O SÍLE MATEMATICKÉHO OBJEVU: HOLD A. M. TURINGOVI KE STÉMU VÝROČÍ JEHO NAROZENÍ

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AMT: Genius and Master of Intuition
The Legacy of a Genius: AMT - the Father of AI
AMT: Pioneer of the Information Age
Turing Eclectic and Eccentric
AMT: Mathematical Genius, WWII Codebreaker, Pioneer of Computing, Gay Icon
Turing as a Natural Scientist

AMT: 1912-2012
Father of Computer Science
Mathematician, Logician
Wartime Codebreaker
Victim of Prejudice
Milestones of Turing’s scientific life:

• Turing machine
• Cracking the code of Nazis’ submarines
• First serious mathematical use of a computer
• Turing test
• Theory of biological growth
23 June 1912: Alan Mathison Turing was born in London

1926: Aged 14, he was sent to Sherborne School in Dorset. His first day of term coincided with the 1926 General Strike. Turing was so determined not to miss his first day of school that he cycled the 97km from his home in Southampton.

His teachers worried that he leaned too heavily towards maths and science, at the expense of the classics. The headmaster wrote to his parents: “If he is to be solely a scientific specialist, he is wasting his time at a public school”.

1927: At the age of 16, Turing got to grips with Albert Einstein’s work and extrapolated Einstein’s questioning of Newton’s Laws of Motion from a text in which this was never made explicit.

1930: Turing’s close school friend Christopher Morcom dies suddenly from bovine tuberculosis. Turing renounces his religious faith and becomes an atheist.

Source: Alan Turing’s Extraordinary, Tragically Short Life: A Timeline, wired.co.uk
1931: Turing goes to study Mathematics at King’s College, Cambridge.

1935: Turing proves the central limit theorem in his dissertation and is made a fellow at King’s at the age of just 22.

1936: Turing published his paper *On Computable Numbers and an Application to the Entscheidungsproblem* (decision problem) in which he outlines the Universal Machine, which later became known as the Turing Machine.

Source: Olivia Solon: Alan Turing’s Extraordinary, Tragically Short Life: A Timeline, wired.co.uk
Turing took the idea of a team of human computers working together and abstracted it, imagining a universal computing machine that could take on all of the individual tasks allocated to the women in the Scientific Computing Service (SCS).
The basic idea:

An abstract model of a human “computer”

- Finite control unit (i.e., a finite table of “behaviors”, so-called finite automaton)
- Read/write head
- Potentially infinite tape

The scheme of a Turing machine

\[ T= (\Sigma, Q, \delta, q_0, f) \]

\[ \delta: \Sigma \times Q \rightarrow \Sigma \times Q \times \{-1, 0, 1\}, \quad q_0, f \in Q \]

Main results:

- A hardware-trivial machine, a mechanical equivalent of today’s notion of “algorithm”, or “program”
- Computes “anything” computable
- All computing power lies in the program
- Construction of a universal, i.e., of a programmable Turing machine
- Anticipation of the stored program computer, and “program as data” key to the first computers
- Existence of problems without algorithmic procedure for their solution (cf. halting problem)
1936-1938: Turing spent time at Princeton in the US studying under Alonzo Church. There he started to study cryptology as well as mathematics. In 1938 he received his PhD; his dissertation was called Systems of Logic Based on Ordinals and introduced original logic and relative computing. The work on 'ordinal logics', probably his most difficult and deepest mathematical work, was an attempt to bring some kind of order to the realm of the uncomputable. This also was connected to the question of the nature of mind, as Turing's interpretation of his ideas suggested that human 'intuition' could correspond to uncomputable steps in an argument.

September 1938: return to Cambridge. Turing started to work part-time at the Government Code and Cypher School. Introduced to German Enigma cipher machine

1939: Churchill's Government searched the country for the best mathematicians, chess champions, Egyptologists and others of suitable ability. The day after war is declared in September 1939, Turing arrives at Bletchley Park. There he works to develop the Bombe, a device for decrypting the messages sent by Germans using their Enigma machines.

Source: Olivia Solon: Alan Turing’s Extraordinary, Tragically Short Life: A Timeline, wired.co.uk
1942: Turing sent to the US as part of an intelligence collaboration. He shared what he knew about Enigma in return for being allowed to inspect the speech encryption system being set up to allow conversations between Churchill and Roosevelt. Turing was somewhat dismissive of US cryptanalysis, believing the Americans to rely too heavily on machinery instead of thought.

1941-43: Breaking of U-boat Enigma, saving battle of the Atlantic. Turing and colleagues manage to break the more complicated German Naval Enigma system. This is extremely helpful for the Allies during the Battle of the Atlantic as it could help them avoid the fearsome German U-boats, which had been responsible for sinking more than 700 Allied ships with 2.3 million tons of vital cargo.

Source: Olivia Solon: Alan Turing’s Extraordinary, Tragically Short Life: A Timeline, wired.co.uk
1941: Turing proposes to his co-worker Joan Clarke, a fellow mathematician and cryptanalyst. Shortly after, Turing had second thoughts, admitting to his fiancée that he was homosexual.

Born: 24 June 1917 in London, England
Died: 4 Sept 1996 in Headington, Oxfordshire, England

1945: At the end of World War II, Turing is awarded an OBE for his services to his country.

