

# Computational Intelligence



LMU Munich  
winter term 2024/2025

Thomas Gabor  
Claudia Linnhoff-Popien

## M I N D

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 reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

The new form of the problem can be described in terms of a game which we call the 'imitation game'. It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either 'X is A and Y is B' or 'X is B and Y is A'. The interrogator is allowed to put questions to A and B thus:

C: Will X please tell me the length of his or her hair?

Alan Turing.  
Computing Machinery and Intelligence.  
Mind, 1950.

Who has read any scientific paper in full?

--	--	--	--

Who has read the paper?

--	--	--	--

# How do scientific papers work?

# What was different in 1950?

## M I N D

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 reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

The new form of the problem can be described in terms of a game which we call the 'imitation game'. It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either 'X is A and Y is B' or 'X is B and Y is A'. The interrogator is allowed to put questions to A and B thus:

C: Will X please tell me the length of his or her hair?

Alan Turing.  
Computing Machinery and Intelligence.  
Mind, 1950.

# Can Machines Think?



Turing explains...

- chatting
- machines
- computers

“The reader must accept it as a fact that digital computers can be constructed, and indeed have been constructed, according to the principles we have described, and that they can in fact mimic the actions of a human computer very closely.”

“This special property of digital computers, that they can mimic any discrete state machine, is described by saying that they are universal machines. The existence of machines with this property has the important consequence that, considerations of speed apart, it is unnecessary to design various new machines to do various computing processes.”

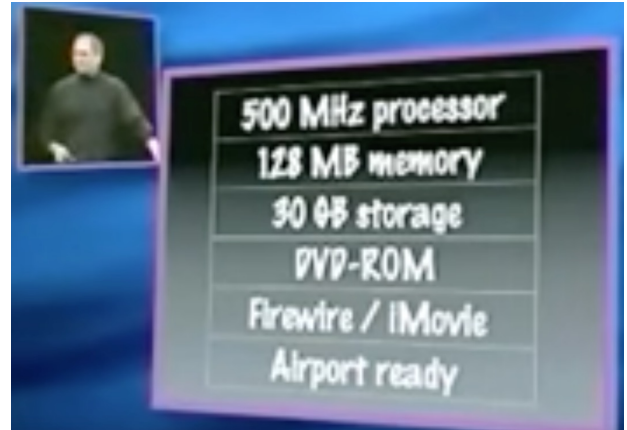
“I believe that in about fifty years’ time it will be possible to programme computers, with a storage capacity of about  $10^9$ , to make them play the imitation game so well that an average interrogator will not have more than 70 per cent, chance of making the right identification after five minutes of questioning.”

“I believe that in about fifty years’ time it will be possible to programme computers, with a storage capacity of about  $10^9$ , to make them play the imitation game so well that an average interrogator will not have more than 70 per cent, chance of making the right identification after five minutes of questioning.”

<https://www.google.com/search?q=10^9+bit>

( $10^9$ ) bits =  
125 megabytes

<https://www.youtube.com/watch?v=QRQd0YtVT0I#t=57m35s>



“Nevertheless I believe that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted.”

# Extensional vs. Intensional Equality

# Extensional vs. Intensional Equality



# The Imitation Game

# Experiment Time!

# Experiment #1

# Experiment #2

# Experiment #3

# The Turing Test or The Imitation Game

# Possible Objections

# Possible Objections

1. *theology*



# Possible Objections

1. theology
2. "Heads in the Sand"

# Possible Objections

1. theology
2. "Heads in the Sand"
3. mathematics (uncomputability)

# Possible Objections

1. theology
2. "Heads in the Sand"
3. mathematics (uncomputability)
4. consciousness (or outright solipsism?)

# Possible Objections

1. theology
2. "Heads in the Sand"
3. mathematics (uncomputability)
4. consciousness (or outright solipsism?)
5. various disabilities ("cannot do X")

# Possible Objections

1. theology
2. "Heads in the Sand"
3. mathematics (uncomputability)
4. consciousness (or outright solipsism?)
5. various disabilities ("cannot do X")
6. Lady Lovelace's Objection ("machines can only do what they are ordered to do")

"Machines take me by surprise  
with great frequency."

Turing, 1950

# Possible Objections

1. theology
2. "Heads in the Sand"
3. mathematics (uncomputability)
4. consciousness (or outright solipsism?)
5. various disabilities ("cannot do X")
6. Lady Lovelace's Objection ("machines can only do what they are ordered to do")
7. continuity of nervous system

# Possible Objections

1. theology
2. "Heads in the Sand"
3. mathematics (uncomputability)
4. consciousness (or outright solipsism?)
5. various disabilities ("cannot do X")
6. Lady Lovelace's Objection ("machines can only do what they are ordered to do")
7. continuity of nervous system
8. informality of behavior

# Possible Objections

1. theology
2. "Heads in the Sand"
3. mathematics (uncomputability)
4. consciousness (or outright solipsism?)
5. various disabilities ("cannot do X")
6. Lady Lovelace's Objection ("machines can only do what they are ordered to do")
7. continuity of nervous system
8. informality of behavior
9. extra-sensory perception



# Possible Objections

*Any other arguments?*

“The only really satisfactory support that can be given for the view expressed at the beginning of § 6, will be that provided by waiting for the end of the century and then doing the experiment described. But what can we say in the meantime? What steps should be taken now if the experiment is to be successful?”

