematics and chess.
- Wittgenstein question why the rules of chess are arbitrary while it's mathematical theory is not arbitrary.
- Turing lectured on chess and mathematical logic.
 - Turing was aiming at “extracting the neatest and tightest set of axioms from which to begin, making them flower according to the exact system of rules into the structure of mathematics, and discovering technical limitations of that procedure” (Hodges, 1992, p. 152).
 - Turing searches predictability, e.g. find a definite method like “a book of rules that could be followed by a mindless player – like the “instruction note” formulation of the concept of computability” (Shanker 1998).

Chess rules and mathematical theory

- The game of chess was instrumental in explaining the concept of language games.
- Wittgenstein ask what defines the game of chess ? Is it it's rules ? Then if you change one of it's rules, are we still playing a chess game ?
- Rule and meaning intertwined in the game of chess.
 - Argument : compares the moves on the board with the transformations of mathematical expression.
 - But in chess we distinguish the games played (instances) from the theory of the game (formal set of rules that define the game).
 - Rules are arbitrary because nothing in the game that determines the rule as necessary.

Learning to play chess

- Wittgenstein questions how we learn to play chess (P.I. § 31)
 - Learning chess by its rules without ever seeing a piece
 - Learning chess by watching / imitation without formulating or learning the rules of the game
 - First learn simple board game then progress to more complicated ones

Learning to play chess = learning to play with words in language games

Concept acquisition process is done via stages, from simple words to more abstract process

Playing a game of Chess

Where is the connection effected between the sense of the words “Let’ play a game of chess” and all the rules of the game ?

- Well, in the list of rules of the game, in the teaching of it, in the everyday practice of playing.

Philosophical Investigations, § 197

Concluding remarks

- Chess as a metaphore for langage acquisition competency challenge the formal approach to the mathematics of chess
- Acquisition by play (or replay) and by teaching become an attractive model to apply to intelligent machines
- Turing Test as an implicit answer to the human / machine metaphor critic
- Extend the Turing Test to chess playing machines
- Re-evaluate Turing's later theory of A.I. In light of Wittgenstein's concepts of chess play and language acquisition.

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