In 1947, Turing competed in the Amateur Athletic Association Championships marathon finishing in 4th place in 2:46:03 - an amazing time for a non-professional runner even today.
**October 1945:** Turing joined the National Physical Laboratory where he worked on developing an electronic digital stored-program computing machine that would later become the ACE (Automatic Computing Engine). By 1946 he had a finished proposal for the computer, but NPL did not have the resources to turn it into reality.

**1947:** Turing returned to Cambridge for a sabbatical year. The Pilot ACE was built in his absence and executed its first program on 10 May 1950.

**1948:** First serious mathematical use of a computer (floating point arithmetic). Turing introduced the *LU decomposition of a matrix.*

\[
\begin{bmatrix}
a_{11} & a_{12} & a_{13} \\
a_{21} & a_{22} & a_{23} \\
a_{31} & a_{32} & a_{33}
\end{bmatrix}
= \begin{bmatrix}
l_{11} & 0 & 0 \\
l_{21} & l_{22} & 0 \\
l_{31} & l_{32} & l_{33}
\end{bmatrix}
\begin{bmatrix}
u_{11} & u_{12} & u_{13} \\
u_{21} & u_{22} & u_{23} \\
u_{31} & u_{32} & u_{33}
\end{bmatrix}
\]


**1949:** Turing became deputy director of the Computing Laboratory at Manchester University, working on software for one of the earliest stored program computers — the Manchester Mark 1. He also explored the problem of artificial intelligence and proposed an experiment (in his seminal paper *Computing Machinery and Intelligence*) which became that attempted to define a standard for machine intelligence, which would later become known as the Turing test. The core idea was that a computer could be said to “think” if a human interrogator could not tell it apart, through conversation, from a human being.

Source: Olivia Solon: Alan Turing’s Extraordinary, Tragically Short Life: A Timeline, wired.co.uk
A reversed form of the Turing test is widely used on the Internet; the CAPTCHA test is intended to determine whether the user is a human or a computer.

Limited form of Turing's question-answer game comparing the machine against the abilities of experts in specific fields:

- Deep Blue (Chess) 1997
- Watson the Computer (Jeopardy) 2011

Completely Automated Public Turing test to tell Computers and Humans Apart, Luis von Ahn, Manuel Blum, Nicholas J. Hopper, and John Langford, 2000
1948: an unpublished manuscript entitled “Intelligent Machinery” on the possibility of a machine possessing the intelligence of man

“schoolboy essay, not suitable for publication” !?

What can disembodied brain do:

(i) Games (chess, bridge, poker...)
(ii) The learning of languages
(iii) Translation of languages
(iv) Cryptography
(v) Mathematics

“Of these (i), (iv), and to a lesser extent (iii) and (v) are good in that they require little contact with the outside world.”

Intellectual, genetical and cultural searches
1949: Turing also worked with his former colleague D G Champernowne on a chess program for a computer that did not exist yet.

1951: Elected Fellow of the Royal Society. (FRS).

Non-linear theory of biological growth


Turing sought to crack another kind of code – how animals could develop from chemical substrates. He believed development could be reduced to mathematical axioms and physical laws. He designed a system of two different interacting molecules, called morphogens, which could establish chemical gradients through a “reaction-diffusion system.”
1952: Without a computer powerful enough to execute his chess program Turochamp, Turing played a game in which he simulated the computer, taking about half an hour to perform each move. The program lost to Turing’s colleague Alick Glennie, but won against Champernowne’s wife.

2012: Chess grandmaster Garry Kasparov completed a game of chess started more than 60 years ago by Alan Turing (Kasparov won in just 16 moves).
January 1952: Turing meets a man called Arnold Murray and invites him over to his house. Murray visits Turing’s house on a number of occasions, staying the night. Murray later helps an accomplice break into Turing’s house. Turing reports the crime and admits having a sexual relationship with Murray. Homosexual acts are illegal in the UK and so both were charged with gross indecency. Turing is given the choice of being imprisoned or chemically castrated with oestrogen hormone injections. He chooses the latter. Turing’s conviction means his security clearance is removed which means he is barred from his cryptopgraphic consultancy for the British government.

07 June 1954: Turing’s cleaner finds him dead. The inquest found he had committed suicide by eating an apple laced with cyanide. He was cremated at Woking, Surrey, England.

‘The day he died felt like driving through a tunnel and the lights being switched off’

2009: Prime Minister Gordon Brown issued an unequivocal posthumous apology to Mr Turing on behalf of the Government, describing his treatment as "horrifying" and "utterly unfair".

2012: Government rejects a pardon for computer genius Alan Turing, from formal legal reasons
Turing Award


Loebner Prize

Since 1990, the Loebner Prize is an annual competition in artificial intelligence that awards prizes to the chatterbot considered by the judges to be the most human-like. The format of the competition is that of a standard Turing test.
There is also a petition to erect a statue of Turing on the fourth plinth at Trafalgar Square.
Turing’s Citation Analysis - Web of Knowledge

Published Items in Each Year

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Sum of the Times Cited: 4571
Average Citations per Item: 571.38
h-index: 6
Computation has become a universal enabler of sciences

Summary:


• 1950: Computing Machinery and Intelligence. Mind

• 1952: The Chemical Basis of Morphogenesis. Philosophical Transactions of the Royal Society of London