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Alan Turing: The Man Behind the Machine

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March 19, 2015

Outline

1. The Man
2. The Work
   - Computability
   - Artificial Intelligence
   - Morphogenesis
3. Sexuality

Biographical and Popular Culture Items

- Biographies (Hodges 1983, . . . , 2012, Leavitt 2006)
- *Breaking the Code*, Play, 1986 and BBC TV, 1996 (Derek Jacobi)
- *Codebreaker*, TV Movie/Documentary (2011, Ed Stoppard)
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- Music: electronic, choral, operatic, a work by Pet Shop Boys (*A Man from the Future*)

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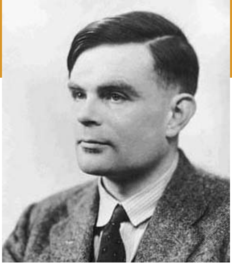
- Music: electronic, choral, operatic, a work by Pet Shop Boys (*A Man from the Future*)
- Why all of this attention?

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

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- 10: Proved impossible (Matiyasevich, 1970, building on work of Robinson, 1969)

Decidability

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- The *Entscheidungsproblem* (1928): Is there an algorithm to decide if a theorem (in first-order logic) can be proved from the axioms of the system?
  - Hilbert's 1930 speech "Wir müssen wissen; wir werden wissen."
  - Radio Address

On Computable Numbers (1936)

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By A. M. TURING.

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

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T defines "computability" algorithmically/mechanically

On Computable Numbers (1936)

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 $q_1, q_2, \ldots, q_R$ 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 $\mathfrak{S}(r)$ 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

Definitions & Things (T, 1936)

(hand-wavy, skipping lots of technicalities and exceptions)

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- Each CSeq has at least one DN, while each DN has only one CSeq.
- (for the math folks) The set of CSeqs is countably infinite.

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- T shows that the Entscheidungsproblem can be reduced to a similar "decision problem" about a TM, one with a negative result.
- Therefore the Entscheidungsproblem is proved to be impossible.
- Solved independently in 1936 by Alonzo Church (1903–1995).

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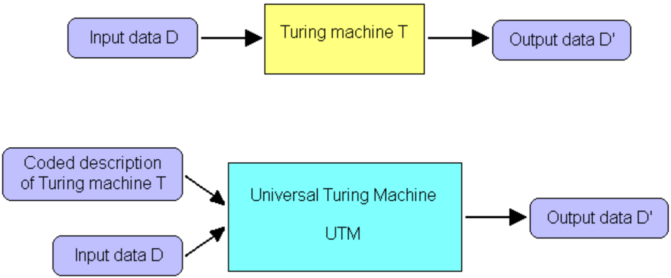
- **Beginnings of modern computing**



http://science.slc.edu/ jmarshall/courses/2002/fall/cs30/Lectures/week08/Computation.html

Theory & Practice

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.

WWII work

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The Point: It was a team effort & T was a leader

After WWII

Computing Machinery and Intelligence

A. M. Turing

1950

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 defi-

Computing Machinery and Intelligence, Mind **LIX** (236) (T, 1950)

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- Passed test (Veselov, Demchenko, & Ulasen, 2014)

Turing test, xkcd.com

The Imitation Game

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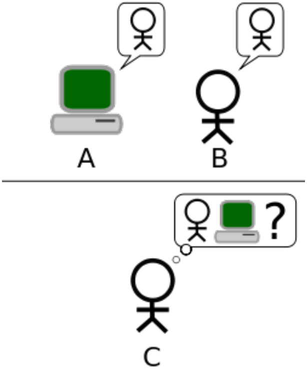
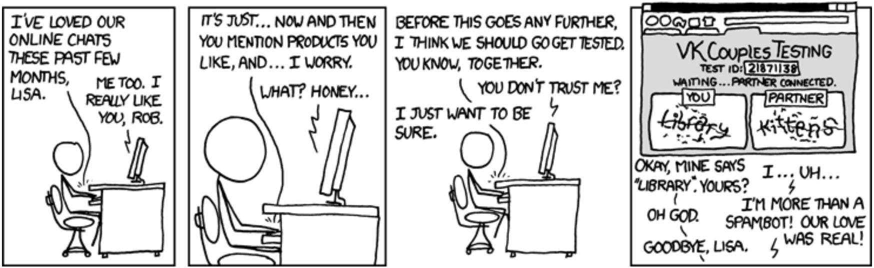


