Computation and Language

Minds as Computers and Turing's Test

Carlotta Pavese

07.11.13

Outline

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Introduction

The Turing Test

Computation and Language

The Computational Theory of Mind

So Far

Functionalism

Minds are what brain do.

The Computational Theory of Mind

Minds are what brains do and brains compute.

Our Questions

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1. Do brains really compute?

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1. Do brains really compute?
2. Why think that the mind computes?

Why Think that the Mind Computes?

Conceptual Considerations

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2. Folk psychology works, but appeals to laws that aren't part of fundamental physics
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   - The computational theory explains how this could be, while allowing that thoughts are physical!

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Empirical Considerations

The Empirical Question

When you actually examine the things intelligent creatures are capable of, is it plausible that computation is involved in doing these things?

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- Consider whether computers could do it

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- *Thought*: The Imitation Game
- *Machine*: Turing Machines (Computer)

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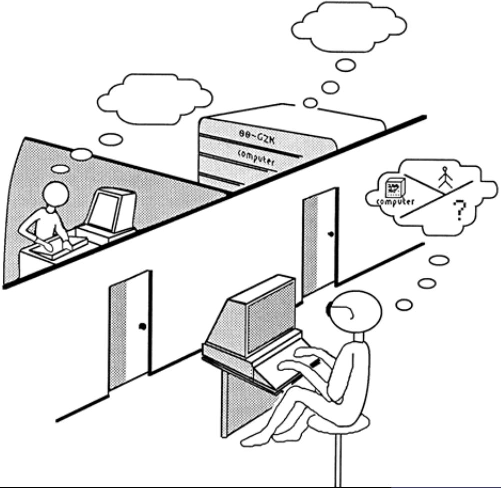
  1. Strategic behavior
  2. Language use
- Turing builds both activities into what he calls the Imitation Game

The Imitation Game

The Setup: Three Rooms, Two People, One Chatbot



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- Typed text exchanged between I & H, and I & M
- I does not know which correspondent is a machine
- I's goal: correctly guess which is the machine
- M's goal: make I guess incorrectly

The Turing Test

A Test for Thought

The Turing Test (CMI:§1,442)

A machine M is said to pass the Turing Test just in case human interrogators cannot detect M in Imitation Games at a rate **better** than **chance**

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Turing's Replacement (CMI:433,442)

We should replace the question

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with the **closely related** question

- *Could there be a machine that passes the Turing Test?*

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Two Issues

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  ### Question

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- We'll get to his main points shortly
- But let's take a second to clarify Turing's proposal

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Language & Intelligence

The Foundation of Turing's Proposal

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  with the 'closely related question'
  - *Could there be a machine that passes the Turing Test?*
- But why should we think that these questions are closely related?
- What is it about Imitation Games that would justify saying that something which passes Turing's Test must be able to think?

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Turing's Intuition

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- The Imitation Game eliminates factors irrelevant to intelligence, e.g. hair, skin, etc.
- But it focuses on activities that definitely require intelligence
- If a machine could really convincingly converse & strategize, what reasons would we have for saying that it can't think?
- Don't these very abilities typically lead us to say that a human can think?

Clarifying Turing's Test

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Exactly What is It Saying?

- Note that the Turing Test does not imply that something couldn't think unless it could pass the Turing Test
- All the Turing Test implies is that something can think if it can pass the Test
- It is an interesting, but separate question whether or not there are intelligent, thinking things which cannot pass the Turing Test

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What Role is Language Use Playing Here?

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How Language Use Makes the Turing Test Harder: I

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- There are good reasons for thinking that language requires exactly this kind of sophistication

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- For scale: roughly 10^{18} seconds since the Big Bang

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Reason 1 (Combinatorial Explosion)

- Language use in the Turing Test introduces a combinatorial explosion that must be solved
- Requires a sophisticated method for responding
- No machine can overcome combinatorial explosion with sheer speed and size

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- It must be pretty resourceful. Intelligent?