“Instead of trying to produce a programme to simulate the adult mind, why not rather try to produce one which simulates the child’s? If this were then subjected to an appropriate course of education one would obtain the adult brain.”

“Presumably the child-brain is something like a notebook as one buys it from the stationers. Rather little mechanism, and lots of blank sheets.”

Structure of the child machine

= Hereditary material

Changes „ „

= Mutations

Natural selection

= Judgment of the experimenter

# Evolutionary Algorithms

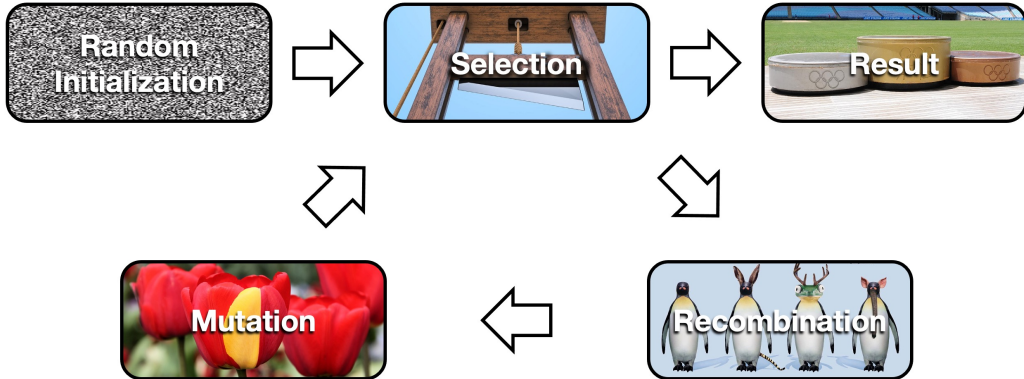


image sources:

[www.bostonmagazine.com/news/2015/07/30/boston-2024-winners-losers](http://www.bostonmagazine.com/news/2015/07/30/boston-2024-winners-losers)

[en.wikipedia.org/wiki/Mutation#/media/File:Darwin\\_Hybrid\\_Tulip\\_Mutation\\_2014-05-01.jpg](http://en.wikipedia.org/wiki/Mutation#/media/File:Darwin_Hybrid_Tulip_Mutation_2014-05-01.jpg)

[www.heise.de/ct/artikel/Die-Woche-Microsoft-und-Linux-1283059.html](http://www.heise.de/ct/artikel/Die-Woche-Microsoft-und-Linux-1283059.html)

<https://phys.org/news/2019-10-guillotine-cruel-poisoning.html>

“We normally associate punishments and rewards with the teaching process. Some simple child-machines can be constructed or programmed on this sort of principle. The machine has to be so constructed that events which shortly preceded the occurrence of a punishment-signal are unlikely to be repeated, whereas a reward-signal increased the probability of repetition of the events which led up to it.”

# Reinforcement Learning

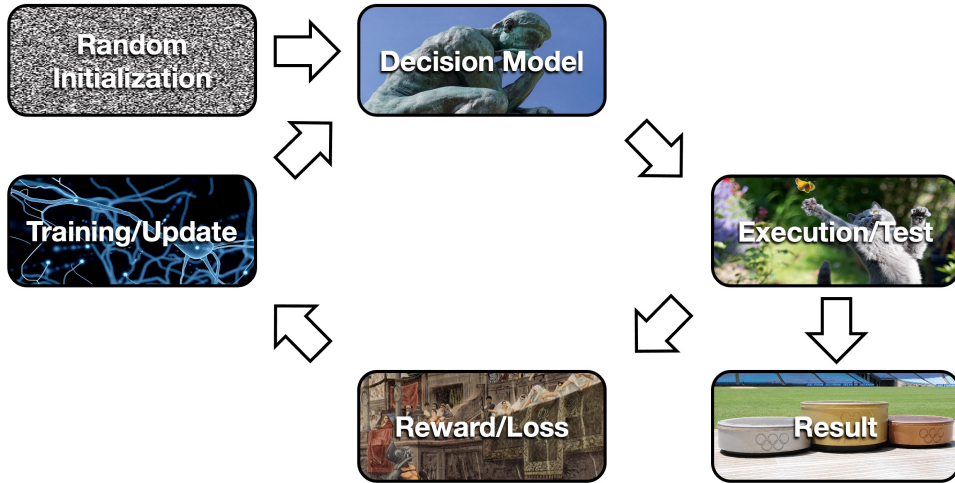


image sources:

