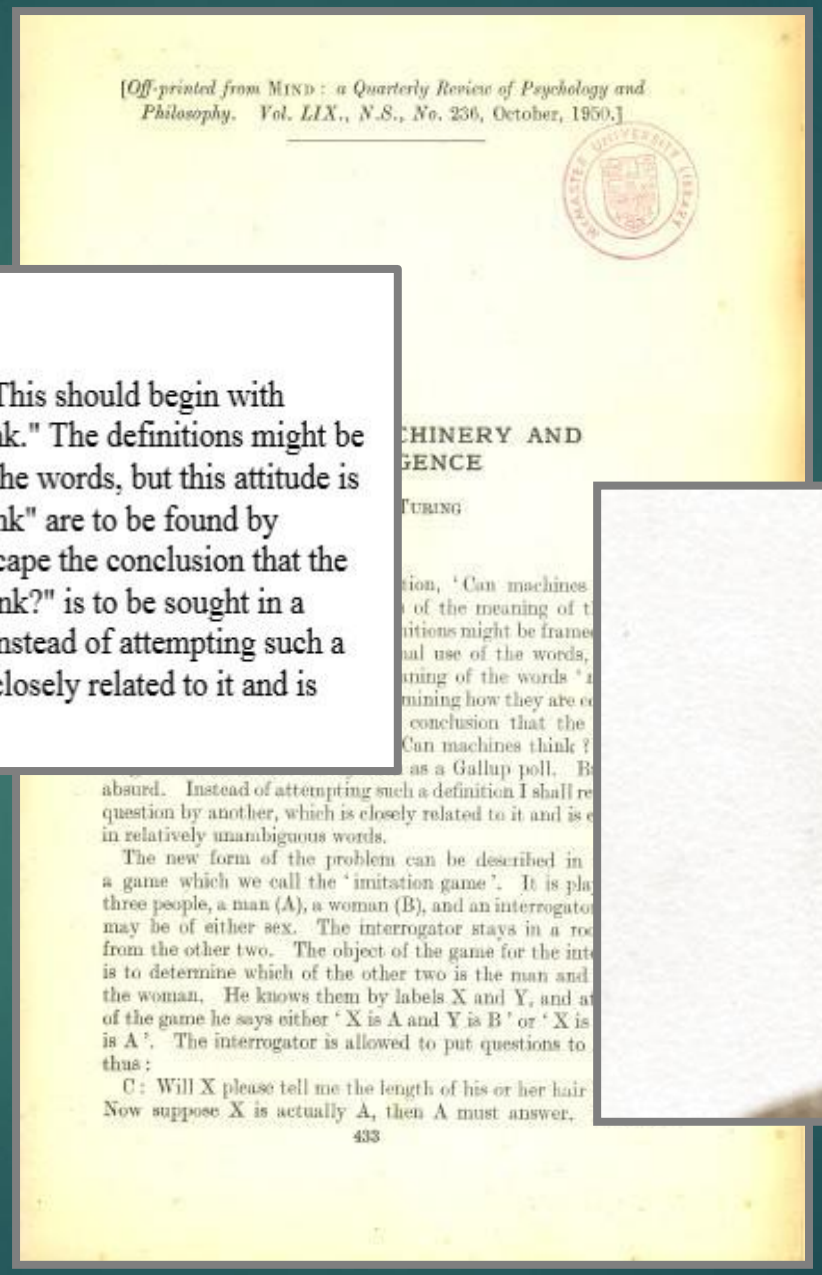
COMS 647

COMMUNICATION TECHNOLOGY

Agenda

- Review
- NLP & Computational Creativity
- Preview

Review



[Off-printed from MIND: a Quarterly Review of Psychology and Philosophy. Vol. LIX., N.S., No. 236, October, 1950.]

CHINERY AND
GENCE

TURING

ion, 'Can machines
of the meaning of t
itions might be frame
al use of the words,
ning of the words '
mining how they are c
conclusion that the
Can machines think ?
as a Gallup poll. B
absurd. Instead of attempting such a definition I shall re
question by another, which is closely related to it and is
in relatively unambiguous words.

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

C: Will X please tell me the length of his or her hair
Now suppose X is actually A, then A must answer.

433

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.

Problem – The question "*Can machines think?*" is difficult if not impossible to answer.

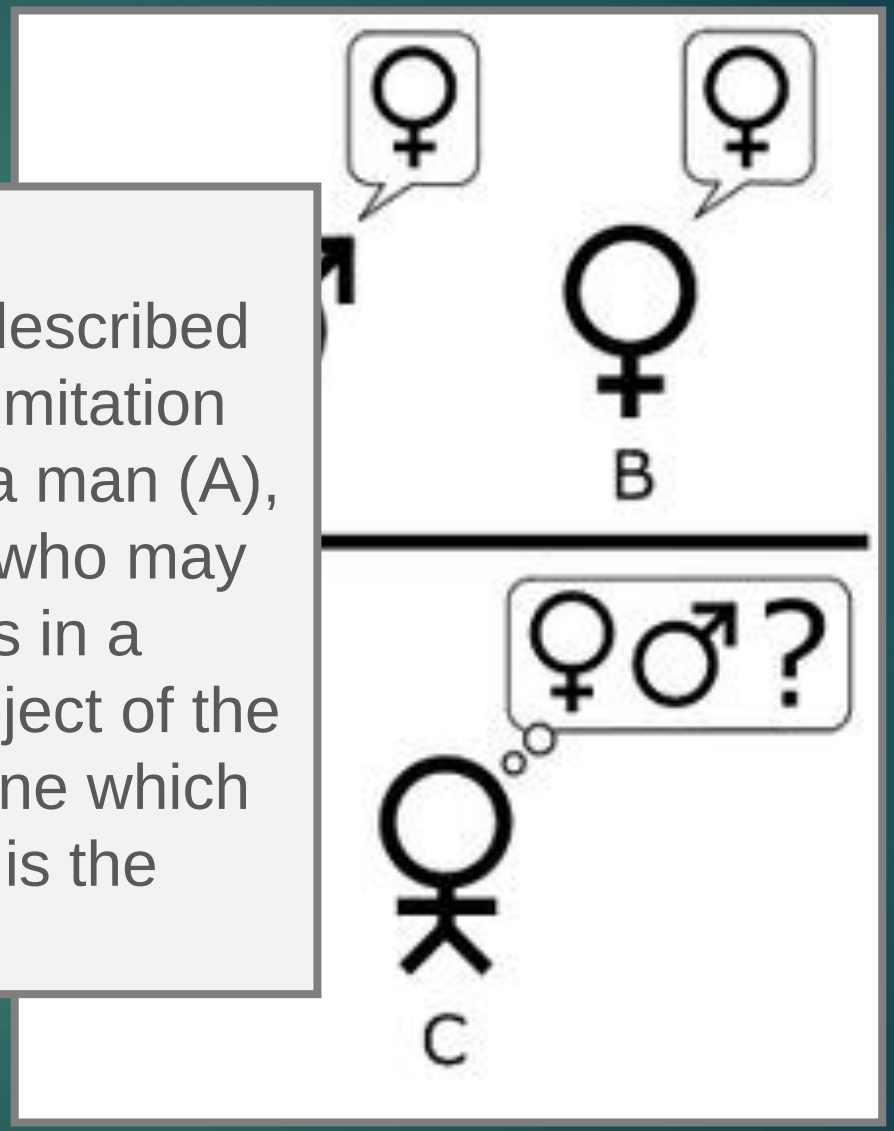
Solution – Change the question. "The Imitation Game."

Alan Turing (1912-1954)

Review

The Imitation Game – phase 1

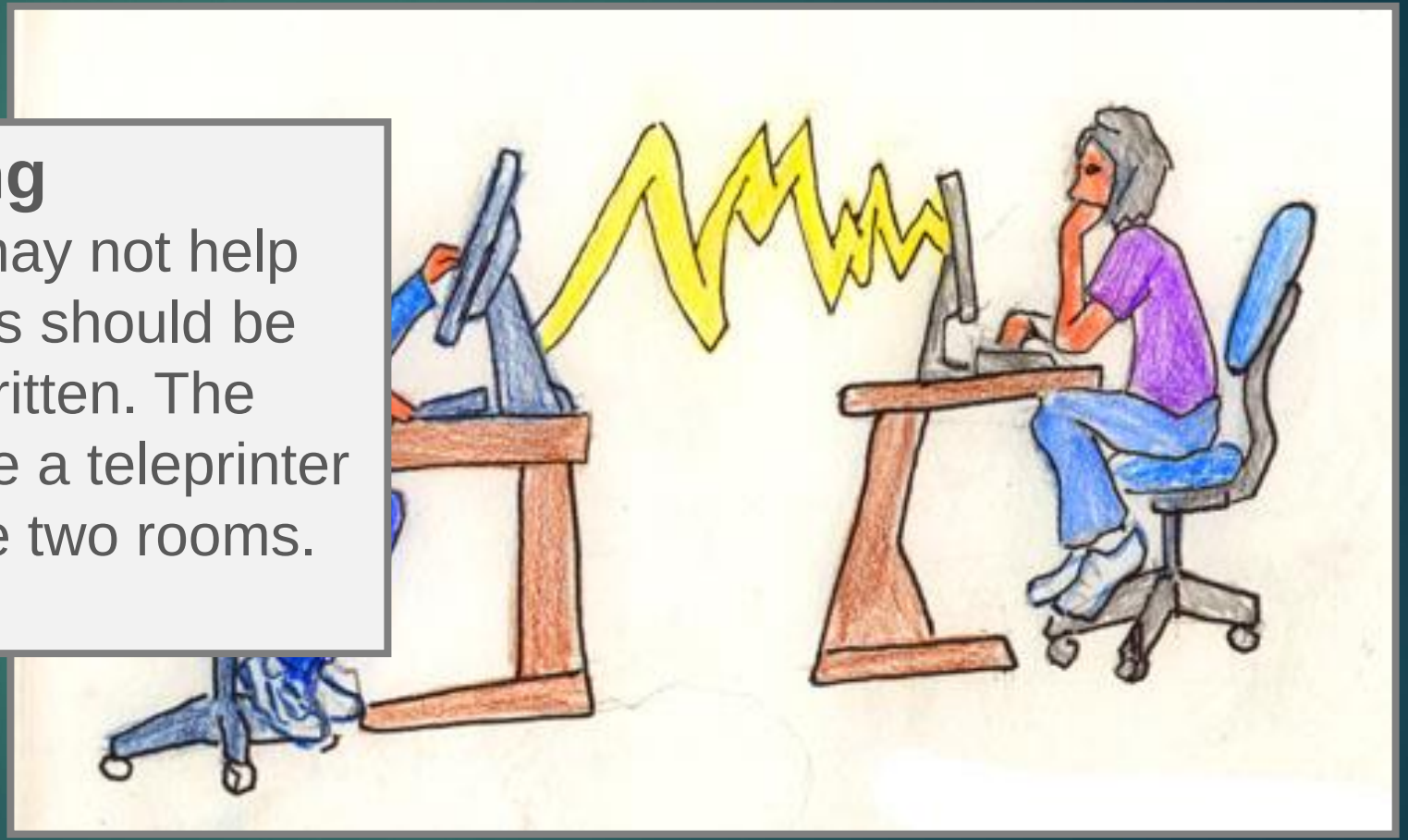
The new form of the problem can be described in terms of a game which we call the 'imitation game.' It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. (Turing,1950)



Review

Chat or Text Messaging

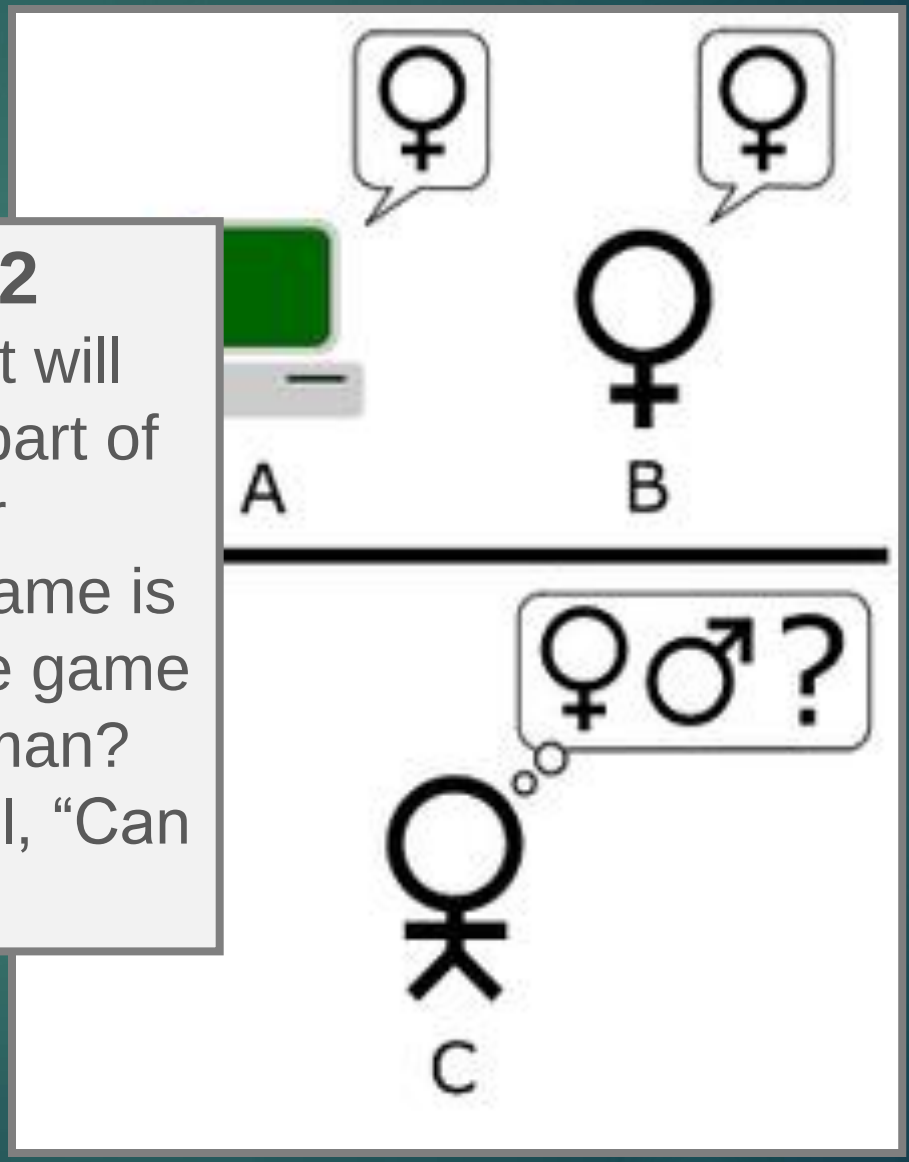
In order that tone of voice may not help the interrogator, the answers should be written, or better still, typewritten. The ideal arrangement is to have a teleprinter communicating between the two rooms. (Turing, 1950)



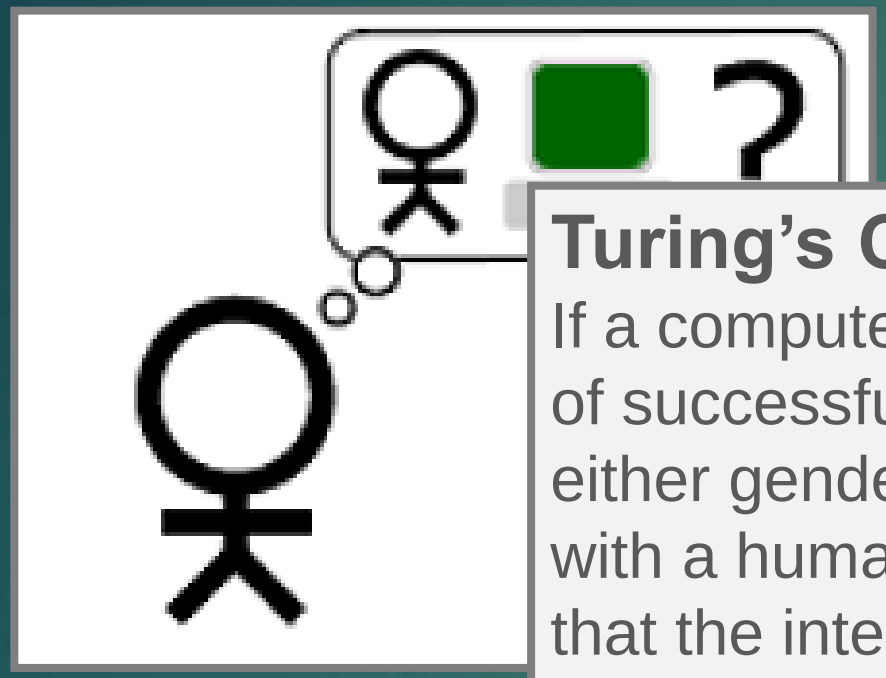
Review

The Imitation Game – phase 2

We can now ask the question, 'What will happen when a machine takes the part of A in this game?' Will the interrogator decide wrongly as often when the game is played like this as he does when the game is played between a man and a woman? These questions replace our original, “Can machines think?” (Turing, 1950)



