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BLOG

DIFFICULT TO DECODE: ALAN TURING'S LIFE AND ITS IMPLICATIONS

Alan Turing. King's College Library, Cambridge. AMT/K/7/11. By kind permission of the Provost and Fellows of King's College, Cambridge.

"Bruce, did you know that it was an openly gay Englishman who was as responsible as any man for winning the Second World War? His name was Alan Turing and he cracked the Germans' Enigma code so the Allies knew in advance what the Nazis were going to do – and when the war was over he committed suicide he was so hounded for being gay. Why don't they teach any of this in schools? If they did… maybe you wouldn't be so terrified of who you are."

– Ned Weeks in Larry Kramer's *The Normal Heart* (1984), a play that depicted the gay community's transition into a more socially conscious, politically organized group.

Alan Turing's shadow quietly looms large in the history of computer science, and his story is increasingly cited as an illustration of injustices faced by the gay community. Despite this, the general public remains largely unaware of his life or his contributions to science and society. The lines from *The Normal Heart*, though more political statements than historical facts, capture Turing's contradictory and boundary-crossing nature. His work spanned many disciplines: mathematics, cryptography, biology, and most famously, the early development of artificial intelligence. He was, at once, a war hero who was largely unrecognized during his lifetime, as well as a man convicted of "gross indecency" with another man and forced to undergo organotherapy, or chemical castration [1]. He invented one of the core concepts of theoretical computer science (the Turing machine), while also building practical computing machines that helped crack the Enigma code – an accomplishment that would remain secret for many years after. He tragically killed himself with cyanide when he was just 41 years old, the reasons for which are still unclear. His contradictions are perhaps evidence of his fertile mind, but also present a man difficult to reconcile into a single characterization. He was and remains, as they say, difficult to decode.

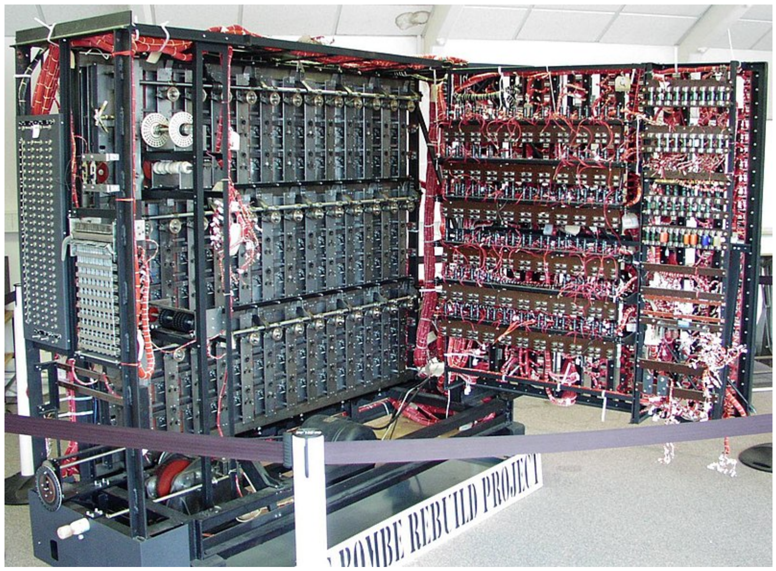
The Turing machine

Turing's work can be divided into three chronological phases — mathematics, code-breaking, and artificial intelligence. Turing first trained as a mathematician at King's College of Cambridge University, UK. His work there culminated in his seminal paper "**On Computable Numbers**", published in 1936 when he was just 24. While the paper is considered a key work in understanding the foundations of mathematics, his method relies, at its heart, on a thought experiment. To explore the limit of what can be mathematically or logically proven, Turing imagined a machine that runs on instructions printed on a tape. The machine can read both instructions and data from the tape, and can, in turn, write to the tape. This prototype of a computing machine is known as the Turing machine and is, even today, used as a mathematical representation of a computer.

Breaking the code

The second phase of Turing's career was his long foray into cryptography while working for the British Secret Service during World War II. Turing was recruited, along with a few other mathematicians, into the code-breaking effort undertaken by the British government at Bletchley Park to crack the Enigma machine. The Enigma was a sophisticated electro-mechanical device used by the German military to encrypt their orders, including those that were transmitted to the

U-boats wreaking havoc on the Atlantic shipping lanes. The “keys” – the sets of rules for encoding messages – used by the Enigma would change constantly. Turing designed machines, known as “bombes”, that could cycle through hundreds and thousands of Enigma settings to match the available “cribs” (the most frequently occurring words across messages) in order to identify the correct key. It was extremely difficult work, tense and taut, equal parts educated guesswork and puzzle solving. Turing’s contributions helped make the decryption work at Bletchley Park a success and played a substantial role in the eventual victory of the Allies.



