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Alan Turing: The Man Behind the Machine

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Alan Turing:
The Man Behind the Machine

Christopher Goff
Professor of Mathematics

January 28, 2016
Outline

1 The Man

2 The Work
   - Computability
   - Artificial Intelligence
   - Morphogenesis

3 Sexuality
Biographical and Popular Culture Items

- *Breaking the Code*, Play, 1986 and BBC TV, 1996 (Derek Jacobi)
- *The Imitation Game*, Film (2014, Benedict Cumberbatch)
- Music: electronic, choral, operatic, a work by Pet Shop Boys (*A Man from the Future*)
Biographical and Popular Culture Items

- *Breaking the Code*, Play, 1986 and BBC TV, 1996 (Derek Jacobi)
- *The Imitation Game*, Film (2014, Benedict Cumberbatch)
- Music: electronic, choral, operatic, a work by Pet Shop Boys (*A Man from the Future*)
- Why all of this attention?
Alan Mathison Turing (1912–1954)

- Born in London in 1912, parents often in India
- 1926, Attended Sherborne, Christopher Morcom (d. 1930)
- 1931, Went to King’s College, Cambridge (Keynes, Forster, etc.)
- 1935, Fellow at King’s, Central Limit Theorem (Lindeberg, 1922)
- 1936–38, Princeton (Disney’s *Snow White*)
- Worked for British government at Bletchley Park, WWII, and in London afterwards
- 1948, Reader at Manchester University
- Died in 1954 from cyanide poisoning, ruled a suicide
The *Entscheidungsproblem* (1928): Is there an algorithm to decide if a theorem can be proved from the axioms of the system?

Hilbert’s 1930 radio speech: “Wir müssen wissen; wir werden wissen.”
ON COMPUTABLE NUMBERS, WITH AN APPLICATION TO
THE ENTCHEIDUNGSPROBLEM

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.
ON COMPUTABLE NUMBERS, WITH AN APPLICATION TO THE ENTSCHEIDUNGSPROBLEM

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The “computable” numbers may be described briefly as the real numbers whose expressions as a decimal are calculable by finite means.

T defines “computability” algorithmically/mechanically
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 $q_1, q_2, \ldots, q_n$ which will be called “$m$-configurations”. The machine is supplied with a “tape” (the analogue of paper) running through it, and divided into sections (called “squares”) each capable of bearing a “symbol”. At any moment there is just one square, say the $r$-th, bearing the symbol $\mathcal{S}(r)$ which is “in the machine”. We may call this square the “scanned square”. The symbol on the scanned square may be called the “scanned symbol”. The “scanned symbol” is the only one of which the machine is, so to speak, “directly aware”. However, by altering its $m$-configu-
Turing Machine (TM)

T describes what would be called the “Turing Machine”: a machine with a set of configurations; a tape divided into squares; a scanner to read the tape

- erase symbol there
- write new symbol there (0 or 1, or perhaps 0-9)
- move right or left one square
- change to a new configuration
Impossibility (T, 1936)

- T shows that the Entscheidungsproblem can be reduced to a similar “decision problem” about a TM, one with a negative result.
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- Therefore Turing proves that Hilbert’s Entscheidungsproblem is impossible.
- Solved independently in 1936 by Alonzo Church (1903–1995).
The Universal Machine (T, 1936)

There is a single TM that can mimic all others, called a “universal” Turing machine (UTM). This UTM can mimic the behavior of any given TM.
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- **Beginnings of modern computing**
The Universal Machine (T, 1936)

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- **Beginnings of modern computing**

  ![Diagram of the Universal Turing Machine (UTM)](http://science.slc.edu/jmarshall/courses/2002/fall/cs30/Lectures/week08/Computation.html)
T was always a tinkerer. He built a few early computers, and wanted to write a chess program.
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The Point: T did more than just come up with the mathematics and logic. He also did the engineering.
T helped break the “unbreakable” Enigma code, and was briefly engaged to Joan Clarke.
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The Point: It was a team effort & T was a leader
After WWII

Vol. lix. No. 236.]

MIND
A QUARTERLY REVIEW
OF
PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING

1. The Imitation Game.

I propose to consider the question, ‘Can machines think?’ This should begin with definitions of the meaning of the terms ‘machine’ and ‘think’. The definitions might be framed so as to
Computing Machinery and Intelligence, Mind **LIX** (236) (T, 1950)

Introduces Turing Test

- “Imitation Game” (Are you talking to a computer or a human?)
Introduces Turing Test

- “Imitation Game” (Are you talking to a computer or a human?)
- T predicts that “in about fifty years’ time it will be possible to programme computers . . . to play the imitation game so well that the average interrogator will not have more than a 70% chance of making the right identification . . . .”
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- T predicts that “in about fifty years’ time it will be possible to programme computers . . . to play the imitation game so well that the average interrogator will not have more than a 70% chance of making the right identification . . . .”
- Passed test (Veselov, Demchenko, & Ulasen, 2014)
TURING TEST EXTRA CREDIT:
CONVINCE THE EXAMINER
THAT HE'S A COMPUTER.