Review

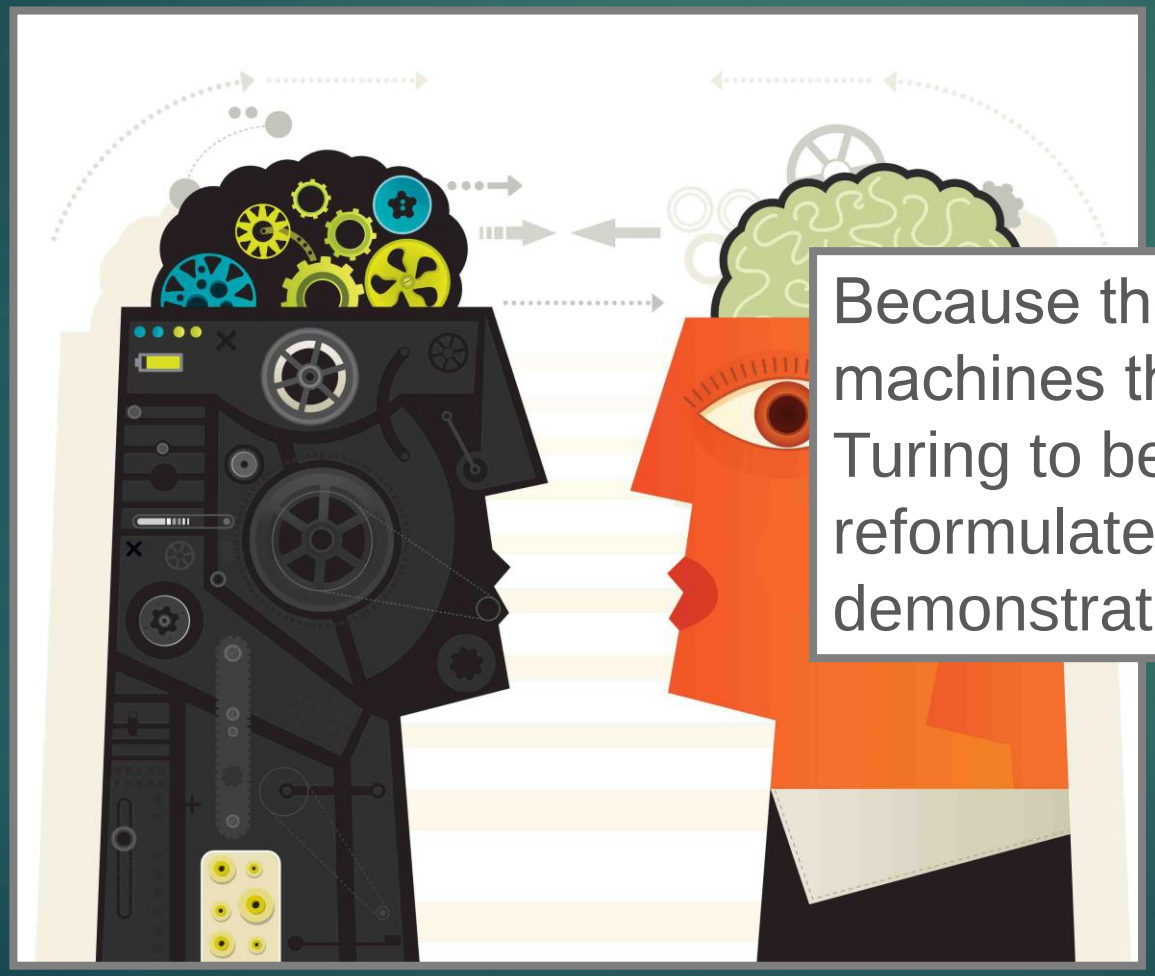


Turing's Conclusion

If a computer does in fact becomes capable of successfully imitating a human being, of either gender, in communicative exchanges with a human interrogator to such an extent that the interrogator cannot tell whether he is interacting with a machine or another human being, then that machine would need to be considered "intelligent."

Review

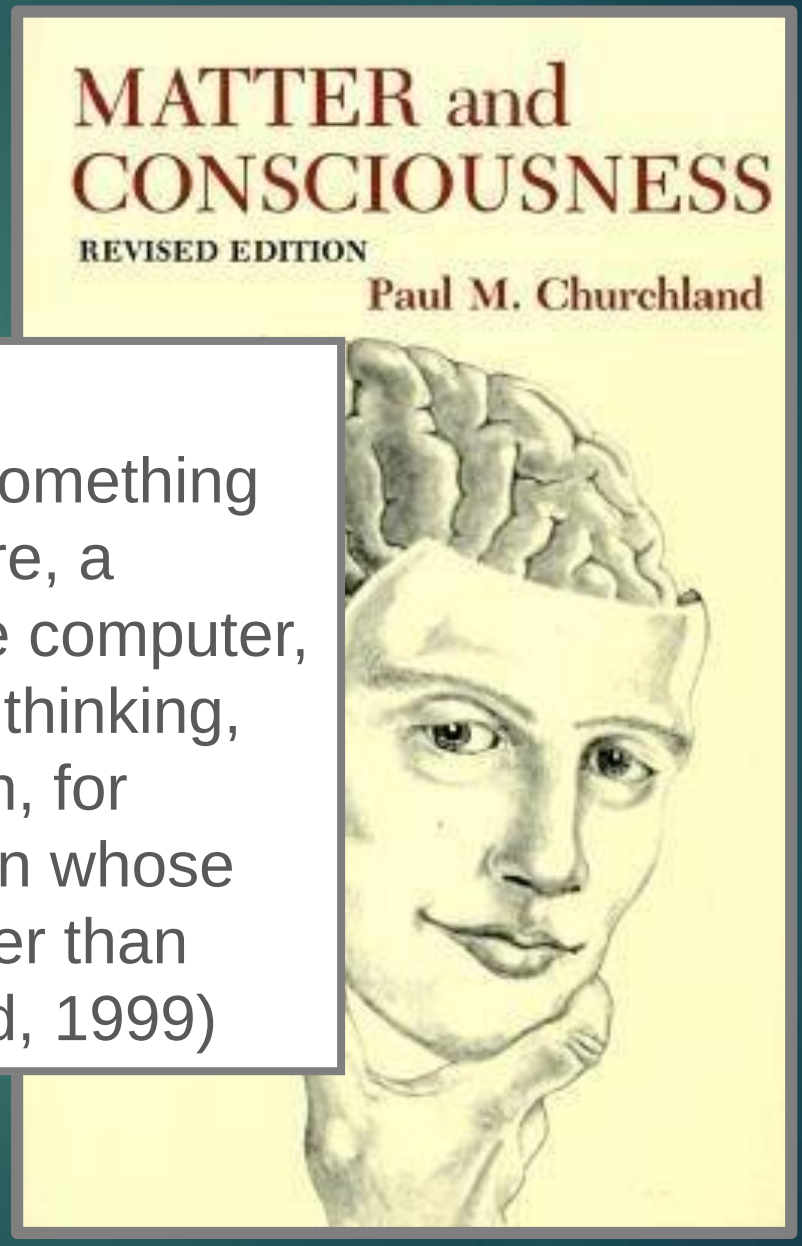
1. Communication is Key



Because the original question “Can machines think?” is considered by Turing to be too meaningless, he reformulates and refers the inquiry to a demonstration of communicative ability.

Review

1. Communication is Key

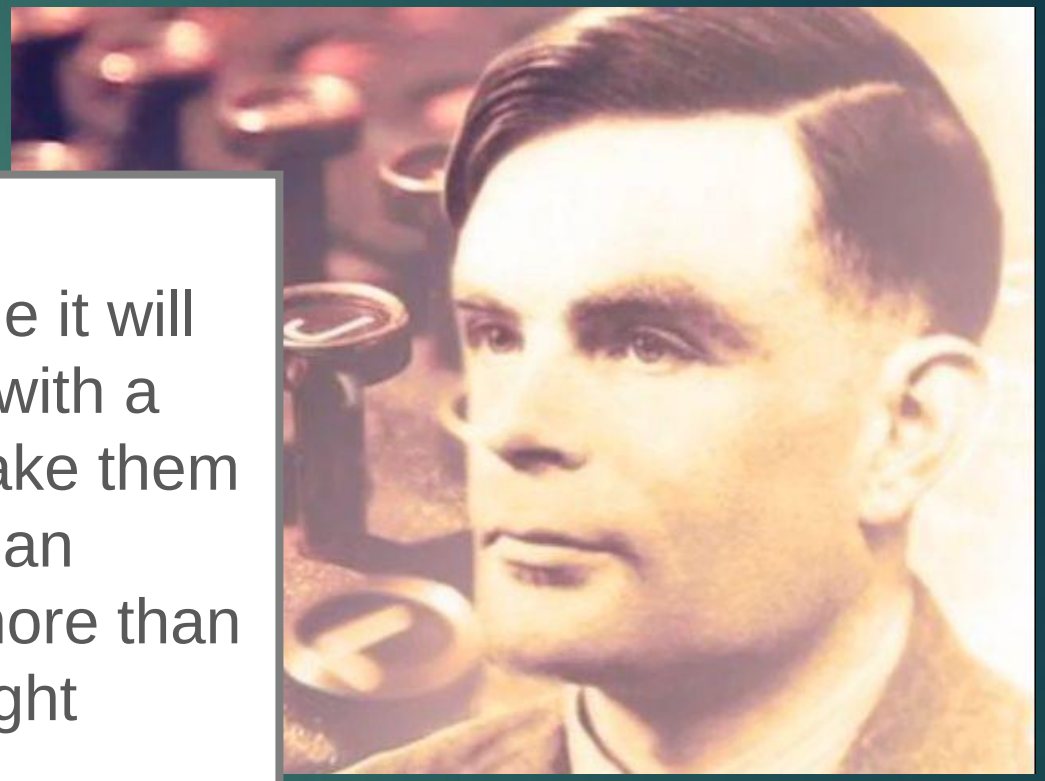


The Other Minds Problem

How does one determine whether something other than oneself—an alien creature, a sophisticated robot, a socially active computer, or even another human—is really a thinking, feeling, conscious being; rather than, for example, an unconscious automaton whose behavior arises from something other than genuine mental states? (Churchland, 1999)

Review

2. Not Too Difficult

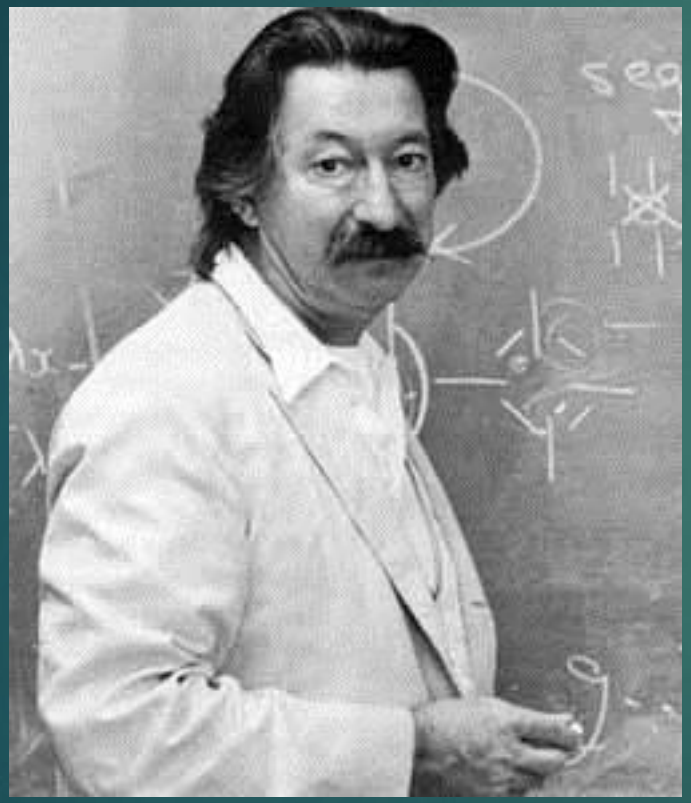


Tipping Point

I believe that in about fifty year's time it will be possible to program 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. (Turing, 1950)

Review

2. Not Too Difficult



Joseph Weizenbaum – ELIZA (1966)

```
Welcome to
                EEEEEE  LL      IIII  ZZZZZZZ   AAAAA
                EE      LL       II       ZZ   AA   AA
                EEEEE   LL       II     ZZZ    AAAAAAA
                EE      LL       II    ZZ      AA   AA
                EEEEEE  LLLLLL  IIII  ZZZZZZZ  AA   AA

 Eliza is a mock Rogerian psychotherapist.
 The original program was described by Joseph Weizenbaum in 1966.
 This implementation by Norbert Landsteiner 2005.

ELIZA: Is something
YOU:   Men are all
ELIZA: What is the
YOU:   They're alway
ELIZA: Can you think
YOU:   Well, my boyi
ELIZA: Is it importa
YOU:   He says I'm
ELIZA: I am sorry to
YOU:   It's true. I
ELIZA: Can you expla
YOU:
```

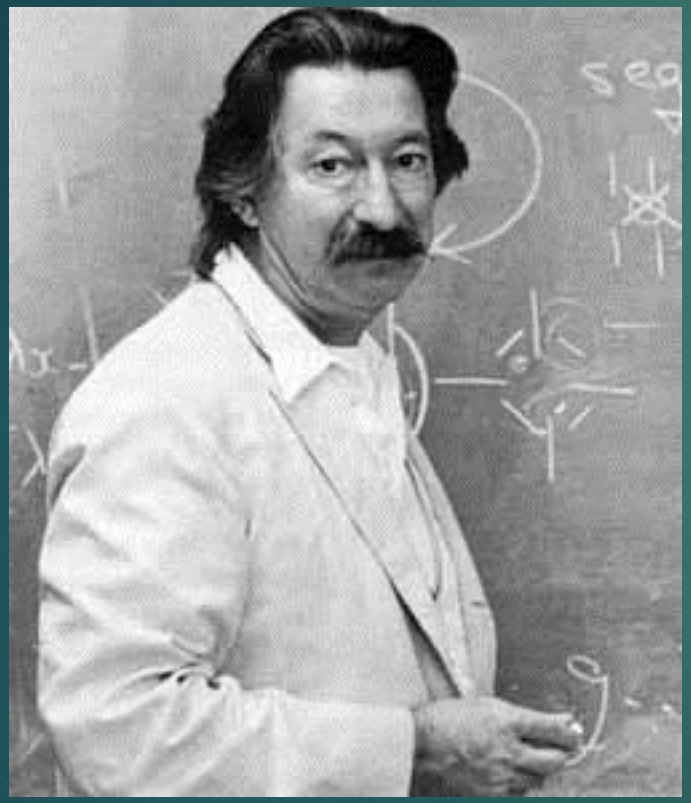
Talk to Eliza

> Hello, I am Eliza.