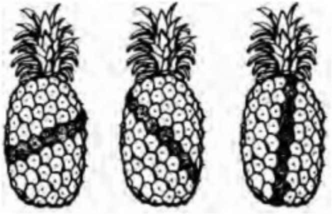
What is lost or gained by removing gender from the statement of the problem?

Suspicion, xkcd.com



Fibonacci phyllotaxis

$$1, 1, 2, 3, 5, 8, 13, 21, 34, 55, \ldots$$



Morphogenesis

- T. (1952). "The Chemical Basis of Morphogenesis". *Philosophical Transactions of the Royal Society of London* **237** (641): 37–72.
- T uses differential equations to model cell conditions leading to pattern formation

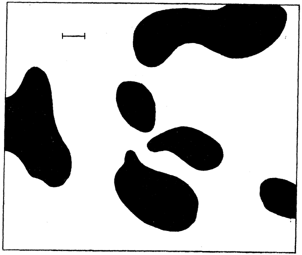


FIGURE 2. An example of a 'dappled' pattern as resulting from a type (*a*) morphogen system. A marker of unit length is shown. See text, §9, 11.

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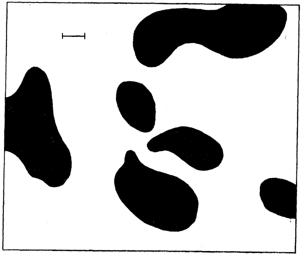

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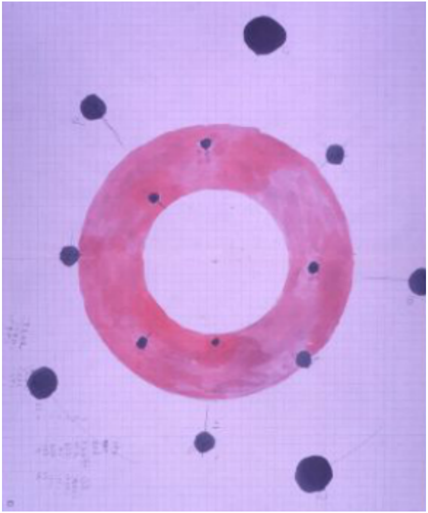
- Biochemical machines

Fibonacci phyllotaxis (unpublished)



$1, 1, 2, 3, 5, 8, 13, 21, 34, 55, \ldots$

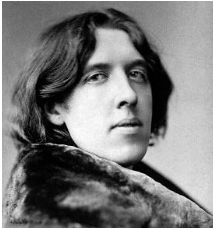
Table 1

Fraction of 2π	Degrees, min, sec. DIVERGENCE	ANGLES. Degrees.
1/2	180°	
1/3	120°	
2/5	144°	
3/8	135°	
5/13	138° 27' 41.5"	138.46154
8/21	137° 8' 34.3"	137.14286
13/34	137° 38' 49.4"	137.64706
21/55	137° 27' 16.4"	137.45454
34/89	137° 31' 41.1"	137.52809
55/144	137° 30' 00.0"	137.50000
89/233	137° 30' 38.6"	137.51073
Limiting value	137° 30' 27.9"	137.5078

(from the Turing Archive, Swinton)

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



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- Trial March 31, T convicted
  (choice: prison vs. probation with hormone treatment)

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  (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)
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- Computer science & AI (Turing test)
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- Did not name his computer Christopher
- Did not harbor a double agent
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- What role did his homosexuality play in the development of his ideas?

Intersections

- Double life, secret life
- Speaking in code
- What is being imitated in the imitation game?
- Is homosexuality part of our programming?

Thank you!