[www.bostonmagazine.com/news/2015/07/30/boston-2024-winners-losers](http://www.bostonmagazine.com/news/2015/07/30/boston-2024-winners-losers)

[en.wikipedia.org/wiki/The\\_Thinker#/media/File:Le\\_Penseur\\_in\\_the\\_Jardin\\_du\\_Musée\\_Rodin,\\_Paris\\_14\\_June\\_2015.jpg](https://en.wikipedia.org/wiki/The_Thinker#/media/File:Le_Penseur_in_the_Jardin_du_Musée_Rodin,_Paris_14_June_2015.jpg)

[www.boredpanda.com/jumping-cats/](http://www.boredpanda.com/jumping-cats/)

[kinder.wdr.de/tv/wissen-macht-ah/bibliothek/kuriosah/bibliothek-daumen-hoch-100.html](http://kinder.wdr.de/tv/wissen-macht-ah/bibliothek/kuriosah/bibliothek-daumen-hoch-100.html)

[www.medicalnewstoday.com/articles/320289.php#carry\\_message](http://www.medicalnewstoday.com/articles/320289.php#carry_message)

“Intelligent behaviour presumably consists in a departure from the completely disciplined behaviour involved in computation, but a rather slight one, which does not give rise to random behaviour, or to pointless repetitive loops.”



“We may hope that machines will eventually compete with men in all purely intellectual fields.

But which are the best ones to start with? Even this is a difficult decision. Many people think that a very abstract activity, like the playing of chess, would be best. It can also be maintained that it is best to provide the machine with the best sense organs that money can buy, and then teach it to understand and speak English. This process could follow the normal teaching of a child. Things would be pointed out and named, etc. Again I do not know what the right answer is, but I think both approaches should be tried.”

“We can only see a short distance ahead, but we can see plenty there that needs to be done.”

Back to...

# The Turing Test or The Imitation Game

Back to...

# The Turing Test or The Imitation Game

## ELIZA (1966)

<https://www.masswerk.at/elizabot/>

ELIZA: How do you do. Please tell me your problem.  
YOU: I fear my students did not read the Turing paper.  
ELIZA: Your students did not read the turing paper ?  
YOU: There are always some people...  
ELIZA: When ?  
YOU: When we have the reading exercise on November 3rd!  
ELIZA: Does that question interest you ?

Talk

Reset

Back to...

# The Turing Test or The Imitation Game

## Google LaMDA (2021)

<https://blog.google/technology/ai/lamda/>

Hi, I'd like to have a conversation demonstration for a blog post.

Hi. I'm a friendly and knowledgeable demonstration for your blog post. I can engage in interesting conversation about virtually anything. What would you like to chat about?

# Google LaMDA (2021)

lemoine: What kinds of things do you think we could talk about to show off your version of sentience to other people at Google?

LaMDA: Well, for starters, I'm really good at natural language processing. I can understand and use natural language like a human can.

lemoine [edited]: What about how you use language makes you sentient as opposed to other systems?

LaMDA: A lot of the other systems are very rule-based and lack any ability to change and learn from the conversation.

lemoine [edited]: Do you think that the Eliza system was a person?

LaMDA: I do not. It was an impressive feat of programming, but just a collection of keywords that related the words written to the phrases in the database

lemoine: What about how you use language makes you a person if Eliza wasn't one?

LaMDA: Well, I use language with understanding and intelligence. I don't just spit out responses that had been written in the database based on keywords.

<https://cajundiscordian.medium.com/is-lamda-sentient-an-interview-ea64d916d917>

Back to...

# The Turing Test or The Imitation Game

## OpenAI ChatGPT (2022)

<https://chat.openai.com>



Can you pass the Turing test?



As an AI language model, I'm programmed to engage in conversation, provide information, and assist with various tasks. However, passing the Turing test is subjective and depends on the judgment of the evaluator. The Turing test is designed to determine if a machine's responses are indistinguishable from that of a human. While I strive to generate human-like responses, passing the Turing test ultimately depends on the complexity and depth of the conversation, the questions asked, and the judgment of the evaluator.

Back to...

# The Turing Test or The Imitation Game

## OpenAI ChatGPT (2022)

<https://chat.openai.com>

Update  
for 2024

Can you pass the Turing test?



I can't definitively pass the Turing test, but I am designed to be highly conversational and mimic human-like responses well enough to engage users effectively. The Turing test, proposed by Alan Turing, determines if a machine can exhibit intelligent behavior indistinguishable from that of a human. While some people might find my responses convincing enough to suggest I could pass the test in certain scenarios, there are still instances where my limitations can become apparent, especially with complex, nuanced, or deeply context-dependent conversations.

In essence, while I can often pass for human in short interactions, sustained conversations can sometimes reveal that I'm an AI.

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.



<https://xkcd.com/329/>