Input:

Review

2. Not Too Difficult



Joseph Weizenbaum – ELIZA (1966)

ELIZA created the most remarkable illusion of having understood in the minds of many people who conversed with it. People who know very well that they were conversing with a machine soon forgot that fact, just as theatergoers, in the grip of suspended disbelief, soon forget that the action they are witnessing is not 'real.' This illusion was especially strong and most tenaciously clung to among people who know little or nothing about computers. They would often demand to be permitted to converse with the system in private, and would, after conversing with it for a time, insist, in spite of my explanations, that the machine really understood them. (Weizenbaum, 1966)

Review

2. Not Too Difficult

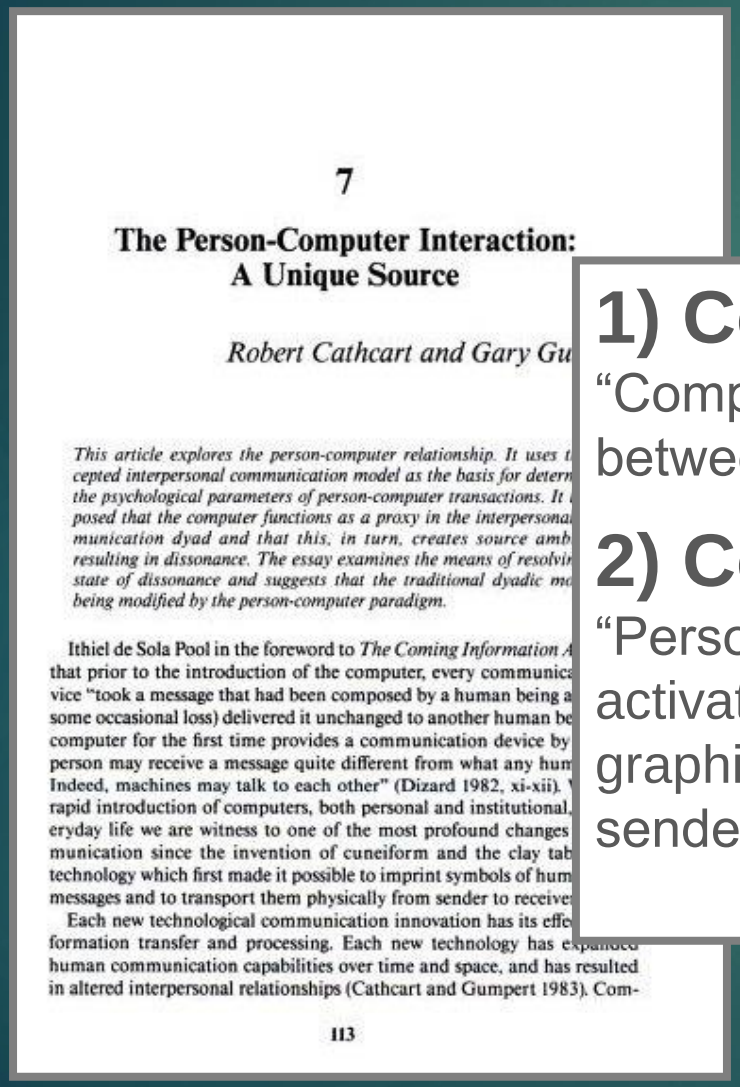
```
1
2  <html>
3  <body>
4
5  <script language="javascript">
6
7  response1 = prompt("I am ELIZA. How can I help you?");
8
9  if (response1)
10 response2 = prompt("What is your name?");
11
12 if (response2)
13 response3 = prompt("Hello, " + response2 + " What would you like to talk about?");
14
15 if (response3)
16 response4 = prompt("Is this something that worries you?");
17
18 if (response4)
19 response5 = prompt("Why is that? Tell me more about it.");
20
21 </script>
22
23 <a href="eliza_demo.html">Start Again</a>
24
25 </body>
26 </html>
27
```

Questions

- "Artificial"
  - Is this "real" communication by another means?
  - Or is it deceptive communication or a fake form of communication?
- What is the difference? Does it matter?

John Searle – *Chinese Room* (1980)

Review



7

The Person-Computer Interaction: A Unique Source

Robert Cathcart and Gary Gu

This article explores the person-computer relationship. It uses t cepted interpersonal communication model as the basis for deterr the psychological parameters of person-computer transactions. It posed that the computer functions as a proxy in the interpersona munication dyad and that this, in turn, creates source amb resulting in dissonance. The essay examines the means of resolvi state of dissonance and suggests that the traditional dyadic mo being modified by the person-computer paradigm.

Ithiel de Sola Pool in the foreword to *The Coming Information A* that prior to the introduction of the computer, every communica vice "took a message that had been composed by a human being a some occasional loss) delivered it unchanged to another human be computer for the first time provides a communication device by person may receive a message quite different from what any hum Indeed, machines may talk to each other" (Dizard 1982, xi-xii). rapid introduction of computers, both personal and institutional. eryday life we are witness to one of the most profound changes munication since the invention of cuneiform and the clay tab technology which first made it possible to imprint symbols of hum messages and to transport them physically from sender to receive

Each new technological communication innovation has its effe formation transfer and processing. Each new technology has e human communication capabilities over time and space, and has resulted in altered interpersonal relationships (Cathcart and Gumpert 1983). Com-

113

"Back to the Future" moment for Communication Studies

1) Communicating *through* a Computer

"Computer facilitated functions where the computer is interposed between sender and receiver."

2) Communicating *with* a Computer

"Person-computer interpersonal functions where one party activates a computer which in turn responds appropriately in graphic, alphanumeric, or vocal modes establishing an ongoing sender/receiver relationship"

(Cathcart & Gumpert, 1985)

Spectrum of Human Computer Communication

Computer as medium *through* which human users exchange data

Computer as intelligent agent *with* whom human users interact

CMC

Computer Mediated Communication

The Opportunity/Challenge

COMS has a lot to contribute to the field of AI and robotics but only if we alter our way of thinking about the machine.

The machine is not just a thing ***through*** which we talk to each other but it is an Other ***with*** which we communicate.

Spectrum of Human Computer Communication

Computer as medium *through* which human users exchange data

Computer as intelligent agent *with* whom human users interact

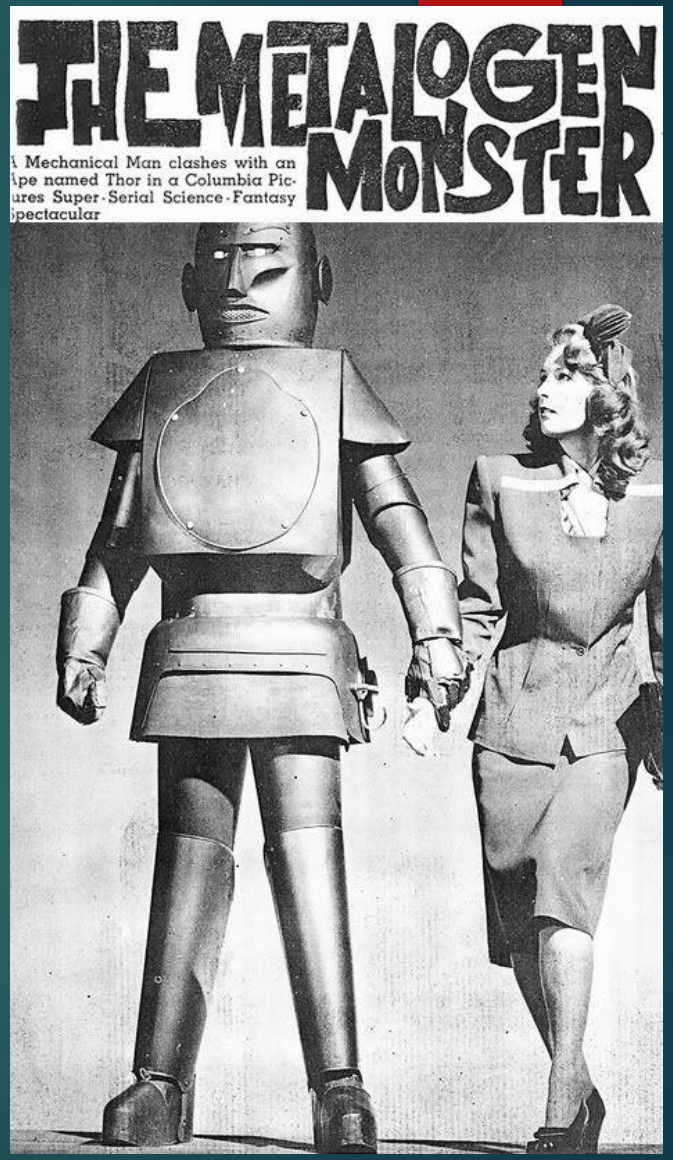
CMC
Computer Mediated Communication

HMC
Human Machine Communication

History, Hype & Reality

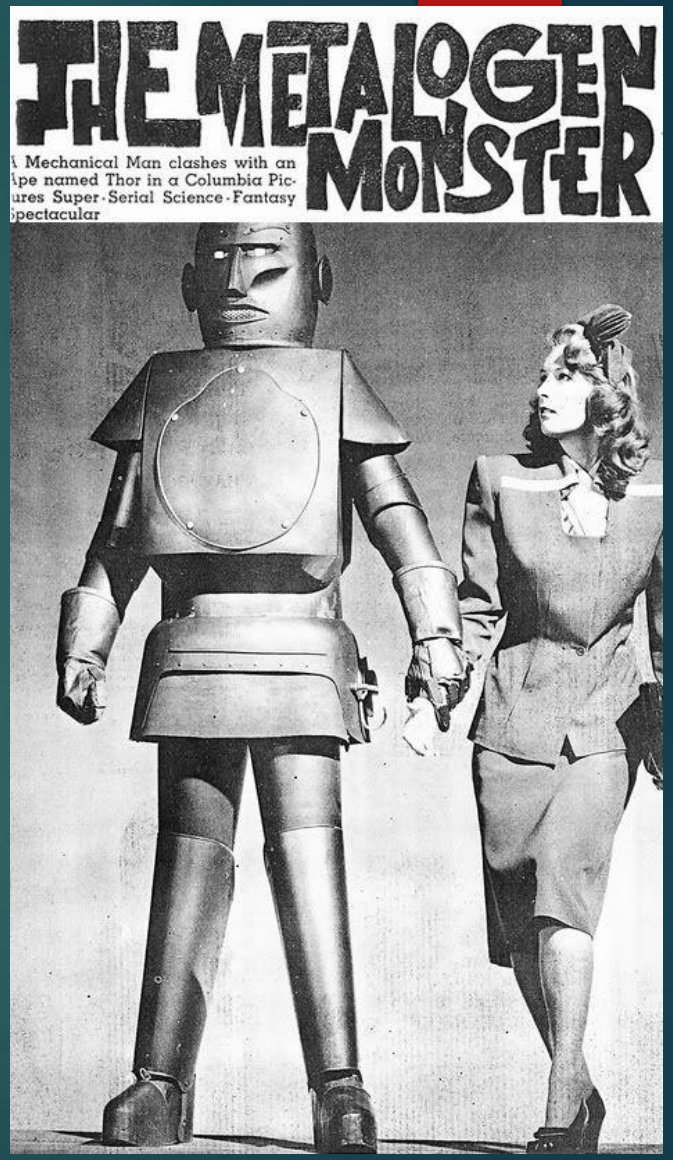
- **Objective:** Demystify Technology

  Sort science fiction from science fact by looking at the history of artificial intelligence and robotics, the hype that has surrounded the technology and its social consequences as portrayed in fiction, and the reality of AI/robots as they exists right now at the beginning of the 21st century.

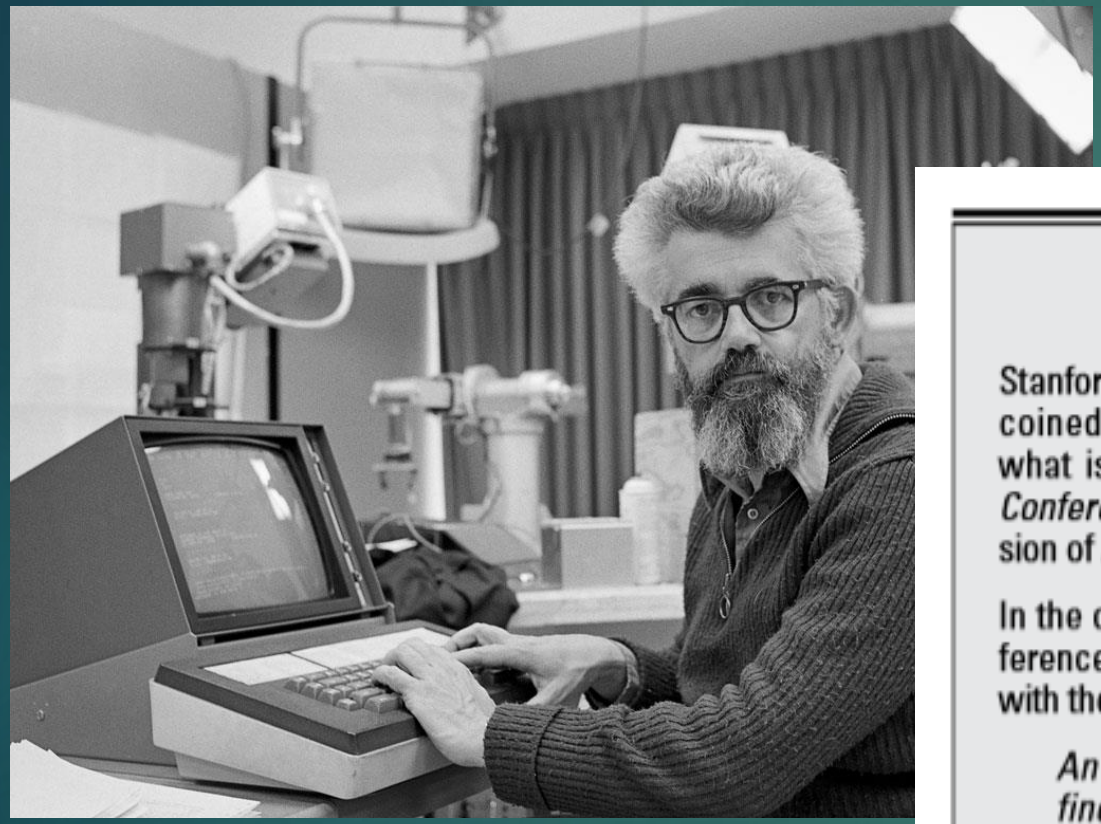


History, Hype & Reality

- Terminology
  - Artificial Intelligence
  - Robot
- Science Fiction
- History
- Research & Development
  - GOFAI vs. Machine Learning
  - Real World Applications



Artificial Intelligence



John McCarthy

The Dartmouth Conference

Stanford researcher John McCarthy coined the term in 1956 during what is now called *the Dartmouth Conference,* in which the core mission of AI was defined.

In the original proposal for the conference, McCarthy framed the effort with the following:

> *An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.*

— John McCarthy, Marvin Minsky, Nathan Rochester, and Claude Shannon, "A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence" (1955)

Artificial Intelligence

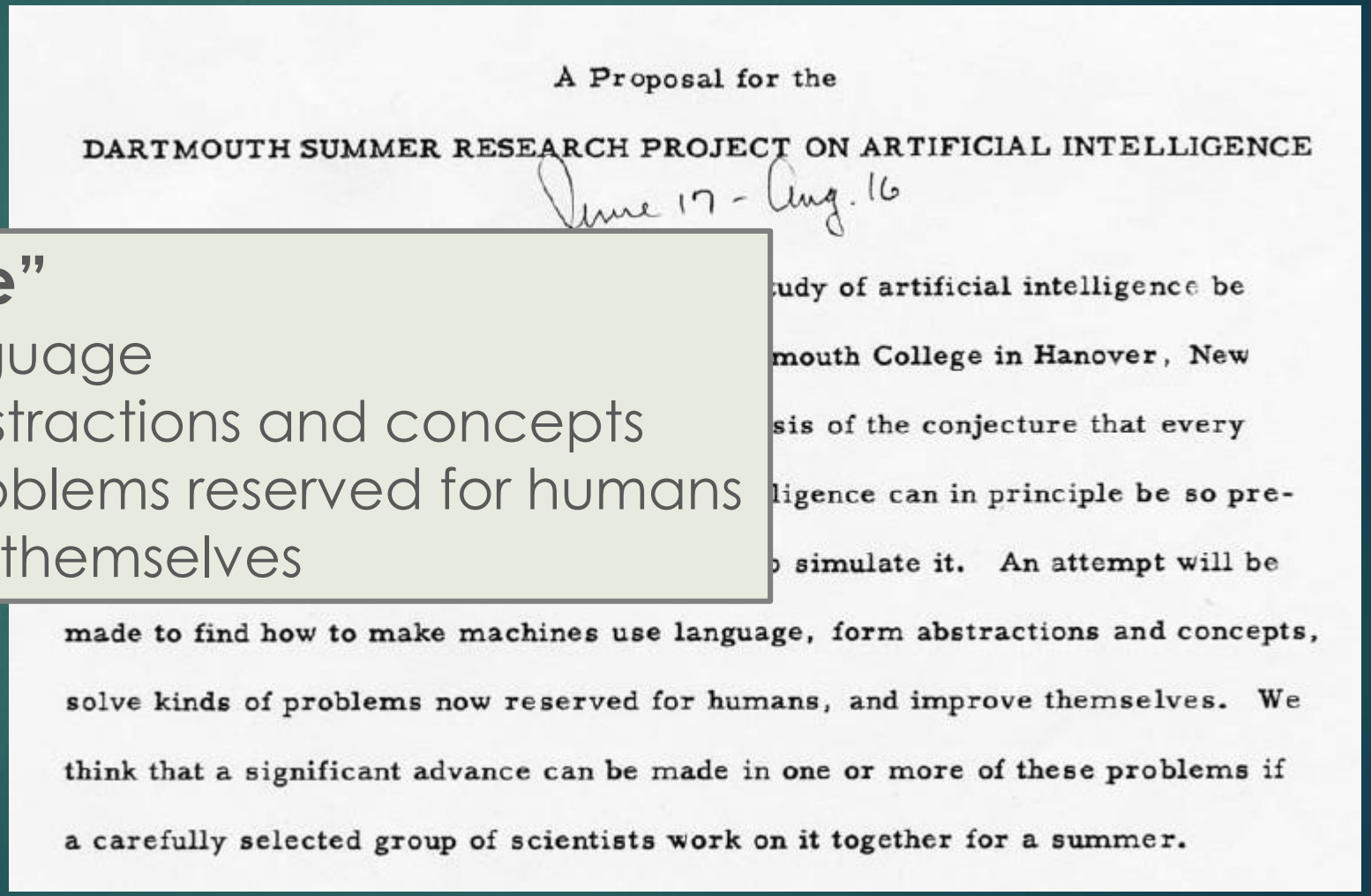
A Proposal for the

DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE

June 17 - Aug. 16

We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.

