Turing’s Program

Cem Bozşahin

Cognitive Science Department, The Informatics Institute, METU

bozsahin@metu.edu.tr

2016
<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>simple</td>
<td>simple</td>
</tr>
<tr>
<td>complex</td>
<td>complex</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Behavior</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>simple</td>
<td>simple</td>
<td>(not empirically relevant)</td>
</tr>
<tr>
<td>complex</td>
<td>simple</td>
<td>(not interesting)</td>
</tr>
<tr>
<td>complex</td>
<td>complex</td>
<td>(not scientifically interesting)</td>
</tr>
<tr>
<td>simple</td>
<td>complex</td>
<td>(real cogsci) (computer science)</td>
</tr>
</tbody>
</table>

The last one was what he was after.
What was Turing up to?

He tried just about everything

- Chemistry
- Cryptology (Enigma)
- Bio-genetics (morphogenesis)
- Abstract computing (algorithms)
- Applied computing (programming)
- Mind-body problem (round-the-house chess)
- Turing test
- Artificial life
- Foundations of mathematics
- Artificial Intelligence
- Marathon
AMT the athlete
Perhaps the right question is:

How was Turing trying to do everything he did?
Mark I, 2011
Turing Machine

Input/Output Tape

Reading and Writing Head (moves in both directions)

Finite Control
A Turing machine to compute $f(n,m) = n \times m$

It copies the second string a number of times given by the first string.


Representation: maps $\#I \#I \#m \ n$ to $aI \ aI \ m \ n$

- $\#$: blank
- $x$: write $x$
- $L$: move left
- $R$: move right
- $L_x$: find first $x$ on left
- $R_x$: find first $x$ on right
Non-Turing extensions to Computing

- Analog devices (where everything represents itself)
- Quantum computing
  - Bankers beware
  - New measures of complexity
What is essential to Turing?

- P-G machine is a TM
- The nature of relation between representation and computing.
- Complexity is defined over representation rather than physical time and space.
- One more move of a TM makes the solution one step more involved.
Reading and Writing Head
(moves in both directions)
Problems

- Formulable but unsolvable problems

  \[\text{diagonal}(X):\]
  
a: if \(\text{halt}(X,X)\) goto a otherwise halt.

  \[\text{diagonal}(\text{diagonal})?\]

- Expressible but unformulable problems

  What is the next number after \(\pi\)?

  The difference is TM representability.
Turing Test

Programming and Turing

Virtual Machine

Interpretive system
Transductive system

Computer

I/O CPU

Alphabet (finite vocabulary)
Lexicon (finitely characterizable tokens)
Grammar (finitely characterizable sentences)

Well-formed programs (source code)
meaningful computation (interp. code)

Person

Performance System

Lexicon (meaning bearing items)
Grammar (meaning bearing phrases)

Phonological Form
Logical Form

Articulatory Perceptual System
Conceptual Intentional System

Bozşahin

Turing’s Program

21/24
- does it look like a TM?
- AMT: intelligent behavior can arise from manipulation of representation.
- With representations, we can build models. Without them we talk about them.
- Turing representability is the key to Turing’s computing.
“I always seem to want to make things from the thing that is commonest in nature.”
On the cliffs: Alan and his mother at St Lunaire, Brittany, in 1921 (see page 10).