A rebuilt bombe displayed at Bletchley Park museum, part of the ***Bombe Rebuild Project****. (Image credit: Tom Yates)*

First steps toward artificial intelligence

Around the end of the War, Turing first described his ideas about building a mechanical brain to his co-worker, the engineer Don Bayley. His ideas had a distinctly computational flavor and were no doubt influenced by his work at Bletchley Park. In computation, one tries to describe the workings of things (nature, the brain, animals, machines, humans) at a level of abstraction that is independent of how they are built. So for Turing, the working of the brain could be described as a computational system, operating with algorithms and with influxes of data. It did not matter whether the algorithms (or “software”) of the system were implemented in a mechanical, electronic, or cellular form (the “hardware”) — Turing was thus articulating the hardware/software distinction that is a key idea in computer science today [2]. At a time when programming computers meant physically rewiring them, such a distinction was not at all obvious.

Indeed, Turing’s computationalism is evident even in “On Computable Numbers”, where the Turing machine works by reading the instructions from a tape; its “hardware” is never described.

His last paper, on **morphogenesis**, is again computationalist: Turing describes a mathematical model (or an algorithm) that can explain the development of certain biological "forms", or body shapes and structures. To prove his point, he simulated this model on the computing machine that he was working on at Manchester after the war, and demonstrated the forms which it can give rise to. This work is considered an early instance of "artificial life" (simulating living systems on a computer) [3].

Turing could never talk about, let alone publish, his Enigma work. And his ideas about building computing machines were only articulated in unpublished reports at the National Physical Laboratory and Manchester University, where he worked after the war. This is perhaps why his most famous publication, the only one directly related to AI, is his 1950 paper for the philosophical journal *Mind* titled "Computing Machinery and Intelligence". In this paper, Turing proposed that the question, "Can machines think?" was ill-defined. Instead, he proposed an alternative formulation: a machine could be said to be "intelligent" if it could fool a human questioner into thinking that it was a human being. This is the famous **Turing test**, and it has been a lasting contribution in the cultural debate about what it means to be intelligent.

The striking thing about the Turing test is how non-essentialist it is: intelligence becomes a characteristic of *performance* rather than something that is innately within us (or within machines). The test is another computational thesis: the machine is supposed to imitate humans through text or symbols; the human body is abstracted out. The Turing test suggests that intelligence is linguistic, that it is separable from its embodiment (the body or any hardware) and that it gets expressed in the form of social cues through language.

Personal life

If computationalism is the consistent thread that ties together Turing's intellectual contributions, his personal life defies categorization. Those who knew Turing described him as a quiet, shy, and sometimes awkward man. He was also a gay man, and by all accounts, quite comfortable with his orientation. Even today, the act of "coming out" to one's contemporaries is still approached gingerly. Yet, more than fifty years ago, Turing came out to his friends without ceremony, often startling them with his candor and matter-of-factness. While it wasn't unusual for gay men to lead fruitful, even if publicly closeted, lives in England during that period of time (one thinks of W. H. Auden, Christopher Isherwood, E. M. Forster, or G. H. Hardy), Turing's direct, often literal mind did not cope well with the duplicity and pretense that was normally necessary to hide one's homosexuality in certain circles. To compound this, he was rarely able to belong to a group; he was too shy and too un-suave. His friend and student Robin Gandy wrote after his death that "because [Turing's] main interests were in things and ideas rather than people, he was often alone.

But he craved for affection and companionship […] the first stages of friendship [were] not easy for him." [4]

This lack of connection with people affected his work as well. A scientist must socialize with his own community of practice. This often happens during training and through informal interactions with others in the field, usually through the cultivation of informal "networks" of colleagues, correspondents and acquaintances. Charles Darwin, for example, had many correspondents all over the world, with whom he exchanged literally thousands of letters, often requests for data and clarifications, as he assembled his theory of evolution by natural selection. Turing did form lasting personal and professional friendships, but he never seems to have had a knack for cultivating informal professional contacts, especially famous ones who could have helped his career. While at Princeton, he wrote to his mother about his Cambridge friend and mathematician Maurice Pryce, "Maurice is much more conscious of what are the right things to do to help his career. He makes great social efforts with the mathematical big-wigs" – a remark that perhaps hints at what it was like to be Alan Turing [5].