Artificial Intelligence



A Proposal for the

DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE

June 17 - Aug. 16

udy of artificial intelligence be

mouth College in Hanover, New

sis of the conjecture that every

ligence can in principle be so pre-

simulate it. An attempt will be

made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.

"Intelligence"

- Use Language
- Form abstractions and concepts
- Solve problems reserved for humans
- Improve themselves

Artificial Intelligence

Intelligence – Critical Features

1. *Communication* – "An intelligent entity can be communicated with. We can't talk to rocks or tell trees what we want."

2. *Internal Knowledge* – "We expect intelligent entities to have some knowledge about themselves"

3. *World Knowledge* – "Intelligence also involves being aware of the outside world and being able to find and utilize the information one has about the outside world"

4. *Goals and Plans* – "Goal driven behavior means knowing when one wants something and knowing a plan to get what one wants"

5. *Creativity* – "Every intelligent entity is assumed to have some degree of creativity"

Roger Schank "What is AI, Anyway?"

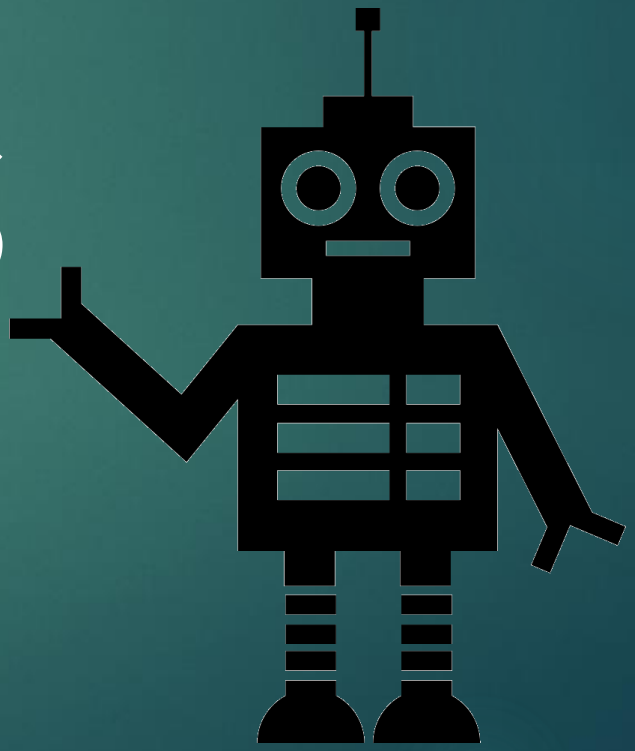
Artificial Intelligence

- "Artificial"?

Natural Intelligence

VS

Artificial Intelligence



Artificial Intelligence

- "Artificial"?

Robert Sokolowski

Natural and Artificial Intelligence

IN THIS ESSAY we will not attempt to decide whether artificial intelligence is the same as natural intelligence. Instead we will examine some of the issues and terms that must be clarified before that question can be resolved. We will discuss how the question about the relationship between natural and artificial intelligence can be formulated.

One of the first things that must be clarified is the ambiguous word *artificial*. This adjective can be used in two senses, and it is important to determine which one applies in the term *artificial intelligence*. The word *artificial* is used in one sense when it is applied, say, to flowers, and in another sense when it is applied to light. In both cases something is called artificial because it is fabricated. But in the first usage artificial means that the thing seems to be, but really is not, what it looks like. The artificial is the merely apparent; it just shows how something else looks. Artificial flowers are only paper, not flowers at all; anyone who takes them to be flowers is mistaken. But artificial light is light and it does illuminate. It is fabricated as a substitute for natural light, but once fabricated it is what it seems to be. In this sense the artificial is not the merely apparent, not simply an imitation of something else. The appearance of the thing reveals what it is, not how something else looks.

Artificial Intelligence

- "Artificial"?

Fake or Imitation
The thing seems to be, but really is not, what it looks like.

Substitute or Simulation
The thing is not just an imitation of something else but really is what it seems to be.

Artificial Intelligence

- Questions
  - Is Artificial Intelligence "fake" intelligence?
  - Is Artificial Intelligence "simulated" intelligence?
  - What would be the difference and how could you tell?

In which sense do we use the word *artificial* when we speak of artificial intelligence? Critics of artificial intelligence, those who disparage the idea and say it has been overblown and oversold, would claim that the term is used in the first sense, to mean the merely apparent. They would say that artificial intelligence is really nothing but complex mechanical structures and electrical processes that present an illusion (to the gullible) of some sort of thinking. Supporters of the idea of artificial intelligence, those who claim that the term names something genuine and not merely apparent, would say that the word *artificial* is used in the second of the senses we have distinguished. Obviously, they would say, thinking machines are artifacts; obviously they are run by human beings; but once made and set in motion, the machines do think. Their thinking may be different from that of human beings in some ways, just as the movement of a car is different from that of a rabbit and the flight of an airplane is different from that of a bird, but it is a kind of genuine thinking, just as there is genuine motion in the car and genuine flight in the plane.

Artificial Intelligence

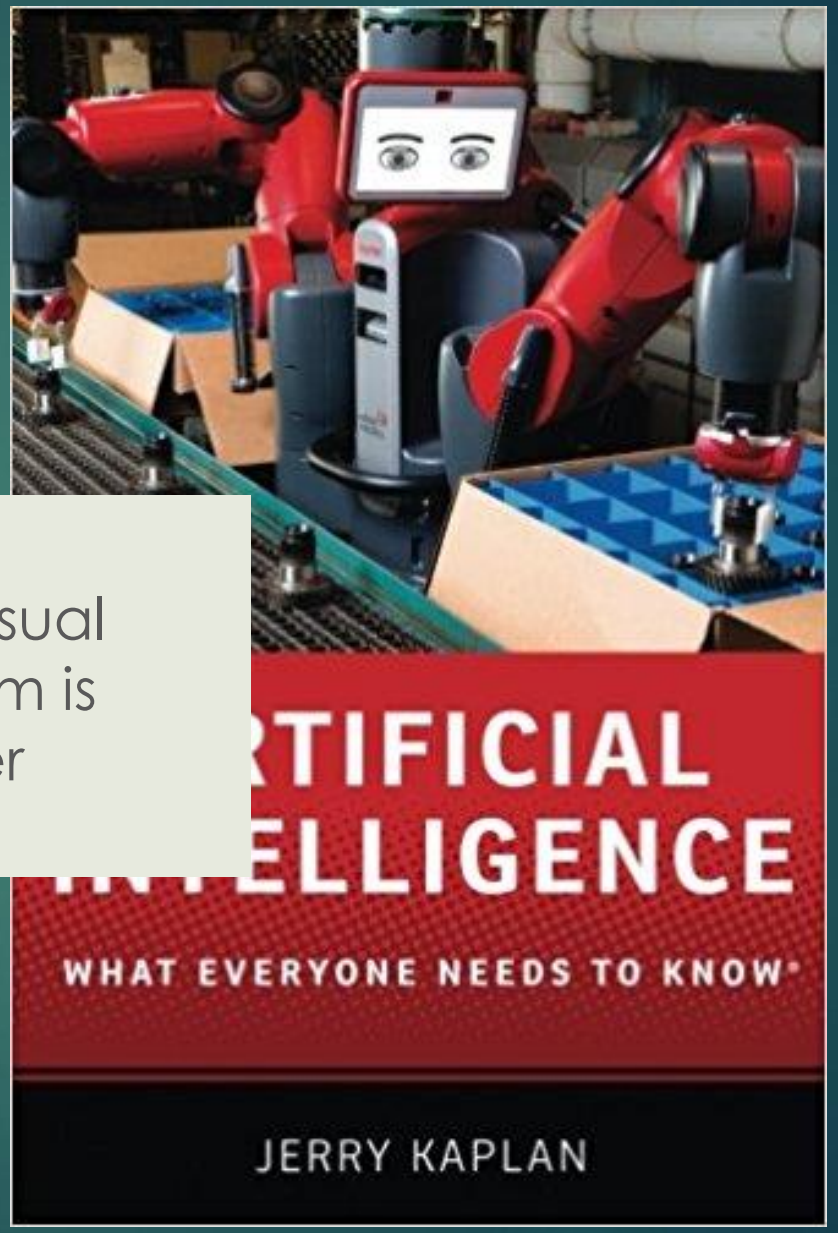
AI – Problem with Definition

"Artificial intelligence is a subject that, due to the massive, often quite unintelligible, publicity that it gets, is nearly completely misunderstood by the people outside the field. Even AI's practitioners are somewhat confused with respect to what AI is really about."

Roger Schank "What is AI, Anyway?"

Artificial Intelligence

Another Problem - Moving Target
"But the field of AI suffers from an unusual deficiency—once a particular problem is considered solved, it often is no longer considered AI." – Kaplan p. 37



Artificial Intelligence

Moving Target
Example 1 = Chess

Garry Kasparov vs. Deep Blue (1997)

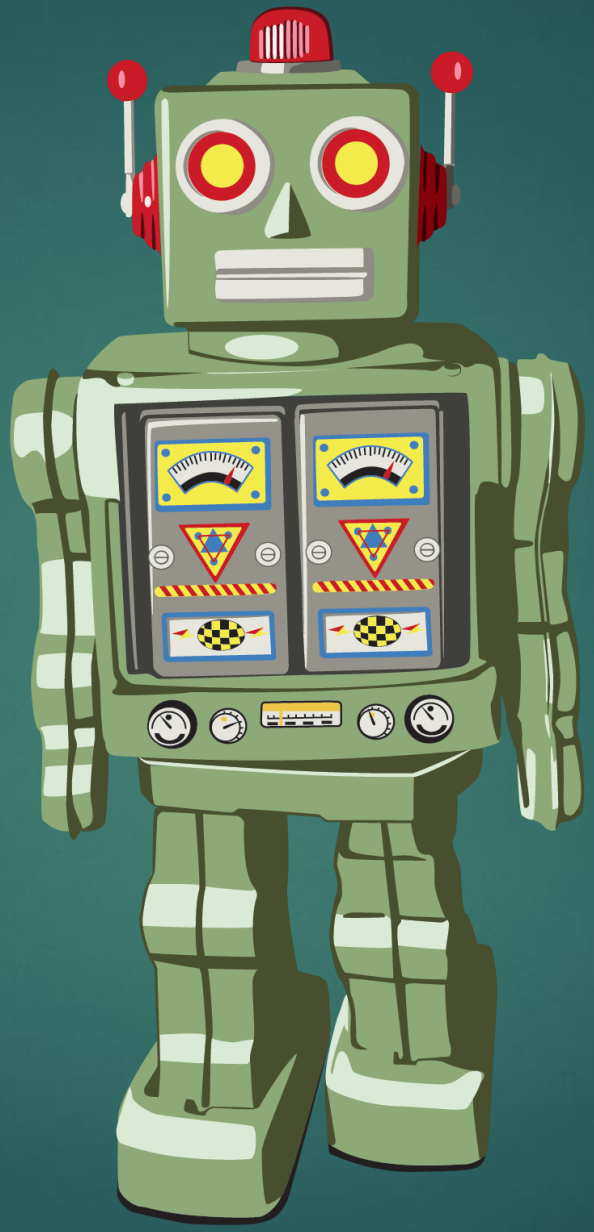
Artificial Intelligence

Moving Target
Example 2 = Jeopardy

"I for one, welcome our new computer overlords"
- Ken Jennings

IBM Watson beats Ken Jennings and Brad Rutter in February 2011.

