# Alan Turing - Computing Machinery and Intelligence (1950)

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November 2, 2024 — 36c8eb68

### 0.1 Learned in this study

### 0.2 Things to explore

- The theory of the imitation game

## 1 Overview

## 2 Thoughts

- Is there a test than be conceived that can differentiate machines from humans?
- Turing suggested a man-woman-computer experiment. What about a man-computer-computer, computer-computer-computer experiment?
- Are we more than simple recorder/player?
- Are there time-invariant rules? (rules that are true regardless of the time at which they are applied)

## 3 Notes

### 3.1 1. The Imitation Game

- The main question: Can machines think?
- Played by three people, a man (A), a woman (B), and an interrogator (C)
- "The object of the game for the interrogator is to determine which of the other two is the man and which is the woman."
- A must attempt to make C identify A and B incorrectly while B must help the interrogator
- New question: What will happen when a machine takes the part of A in this game?

### 3.2 2. Critique of the New Problem

- "If the man were to try and pretend to be the machine he would clearly make a very poor showing. He would be given away at once by slowness and inaccuracy in arithmetic."

### 3.3 3. The Machines concerned in the Game

- The only allowed machines are digital computers
- "The short answer is that we are not asking whether all digital computers would do well in the game nor whether the computers at present available would do well, but whether there are imaginable computers which would do well."

## 3.4 4. Digital Computers

- A digital computer consists of three parts:
  - Store
  - Executive unit
  - Control

## 3.5 5. Universality of Digital Computers

- "This special property of digital computers, that they can mimic any discrete state machine, is described by saying that they are universal machines."
  - **Is it Turing argument that we are nothing more than FSM?**

## 3.6 6. Contrary Views on the Main Question

- The Theological Objection: "Thinking is a function of man's immortal soul. God has given an immortal soul to every man and woman, but not to any other animal or to machines."
- The 'Heads in the Sand' Objection: "The consequences of machines thinking would be too dreadful. Let us hope and believe that they cannot do so."
- The Mathematical Objection: Based on Gödel's theorem, a machine/digital computer with an infinite capacity may be unable to do certain things.
  - "If it is rigged up to give answers to questions as in the imitation game, there will be some questions to which it will either give a wrong answer, or fail to give an answer at all however much time is allowed for a reply."
- The Argument from Consciousness: "The only way to know if a man thinks is to be that particular man."
- Arguments from Various Disabilities: "I grant you that you can make machines do all the things you have mentioned but you will never be able to make one to do X"
  - Errors of functioning: Behaving differently than it was designed to do.
  - Errors of conclusion: When some meaning is attached to the output signals and are deemed incorrect.
- Lady Lovelace's Objection: "The Analytical Engine has no pretensions to *originate* anything. It can do *whatever we know how to order it* to perform."
- Argument from Continuity in the Nervous System: "The nervous system is certainly not a discrete-state machine. [. . . ] It may be argued that, this being so, one cannot expect to be able to mimic the behaviour of the nervous system with a discrete state system."
- The Argument from Informality of Behaviour: "If each man had a definite set of rules of conduct by which he regulated his life he would be no better than a machine. But there are no such rules, so men cannot be machines."
- The Argument from Extra-Sensory Perception: (telepathy, clairvoyance, precognition, psycho-kinesis) Is it possible that some E.S.P. be used to determine who is who in the imitation game?

## 3.7 7. Learning Machines

- Ideas can be of sub/super-critical nature, that is, produce less than one idea in reply to an initial idea, or generate many *new* ideas
- Turing asks "Can a machine be made to be super-critical?"
- The "skin of an onion analogy": Functions of the mind/brain which we explain as purely mechanical. These are considered a layer of the onion skin which we can strip off, in hopes to get to the *real mind*. However, is the next layer the real mind or simply another mechanical layer?
  - From this analogy, Turing asks whether "we ever come to the"real" mind or do we eventually come to the skin which has nothing in it?"
    - "In the latter case the whole mind is mechanical."
- "Estimates of the storage capacity of the brain vary from 10^10 to 10^15 binary digits. I incline to the lower values and believe that only a very small fraction is used for the higher types of thinking. Most of

it is probably used for the retention of visual impressions. I should be surprised if more than 10^9 was required for satisfactory playing of the imitation game, at any rate against a blind man. (Note—The capacity of the *Encyclopaedia Britannica*, 11th edition, is 2 x 10^9.) A storage capacity of 10^7 would be a very practicable possibility even by present techniques."

- Three important components to the process of trying to imitate and adult human mind:
  - The initial state of the mind
  - The education to which it has been subjected
  - Other experience, not to be described as education, to which it has been subjected
- Why not simulate a child's mind?
  - "Rather little mechanism, and lots of blank sheets."
- The problem is now divided into two parts:
  - The child-programme
  - The education process
- Similarities with the process of finding a good child-machine and evolution
  - Structure of the child machine = Hereditary material
  - Changes of the child machine = Mutations
  - Natural selection = Judgment of the experimenter
- It will be important to have some order in which the rules are to be applied (as many alternative are available)
- "Intelligent behaviour presumably consists in a departure from the completely disciplined behaviour involved in computation, but a rather slight one, which does not give rise to random behaviour, or to pointless repetitive loops."
- "How could one keep track of the different genetical combinations that had been tried, so as to avoid trying them again?"

# 4 References


- Turing, Alan. *Computing Machinery and Intelligence*. Mind, volume 59, issue 236, 1950. 433-460. Ed. B. Jack Copeland. The Essential Turing. Oxford: Clarendon Press, 2004. 441-464