YOU KNOW, YOU MAKE
SOME REALLY GOOD POINTS.

I'M ... NOT EVEN SURE
WHO I AM ANYMORE.
The Imitation Game

- Often thought of as one human & one unknown (machine or human)
The Imitation Game

- Often thought of as one human & one unknown (machine or human)
- T frames it using gender
The Imitation Game

- Often thought of as one human & one unknown (machine or human)
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What is lost or gained by removing gender from the test?
Suspicion, xkcd.com

I've loved our online chats these past few months, Lisa.

Me too. I really like you, Rob.

It's just... now and then you mention products you like, and... I worry.

What? Honey...

I just want to be sure.

Before this goes any further, I think we should go get tested. You know, together.

You don't trust me?

Okay, mine says "library". Yours?

Oh god. I'm more than a spambot! Our love was real!

Goodbye, Lisa.
Morphogenesis

- T uses differential equations to model cell conditions leading to pattern formation.

![Figure 2](image-url)  

*Figure 2.* An example of a ‘dappled’ pattern as resulting from a type (a) morphogen system. A marker of unit length is shown. See text, §9, 11.
Morphogenesis

- T uses differential equations to model cell conditions leading to pattern formation

![Figure 2. An example of a ‘dappled’ pattern as resulting from a type (a) morphogen system. A marker of unit length is shown. See text, §9, 11.](image)

- Biochemical machines
Homosexuality before 1952

- Gross Indecency, 1885
- Oscar Wilde, 1895
- Kinsey report, 1948
- Red Scare/Lavender Scare (McCarthyism, c.1950)
- Guy Burgess (of the Cambridge Five), 1951, 1956
1952

T met Arnold Murray, age 19, in late 1951
T’s home is burgled, January
T reported the crime and his relationship with Arnold
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T’s home is burgled, January
T reported the crime and his relationship with Arnold
T is charged with “gross indecency”
Accession of Queen Elizabeth II, February
Trial March 31, T convicted
(choice: prison vs. probation with hormone treatment)
1952

- T met Arnold Murray, age 19, in late 1951
- T’s home is burgled, January
- T reported the crime and his relationship with Arnold
- T is charged with “gross indecency”
- Accession of Queen Elizabeth II, February
- Trial March 31, T convicted
  (choice: prison vs. probation with hormone treatment)
- T chose probation (which ended in April 1953)
- *The Chemical Basis of Morphogenesis* appears
After 1952

- Watson and Crick, 1953
- Turing’s death, June 1954 (accident vs. suicide)
- Decline of McCarthy, 1954
- Wolfenden report, 1957, 1967
Legacy

- Computability (Universal Turing Machine)
- Code-breaking effort (OBE by King George VI, 1945)
- Computer science & AI (Turing test)
- Morphogenesis
Legacy

- Computability (Universal Turing Machine)
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- Morphogenesis
- Did not name his computer Christopher
- Did not harbor a double agent
- 2013 Royal Pardon
Computability (Universal Turing Machine)
Code-breaking effort (OBE by King George VI, 1945)
Computer science & AI (Turing test)
Morphogenesis
Did not name his computer Christopher
Did not harbor a double agent
2013 Royal Pardon
What role did his homosexuality play in the development of his ideas?
Stereotypes & Themes

- Isolated and lonely
- Prefer company of computers
- Effeminate/wimpy/nerdy
- Socially awkward

To what degree are these stereotypes "gendered"? Do they help or hinder progress in programming... in business? 

Source of next charts: http://www.informationisbeautiful.net/visualizations/diversity-in-tech/
Stereotypes & Themes

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### Diversity in the Technology Sector: Social

#### Diversity in Tech
Employee breakdown of key technology companies

<table>
<thead>
<tr>
<th>Gender</th>
<th>USA Population (Total)</th>
<th>Facebook</th>
<th>Flickr</th>
<th>Google+</th>
<th>Instagram</th>
<th>LinkedIn</th>
<th>Pinterest</th>
<th>Tumblr</th>
<th>Twitter</th>
<th>YouTube</th>
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<tr>
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<td>1</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>
# Diversity in the Technology Sector: Tech

<table>
<thead>
<tr>
<th>Tech Company</th>
<th>Total (X)</th>
<th>Top 50 US Companies (Y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon</td>
<td>37</td>
<td>46</td>
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<tr>
<td>Apple</td>
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<tr>
<td>Dell</td>
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<td>eBay</td>
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<td>Google</td>
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<td>HP</td>
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<td>Intel</td>
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<tr>
<td>Microsoft</td>
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<td>NVIDIA</td>
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<td>Pandora</td>
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<td>Salesforce</td>
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</tr>
<tr>
<td>Yahoo!</td>
<td>37</td>
<td>46</td>
</tr>
<tr>
<td>VS.</td>
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</tr>
</tbody>
</table>
Diversity in the Technology Sector: Sexual Orientation, Gender Identity & Expression

- Difficult to find data.
- Difficult to see the big picture.
- Difficult to tell the story.
Thank you!