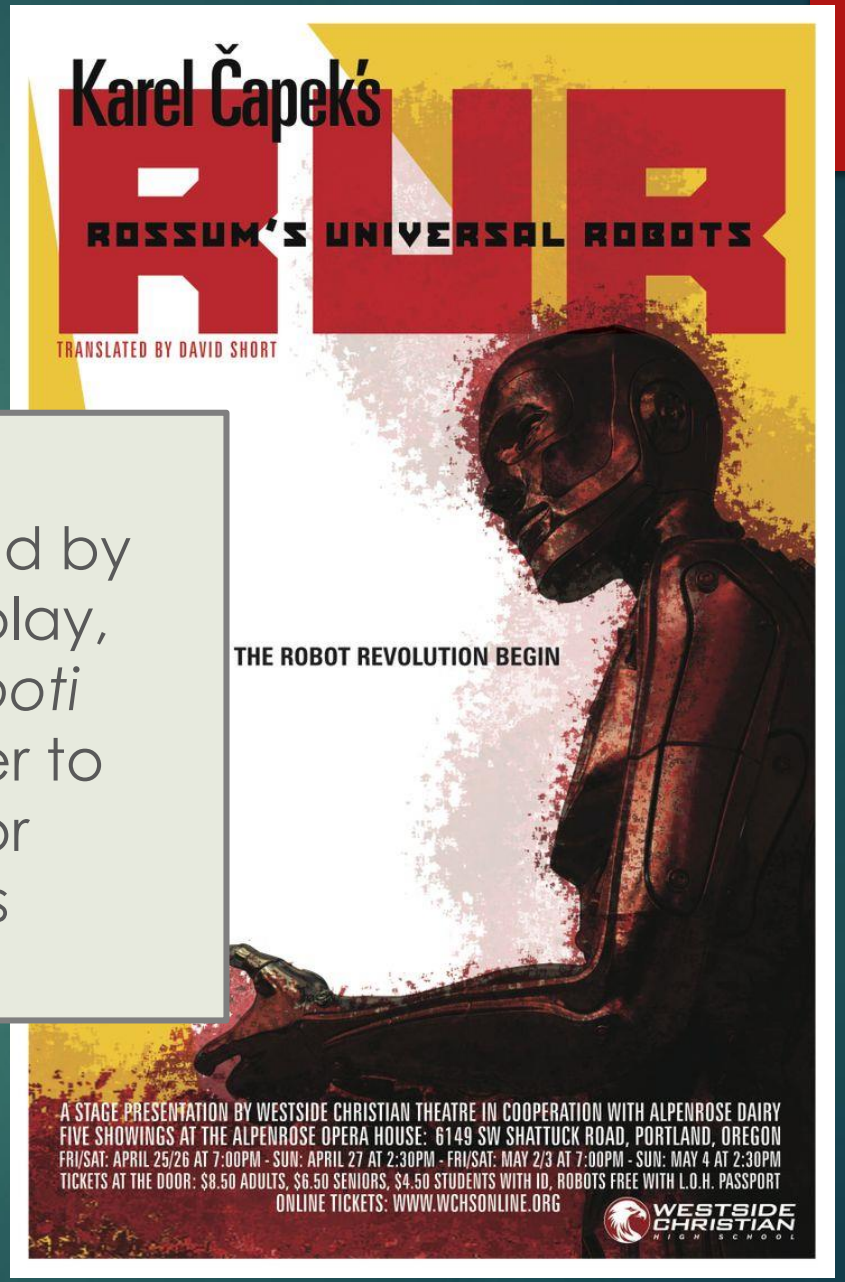
Robot



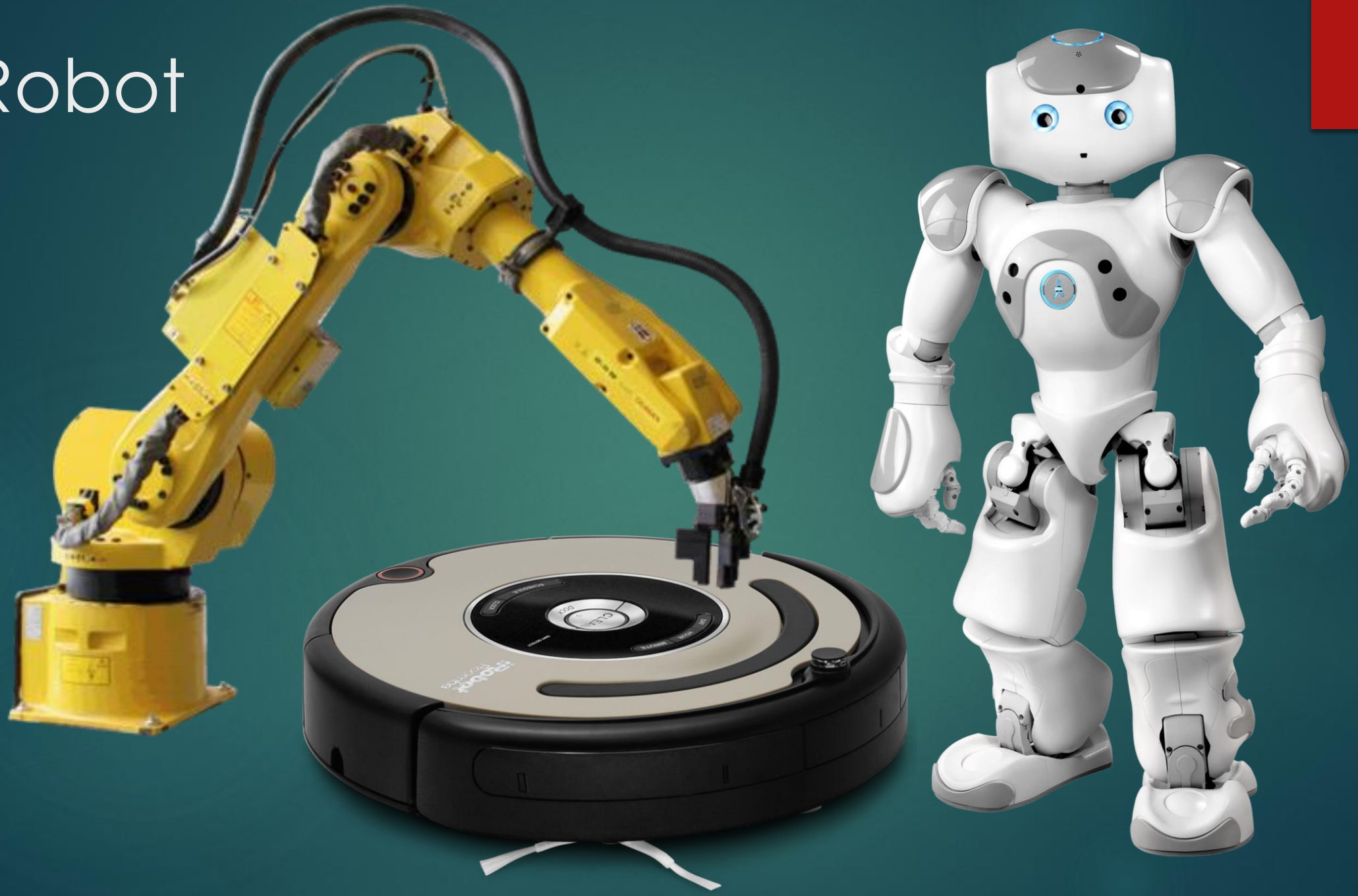
Robot

Robot

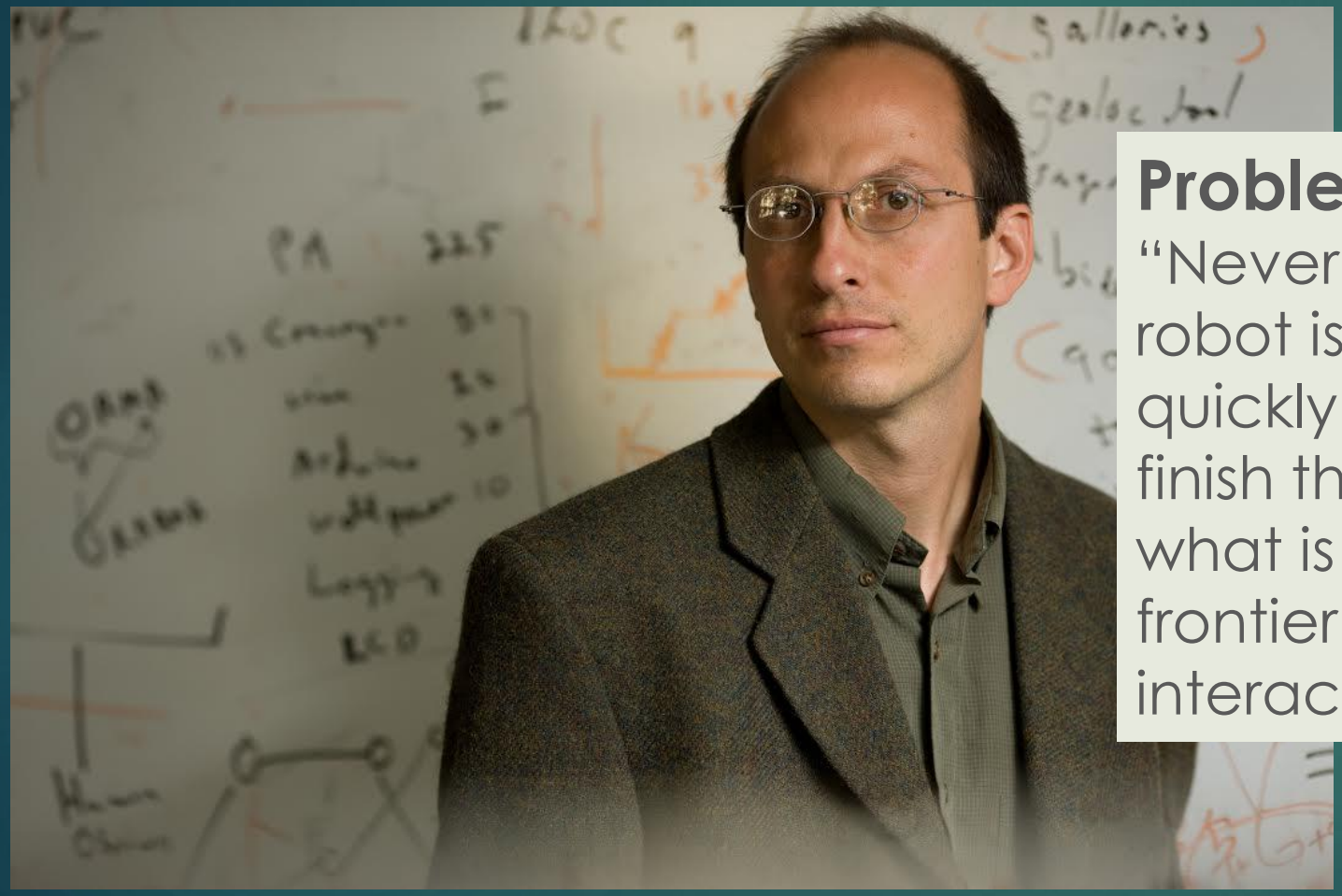
The word **robot** came into the world by way of Karel Čapek's 1920 stage play, R.U.R. or *Rossumovi Univerzální Roboti* (Rossum's Universal Robots) in order to name a class of artificial servants or laborers. In Czech "robota" means servant or slave.



Robot



Robot



Illah Nourbakhsh – Professor of Robotics CMU

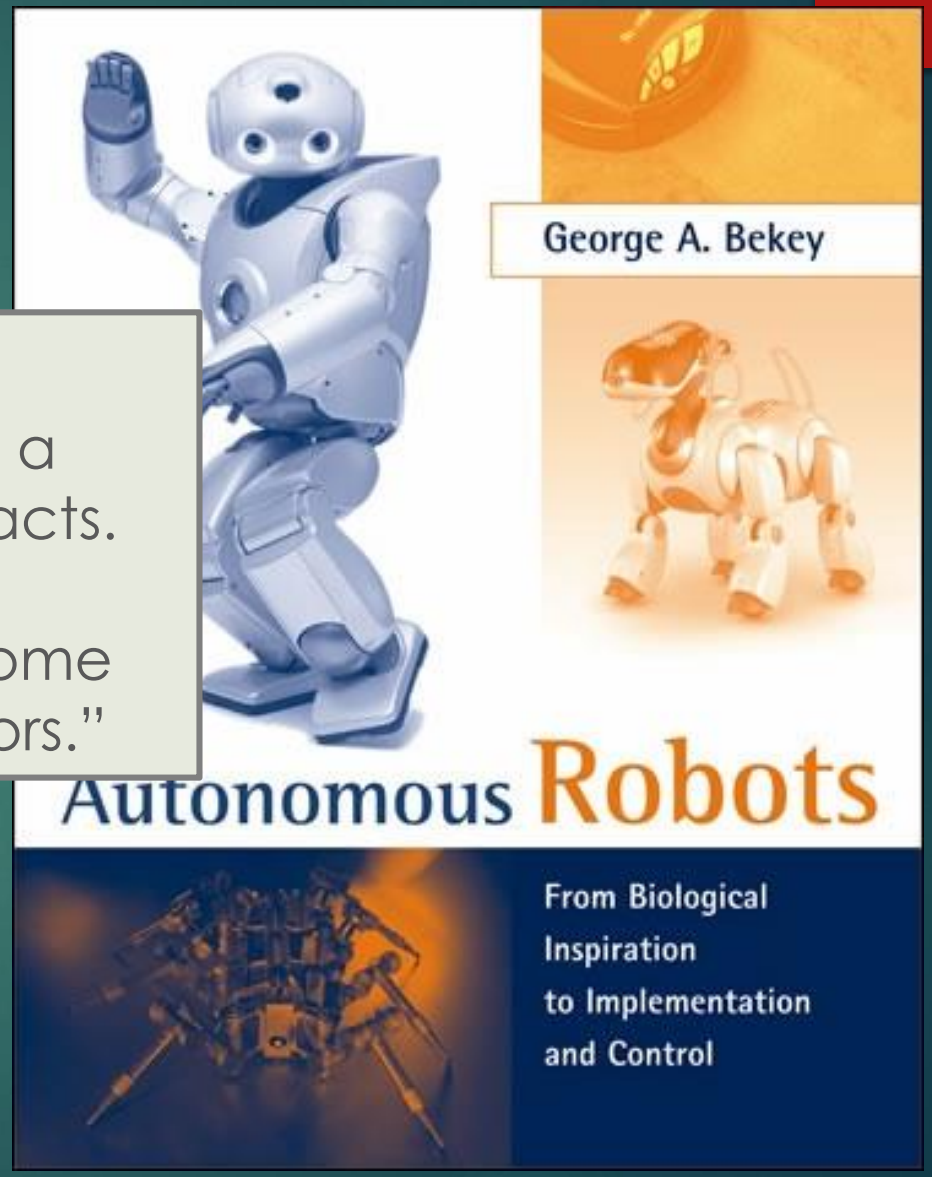
Problem with Definition

"Never ask a roboticist what a robot is. The answer changes too quickly. By the time researchers finish their most recent debate on what is and what isn't a robot, the frontier moves on as whole new interaction technologies are born."

Robot

Sense-Act-Think Paradigm

"In this book we define a robot as a machine that senses, thinks, and acts. Thus, a robot must have sensors, processing ability that emulates some aspects of cognition, and actuators."



Robot

1. Sense
Speech Recognition

Figure 2-2: A waveform generated when an intelligent assistant captures voice.

Robot

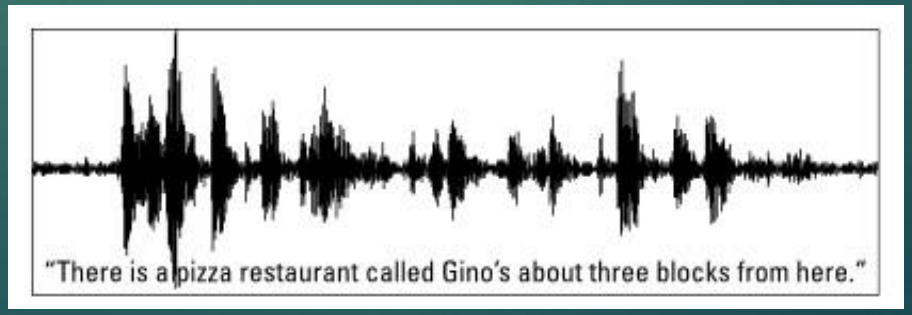
2. Think
Make Inferences

Move from the captured sound to words to ideas to user needs. In this case, the system identifies the word “pizza” from the input. Infers that the user wants to get a pizza. It therefore accesses GPS info, looks up restaurants that serve pizza, and ranks them according to some criteria like location, rating, or price.

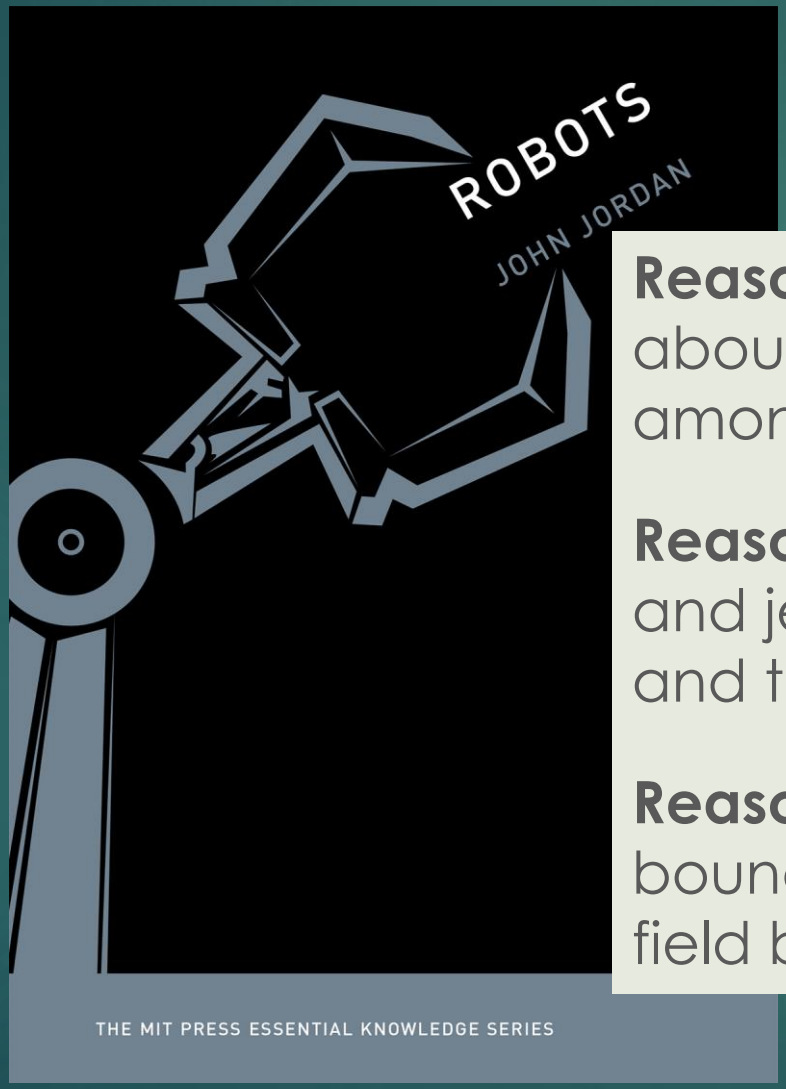
Robot

3. Act
Communicate Results

This involves organizing the results into a reasonable set of ideas to be communicated, mapping the ideas onto a sentence or two (natural language generation), and then turning those words into sounds (speech synthesis).