Unfortunately, Turing paid a toll for the idiosyncrasies of his private and social life. In 1952, he was convicted for his homosexuality, a crime at the time. Strangely, this predicament began when his home was burgled. Turing knew who the burglar was — a friend of Arnold Murray, the young working-class man whom he was seeing. When the police asked him how he knew the identity of the offender, he admitted to his relationship with Murray. Turing would have known the legal status of his homosexuality, and the reason behind this admission to the authorities remains unclear. When convicted, he chose treatment with estrogen hormones as an alternative to jail time. About a year after his treatment was completed, he killed himself by eating an apple stained with cyanide. The motivations and circumstances of Turing's death, and whether it was truly a suicide, remain as mysterious as they are tragic.

Sculpture of Turing at Bletchley Park, by artist Stephen Kettle. (Image credit: Wikimedia Commons user SjoerdFerwerda)

Turing's legacy

On June 23 2009, a computer programmer named **John Graham-Cumming** created a **petition** on the UK Government's website, asking that Turing be pardoned by the government. By September 2009, the petition had gathered over 30,000 signatures, spurred on by BBC coverage and online social networks like Reddit. Eventually, then Prime Minister Gordon Brown apologized for Turing's treatment, though stopping short of offering a full pardon. The government refused to grant a pardon again after a similar petition in 2011, with Lord McNally, the Minister of State for Justice, explaining that the "long-standing policy has been to accept that such convictions took place and, rather than trying to alter the historical context and to put right what cannot be put right, ensure instead that we never again return to those times."

There is something to be said for the fact that the very technology Turing pioneered would unite strangers via the Internet to further recognize his contribution and defend his name. And Turing's legacy is here to stay. Computers – and the Internet – have changed the world. Disciplines like **cognitive science** and psychology take computation as a foundation for their descriptions of their phenomena of interest. Computer science's premier professional body gives an annual Turing Award, the highest distinction in computer science. The man who remained relatively obscure when he died has been justly rehabilitated today, as attested by the many celebrations of the centenary of his birth. The technology born of Turing's work allows us to collectively reexamine a provocative man with a compelling story that may have otherwise rested in the shadows of Bletchley Park.

Alan Turing is remembered as part mathematical genius, part martyr; a rare innovator who found himself at odds with the very culture his work would protect and advance. The thread connecting these pieces and parts remains elusive. No biography will account for the inner workings of a special mind like Turing's, or the unique time that shaped him. However, these inner features are perhaps not what really matter. The Turing test proposes that the inner-workings of a machine or mind do not define its character, but rather the outward expression of its ability. Like Turing, we are all composites of biological, cultural, and historical components. But like Turing, these qualities do not bind us to any single characterization. The flow of history will swell onward, and the cultural pendulum will continue to swing, but ultimately, we will judge our own humanity not on these factors, but by the way that we meet the challenges of our own time. We honor Turing's legacy by facing the future interconnected yet untethered by our wiring, attentive to our history but unbridled by it; resilient and plastic, poised to preserve yet anxious to begin anew.

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The authors would like to thank Arthur Smith for pointing out the mention of Turing in The Normal Heart.

Notes:

[1] Turing's life and work are exhaustively described in Andrew Hodges's magisterial biography *Alan Turing: The Enigma*.

[2] The hardware/software distinction, the idea that a program can be "stored" rather than wired, is credited to John von Neumann in the US, who advocated it in his proposal for the Electronic Discrete Variable Automatic Computer, or EDVAC. Although the "First Draft of a Report on the EDVAC" does not cite Turing, scholars believe that von Neumann was indeed influenced by Turing's "On Computable Numbers". See *The Essential Turing* (Ed: Jack Copeland), pp 21-30. Turing also met and worked with von Neumann at Princeton from 1936-38.

[3] Copeland, pp 508-518.

[4] Hodges, p 516.

[5] Hodges, p 130.

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3 thoughts on “Difficult to decode: Alan Turing’s life and its implications”

Robin White

JULY 22, 2018 AT 3:55 PM

Because of the secrecy of his work, The police didn’t know of his amazing work in saving maybe millions of people, Thus his treatment by the authorities. This man has to be given a full pardon, And a statue erected if him. His achievements should be taught in schools too.

REPLY

aneesshah47

MARCH 2, 2020 AT 2:04 AM

This is the extraordinary story of a mathematical genius Alan Turing, who, from a code-breaking war hero, became a criminal overnight.

REPLY

Ewan Swidorski

DECEMBER 15, 2020 AT 8:49 AM

Hello I am Ewan, I am taking part in an NHD competition. I was wondering if I could get someone here to do an interview about Alan Turing. Thanks!

REPLY

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