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Language & Intelligence

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- Not only possible interpretations of (23) and (23)...
- It's possible to interpret in the converse manner

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- So, this fact unlikely to explain their denial of a permit

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Reason 2 (Integrated World Knowledge)

- Interpreting natural language requires more than internalized grammar and vocabulary.
- Requires selecting among possible interpretations by incorporating world knowledge and other information into an overall inference to the best explanation of what the speaker meant
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- Sounds pretty smart

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Loebner Prize

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Turing Test

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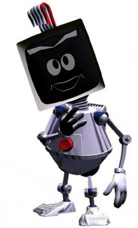
  - Best chatbots get Loebner Prize



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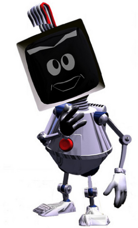

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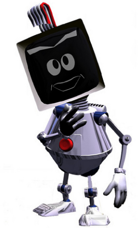

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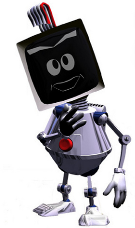

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- How does *Jeopardy!* compare to Turing's Test?

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- Does Watson count as intelligent?
  - What advantages does Watson have?

Outline

Language

It's a Hard Problem

- Language allows a potential infinity of sentences,
  - Interesting problem for understanding the mind!
- How are we able to come to understand a potential infinity of sentences, despite having limited storage space in our brain?
- Modern linguistics addresses this question by assuming the brain is a kind of computer

Modern Linguistics

One Important Factor

- Modern linguistics is the result of many innovative ideas by many different researchers
- But Noam Chomsky's work was particularly influential in shaping the way researchers thought about language
- After debunking behaviorist approaches to language and simple mechanical models of language, Chomsky proposed a new one: generative grammar

Generative Grammar

Some Details

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- UG may be thought of as a customized language acquisition device

The Contrast in High-Relief

Key Points

- Behaviorism treats the mind/brain as a ‘black box’ whose internal states are irrelevant

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- Generative grammar maintains that internal states of speakers are central
- Language learning is more like growth or maturation
- Once internal states become focus of inquiry, explaining linguistic behavior amounts to explaining how a speaker’s knowledge of language is exploited in linguistic behavior

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- It doesn't look like it

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Against Analogical Generalization

(From Chomsky's *Knowledge of Language*, p.8)

- Consider:
- John ate an apple
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- So, analogical generalization is inadequate

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- Generative grammar can explain this by appeal to a innate genetic endowment for language learning called

Types of Grammars

Three Types

Mental Grammar

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Descriptive Grammar

An idealized form of the mental grammars of all the speakers of a language community

Key Concepts

Of Theoretical Linguistics

Lexicon: Words and morphemes in the mental dictionary

Morphology: The structure of words

Syntax: The structure of phrases and sentences

Semantics: The meaning of words and sentences

Phonetics: The sounds of a language, the physical aspects of those sounds

Phonology: The sound patterns of a language

Orthography: A conventionalized writing system for a particular language

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  - This is the syntactic component of the Grammar
- Many different proposals for syntactic component
- We are going to look at a particularly simple one: a

Outline

A Mental Grammar

What are We After?

- A list of the basic kinds of words

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- But, it is important that the rules generate all and only the grammatical sentences
- A Mental Grammar needs to deliver the syntax of the speaker’s language
- Also important: only finitely many rules

The Word List

The Basic Categories of Words

Category	Examples
Verb (V)	*attack, quit, run, give*
Adjective (A)	*careful, happy, angry, think, tell*
Adverb (Adv)	*very, carefully*
Noun (N)	*broth, friend, happiness*
Proper Name (Name)	*John, Mary, Athens*
Determiner (D)	*a, some*
Preposition (P)	*about, for*
Pronoun (Prn)	*I, me, him*
Auxiliary (Aux)	*can, must, had, is, will*
Complementizer (C)	*that*

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Some Notation

- Rules combine words and phrases into bigger phrases

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Some Simple Sentences with DP and V

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A Sophisticated Example

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Billy ran and Sarah swam

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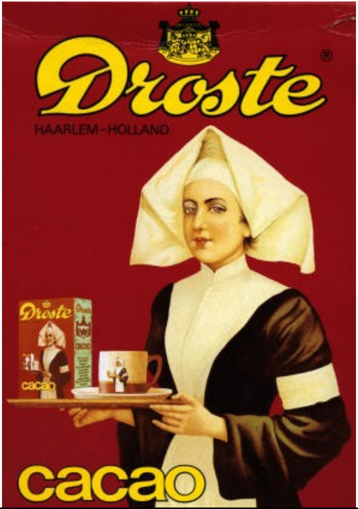
- This is the basis for generating infinity of sentences

Recursive

Images



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    - Yes!