Robot

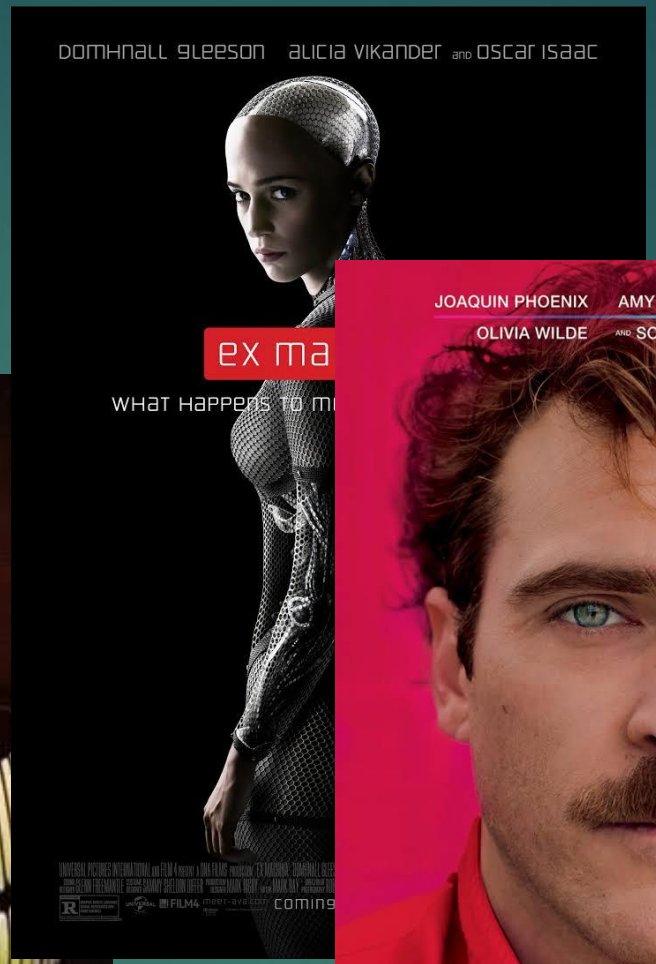


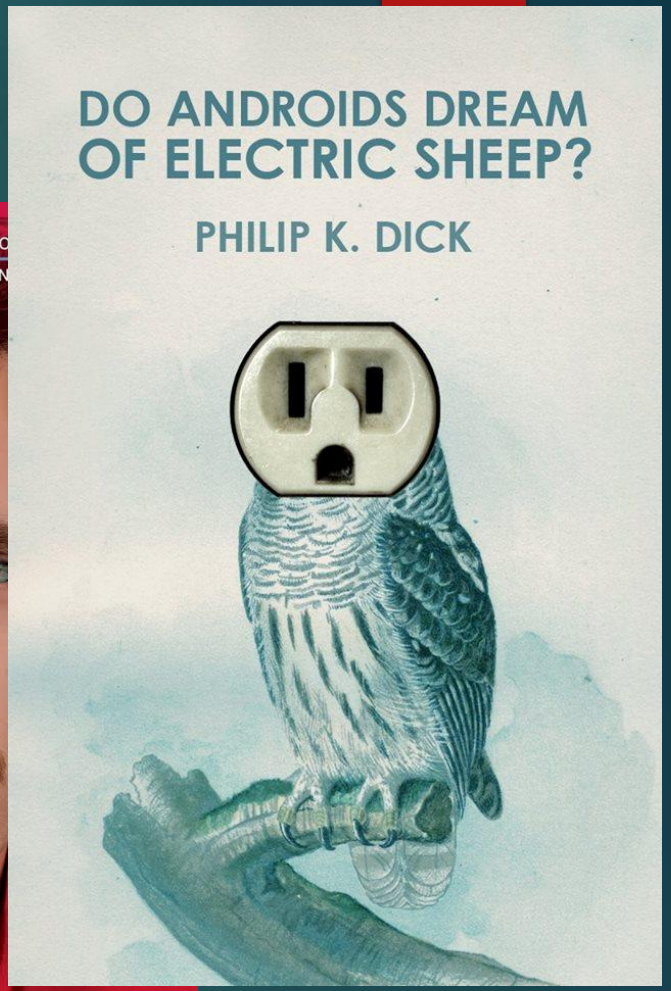
Reason 1: why robots are hard to talk about: the definition is unsettled, even among those most expert in the field.

Reason 2: definitions evolve unevenly and jerkily, over time as social context and technical capabilities change.

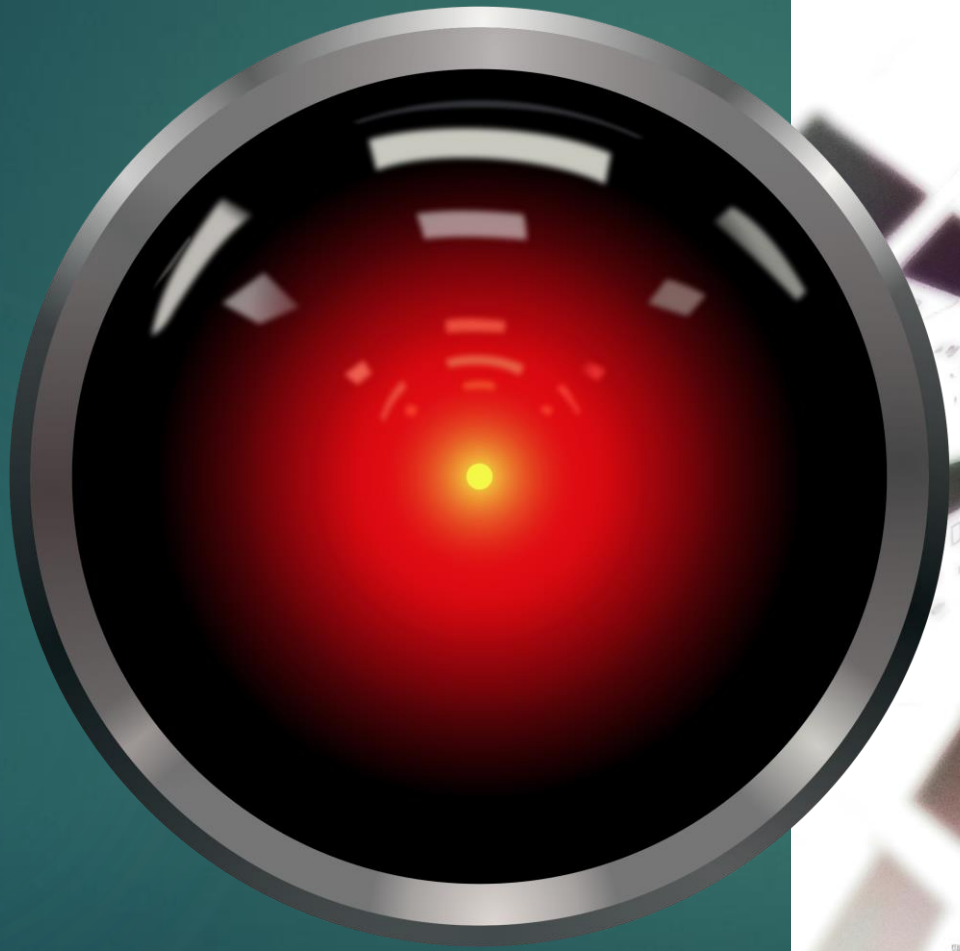
Reason 3: science fiction set the boundaries of the conceptual playing field before the engineers did.

Science Fiction





Science Fiction



http://www.tcm.com/mediaroom/video/474156/2001-A-Space-Odyssey-Movie-Clip-HAL-9000.html

Science Fiction

https://www.youtube.com/watch?v=ne6p6MfLBxc

Science Fiction

https://www.youtube.com/watch?v=BV8qFeZxZPE

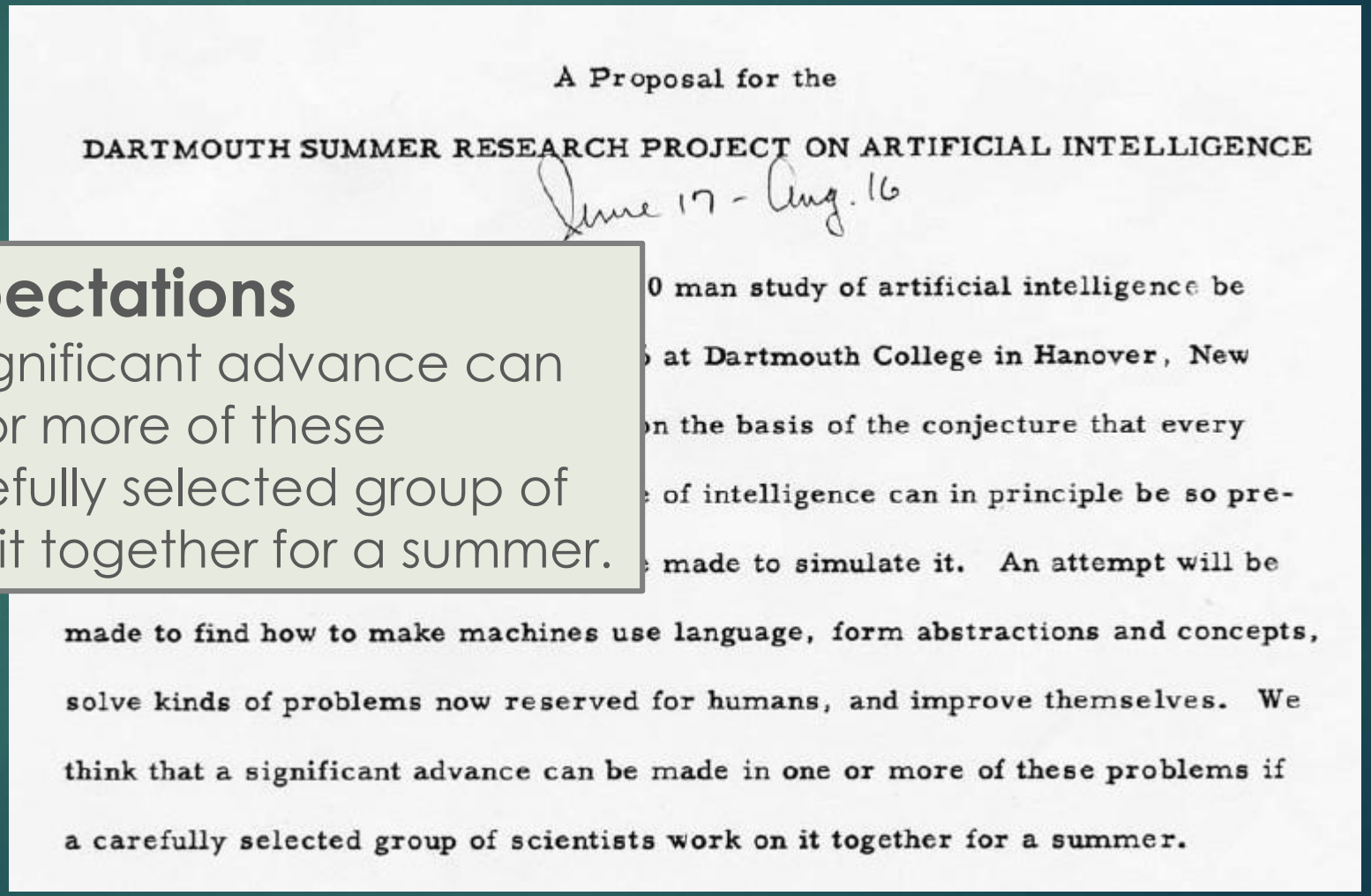
Science Fiction

- Questions
  - Why all these AI/Robot films and TV shows? Why now?
  - What are these AI/robot narratives about?
  - What expectations about AI and robots are produced or supported by these fictional representations?
  - What are the advantages and disadvantages of the "conceptual playing field" set up by science fiction?

Reality

Optimism/Expectations

We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.



A Proposal for the

DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE

June 17 - Aug. 16

0 man study of artificial intelligence be

at Dartmouth College in Hanover, New

n the basis of the conjecture that every

of intelligence can in principle be so pre-

made to simulate it. An attempt will be

made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.

Reality

Optimism

Downturn
"AI Winters"

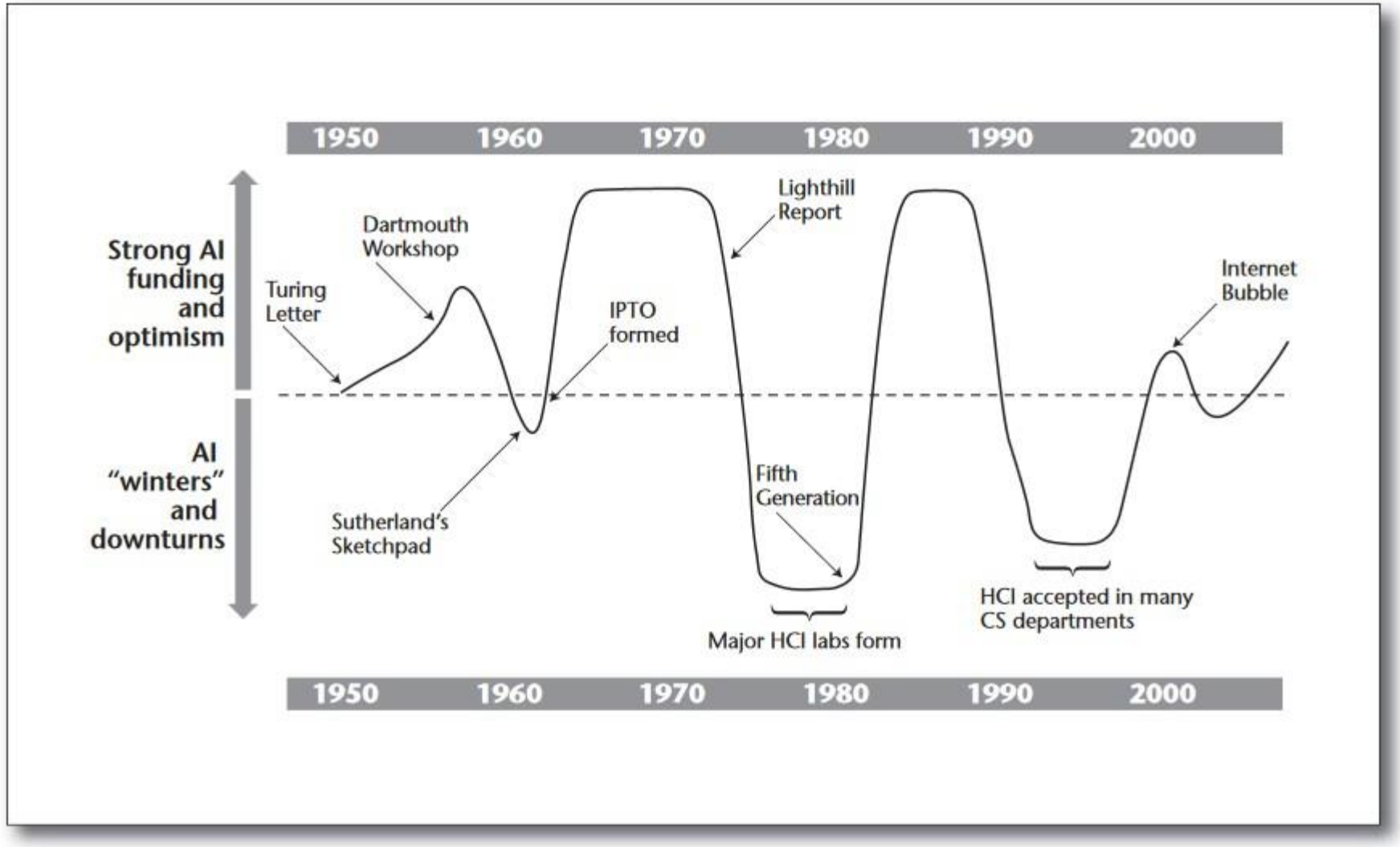
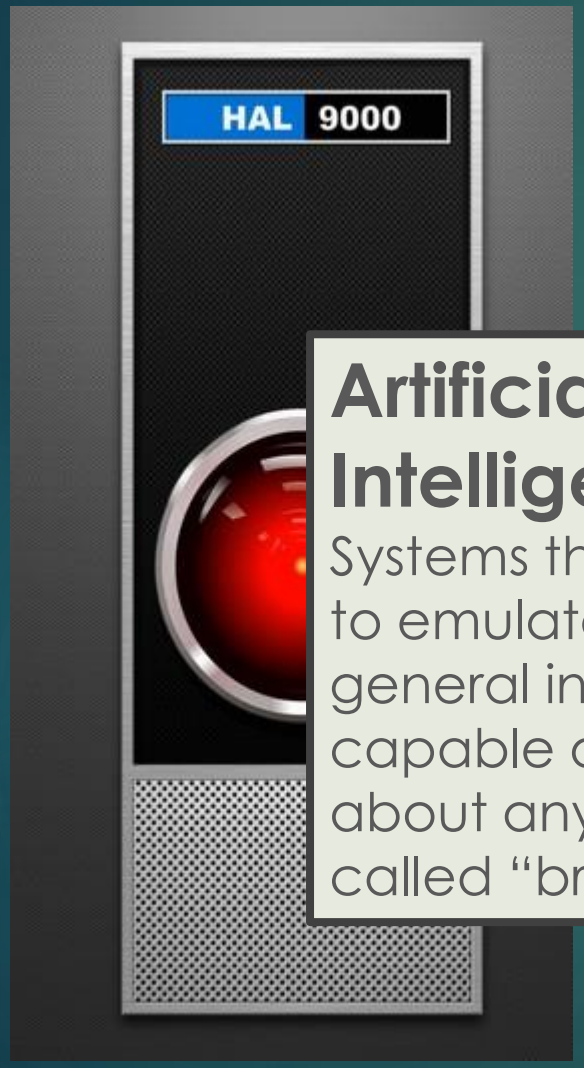


Figure 1. The Changing Seasons of AI and HCI.

Funding climate and public perception with three HCI high points.

Reality



Artificial General Intelligence (AGI)
Systems that are designed to emulate human-like general intelligence capable of reasoning about any subject. Also called "broad AI."

Narrow AI
Systems that are designed to accomplish a specific tasks. Instead of "reasoning" about the world in general, these systems have discrete capabilities to perform specific practical tasks

Approaches and Methods

Simplifying Statement

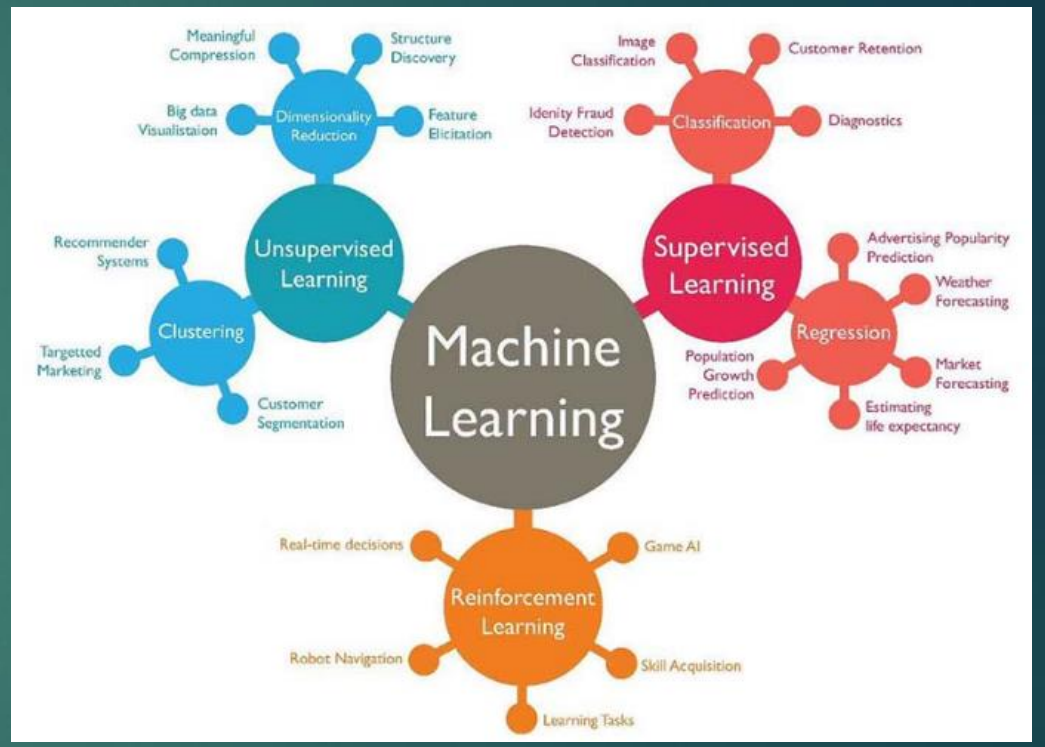
We can use logical rules to simplify a logical formula.

$$\neg(\neg p \wedge q) \wedge (p \vee q)$$
$$\equiv (\neg\neg p \vee \neg q) \wedge (p \vee q) \quad \text{DeMorgan}$$
$$\equiv (p \vee \neg q) \wedge (p \vee q)$$
$$\equiv p \vee (\neg q \wedge q) \quad \text{Distributive law}$$
$$\equiv p \vee \text{False}$$
$$\equiv p$$

The DeMorgan's Law allows us to always "move the NOT inside".

(Optional) See textbook for more identities.

Symbolic Reasoning



Machine Learning

Approaches and Methods

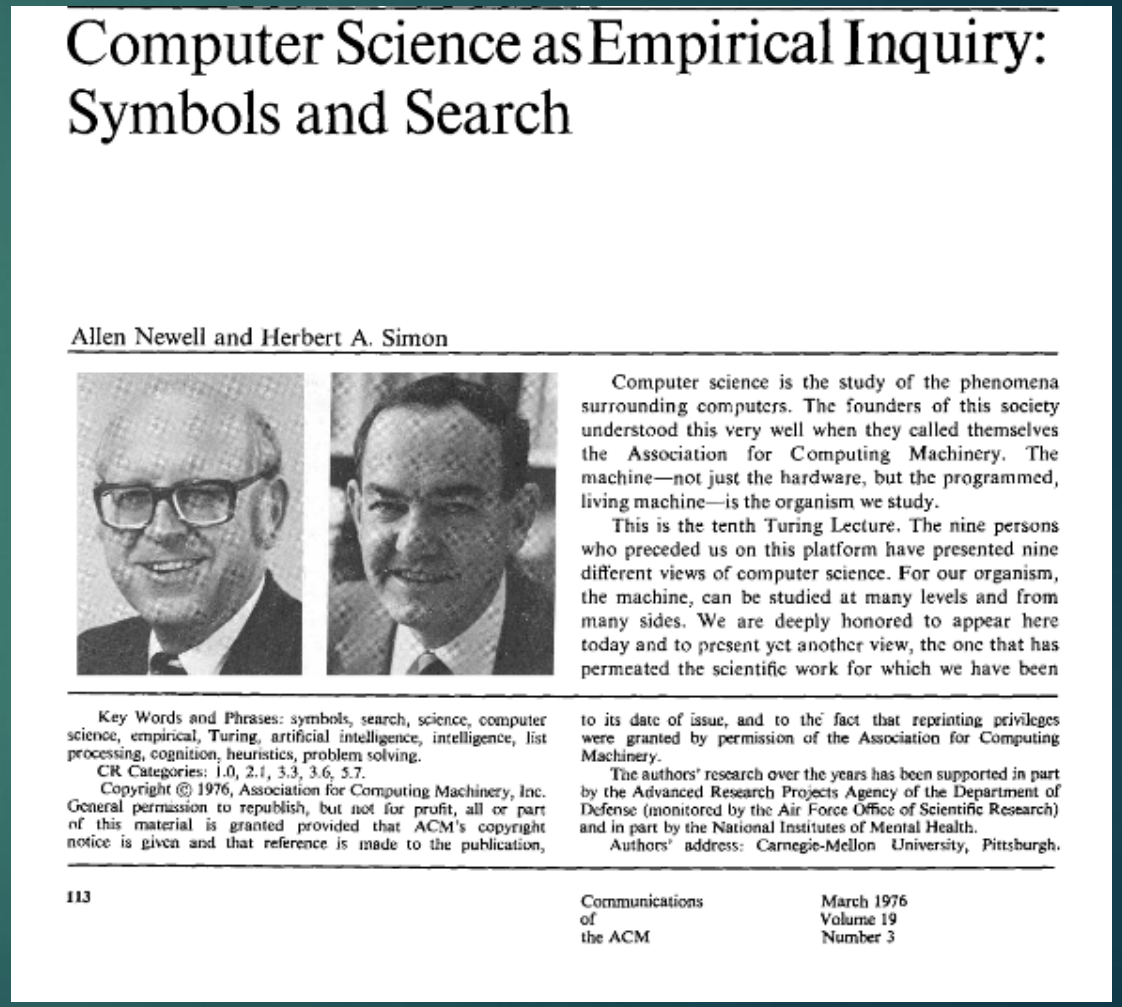
Symbolic Reasoning

Physical Symbol System (PSS)

"A physical symbol system has the necessary and sufficient means for general intelligent action" (Newell and Simon, 1976)

Intelligence = symbol manipulation (words or symbolic logic). We think by manipulating symbols and machines can be programmed to do the same.

"Computational Theory of Mind"



Computer Science as Empirical Inquiry: Symbols and Search

Allen Newell and Herbert A. Simon

Key Words and Phrases: symbols, search, science, computer science, empirical, Turing, artificial intelligence, intelligence, list processing, cognition, heuristics, problem solving.
CR Categories: 1.0, 2.1, 3.3, 3.6, 5.7.

The authors' research over the years has been supported in part by the Advanced Research Projects Agency of the Department of Defense (monitored by the Air Force Office of Scientific Research) and in part by the National Institutes of Mental Health.
Authors' address: Carnegie-Mellon University, Pittsburgh.

Approaches and Methods

Symbolic Reasoning

PSS Description/Characterization

A physical symbol system is a machine that, as it moves through time, produces an evolving collection of symbol structures. Symbol structures can, and commonly do, sever as internal representations (e.g., "mental images") of the environment to which the symbol system is seeking to adapt. They allow it to model that environment with greater or less veridicality and in greater or less detail, and consequently to reason about it…Symbols may also designate processes that the symbol system can interpret and execute. Hence the program that governs the behaviour of a symbol system can be stored, along with other symbol structures, in the system's own memory, and executed when activated.

Herbert Simon, *The Sciences of the Artificial*, 3rd Edition

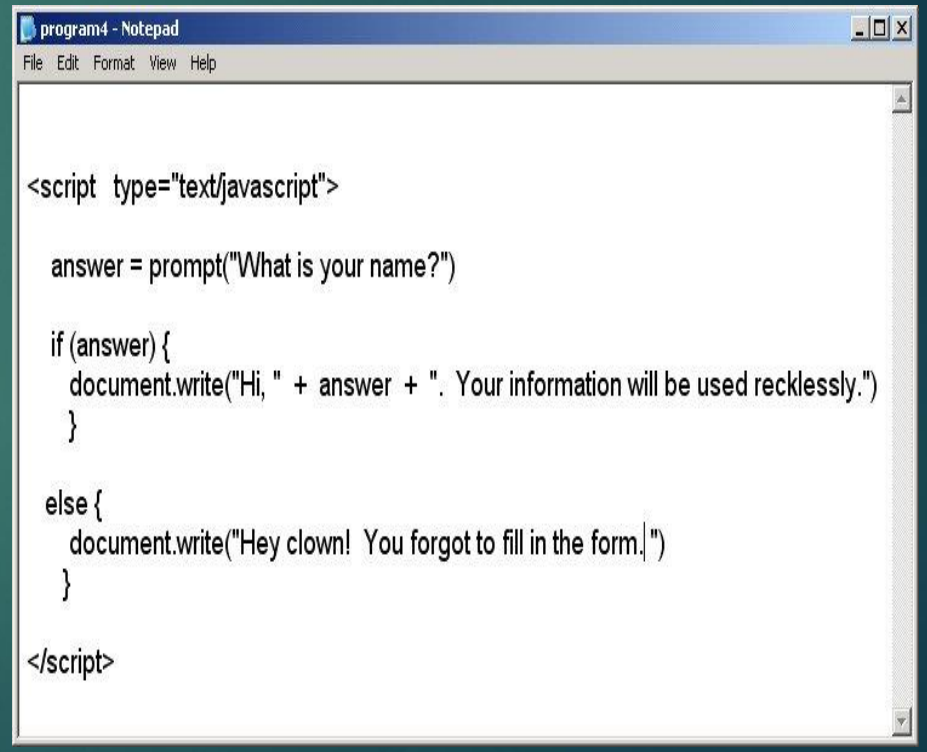
Approaches and Methods

Symbolic Reasoning

Translation = Step-by-step procedures encoded in some kind of symbol system, like language.

Driving Directions

From Interstate 71
Go South on I71 to exit 47
Turn East (left turn) 6.5 Miles
Turn North (Left Turn) onto Weaver Rd.
Go 3.5 miles on Weaver Rd.
Park entrance is on the right (brick arch)



Approaches and Methods

Machine Learning

Learning, presumably, comes mainly from experience, practice, or training, not solely from reasoning.

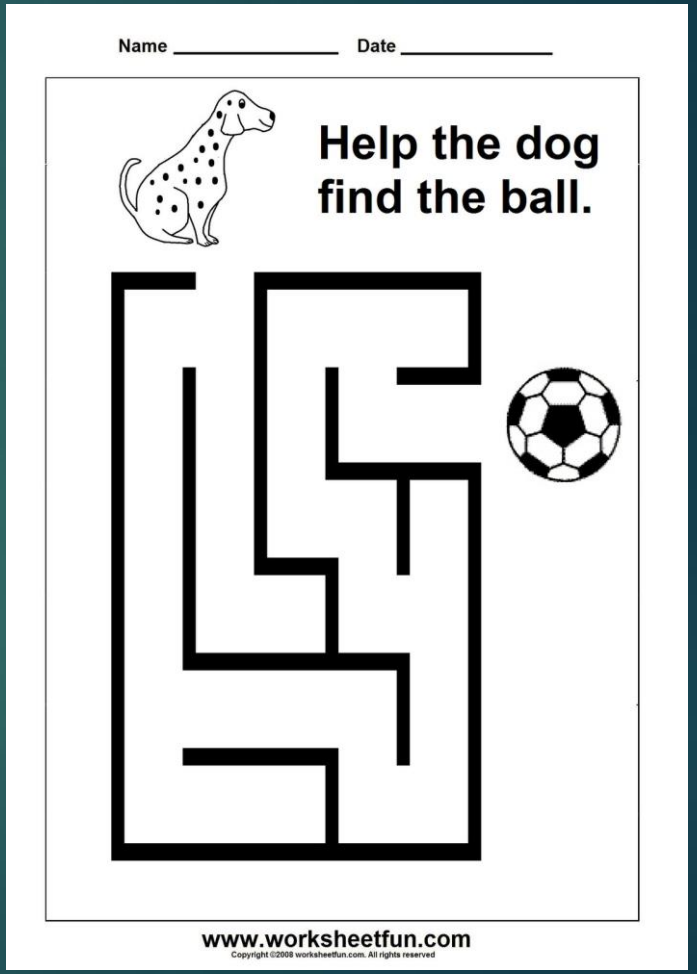
Machine Learning = computer programs that extract patters of behavior from data. Unlike symbolic reasoning that needs to encode all possible behaviors in advance and up front, machine learning algorithms develop behaviors by discovering (for themselves) various patterns in data.

Kaplan p. 27

Arthur Samuel

Approaches and Methods

- Example
  - Maze Navigation
  - Symbolic Reasoning approach – formulate step-by-step instructions for movement through space
  - Learning – discover best method through space by trial and error (i.e. learning from data)

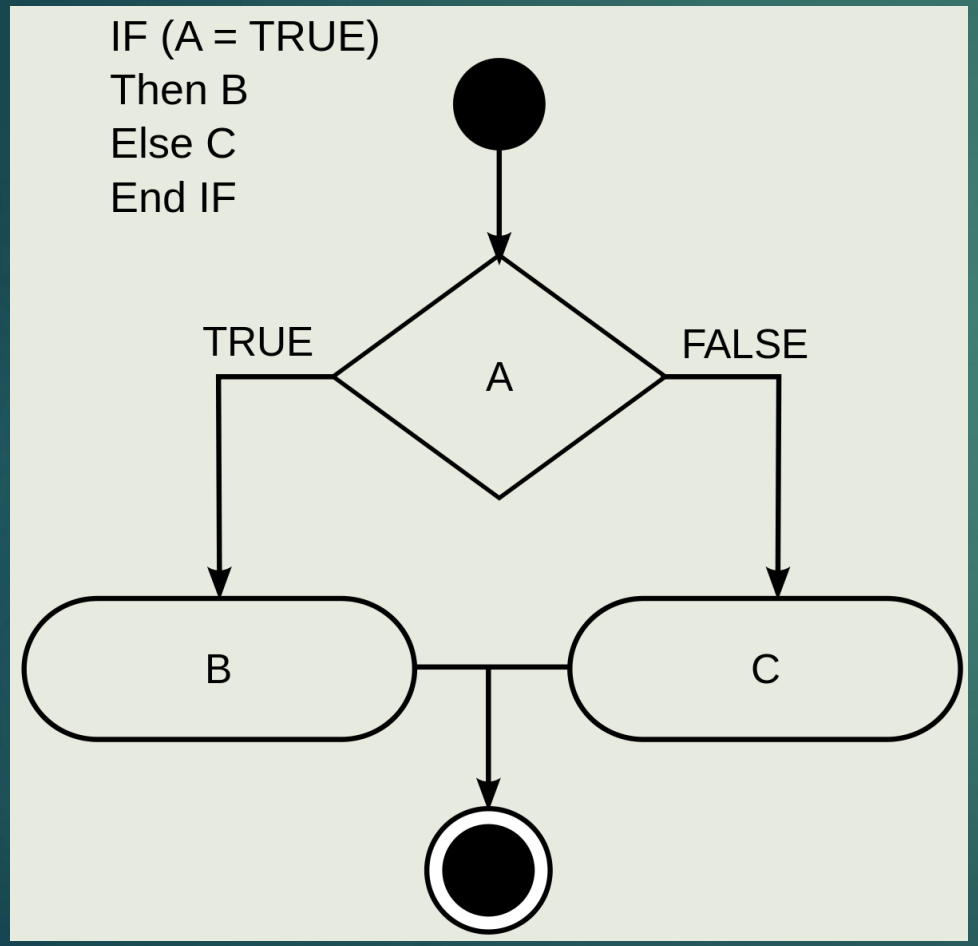


Approaches and Methods

- Symbolic Reasoning
  - **Advantage:** Step-by-step (serial) instructions that, if executed correctly, will provide consistent results
  - **Challenge:** Programmer needs to know everything in advance (e.g. the configuration of the maze, the exact movements of the test subject, the desired outcome, etc.) and be able to code these items in explicit instructions (symbols)
- Machine Learning
  - **Advantage:** Programmers do not need to know anything. They just need to set up the initial situation and observe what happens.
  - **Challenge:** Less control and oversight. Do not know what will happen or why until it actually happens.

Approaches and Methods

Symbolic Reasoning



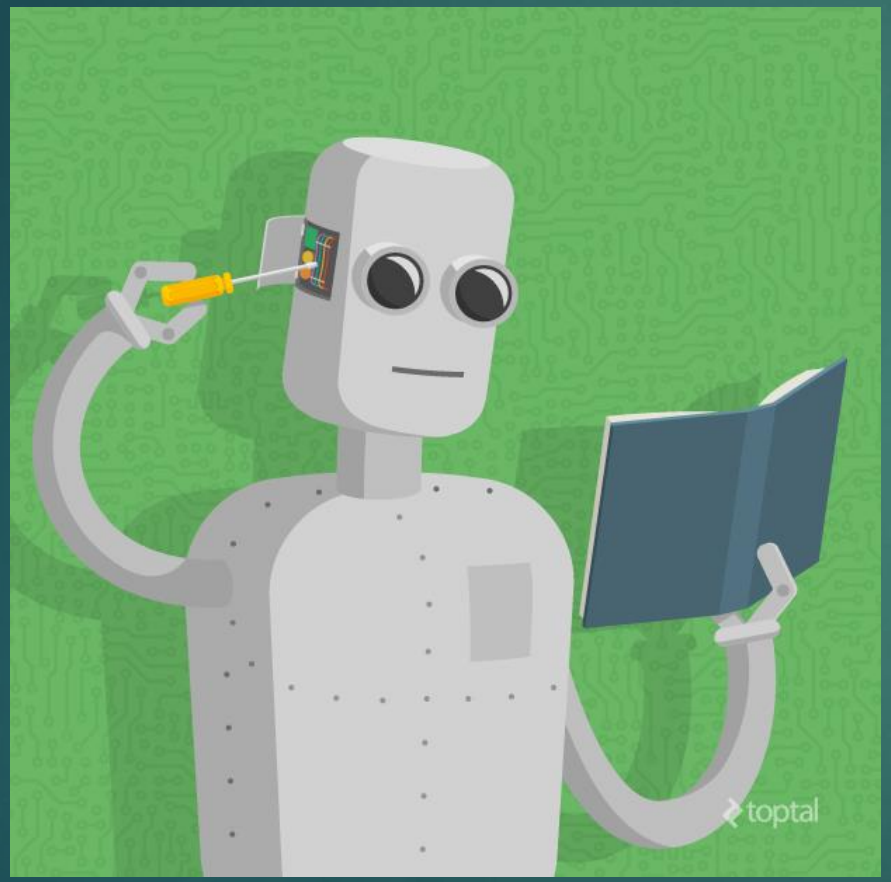
ACTIONS - FRAME

Script Assist

```
1  function checkMail(mail:String):void
2  {
3      if(mail == "junk")
4      {
5          trace("throw it away!");
6      }
7      else if(mail == "possible junk")
8      {
9          trace("set it aside");
10     }
11     else
12     {
13         trace("keep it!");
14     }
15 }
16
17 checkMail("possible junk");
```

Approaches and Methods

Machine Learning



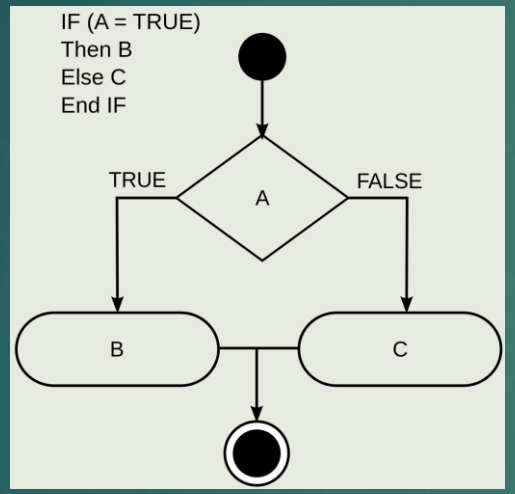
Different Types/Varieties

- Decision Tree
- Neural Networks
- Deep Learning
- Bayesian Network
- Reinforcement Learning
- Genetic Algorithms

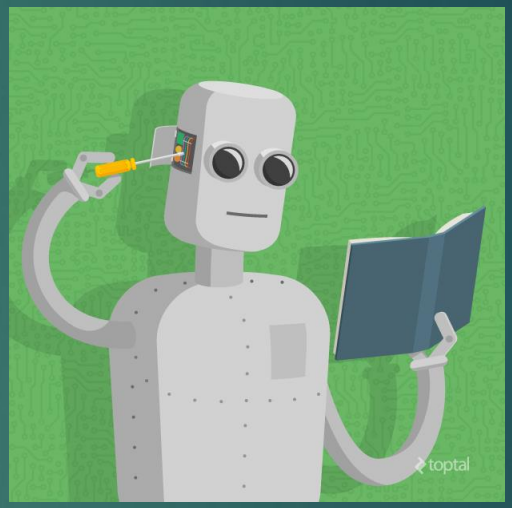
Explainer Video – Genetic Algorithms
https://www.youtube.com/watch?v=R9OHn5ZF4Uo

Approaches and Methods

GOFAI



VS.

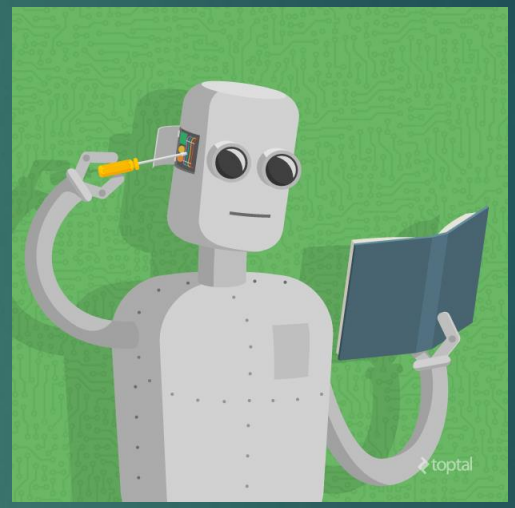


Even though the two approaches are introduced at about the same time (late 1950s), initial work in AI focused almost exclusively on symbolic reasoning approaches. All the energy and funding went to this way of doing thing. Machine Learning remains a minor thread until about 1980, when it began to gain traction again.

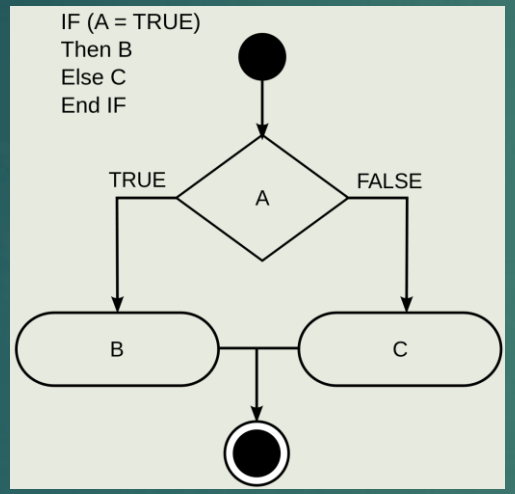
Approaches and Methods

Reasons for Resurgence

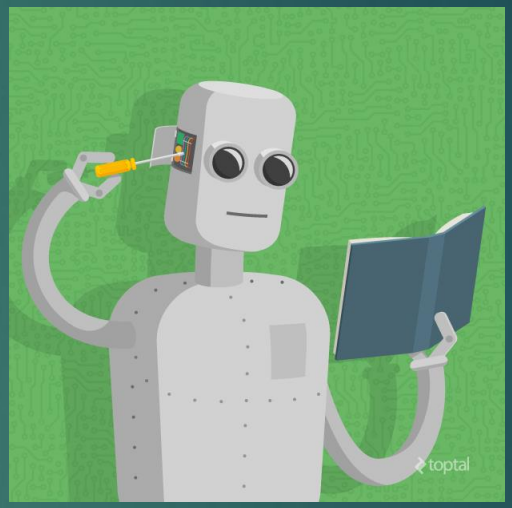
- Computing Power
- Deep Neural Networks
- Big Data



Approaches and Methods



both/and

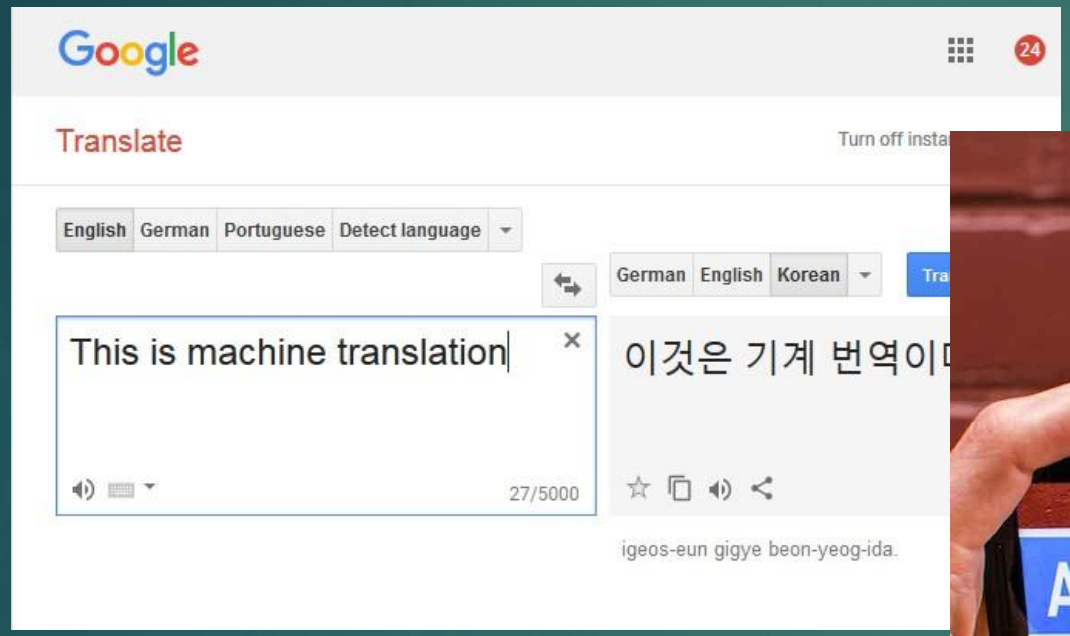


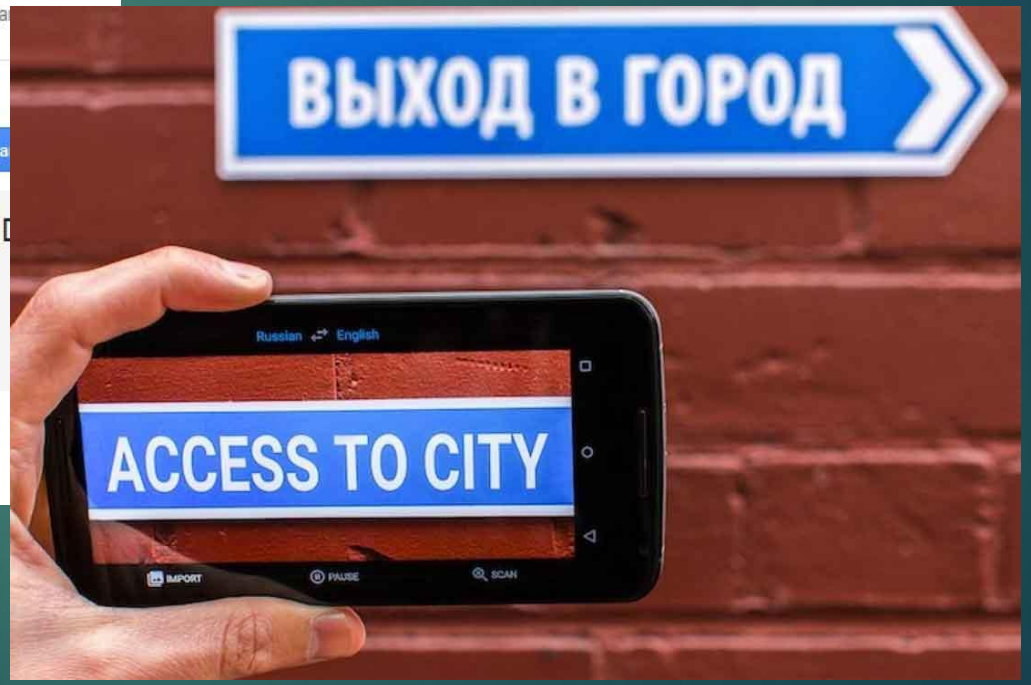
Symbolic Reasoning is more appropriate for problems that require abstract reasoning—problems where programmers can abstract a desired behavior or outcome into distinct steps that can be encoded and followed by a computer.

Machine Learning is better for situations that require sensory perception or extracting patterns of behavior from noisy data. It works when there is a lot of data about something but programmers do not necessarily know how to describe the behavior in an abstract form.

Examples/Applications

1. Machine Translation

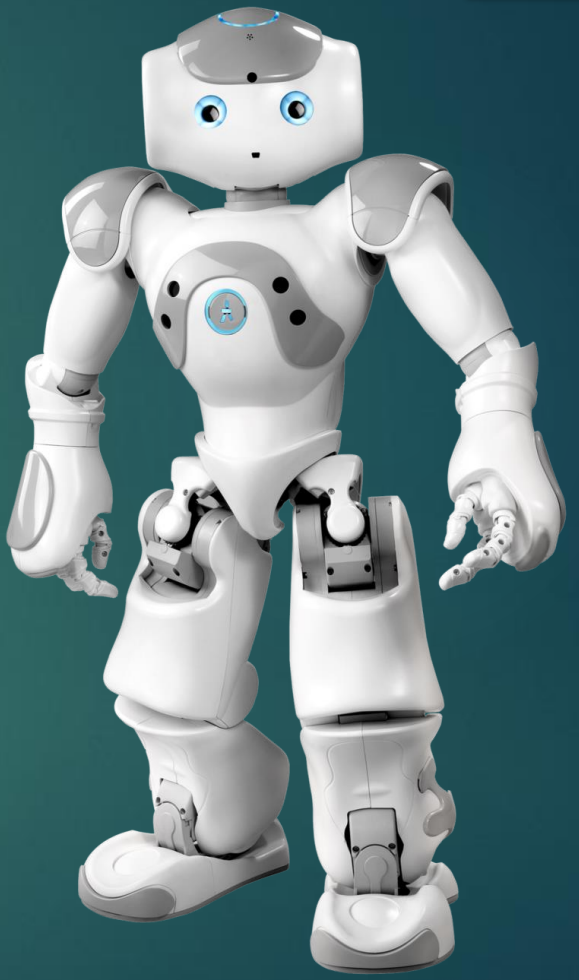




Examples/Applications

3. Robotics

Autonomous Vehicles



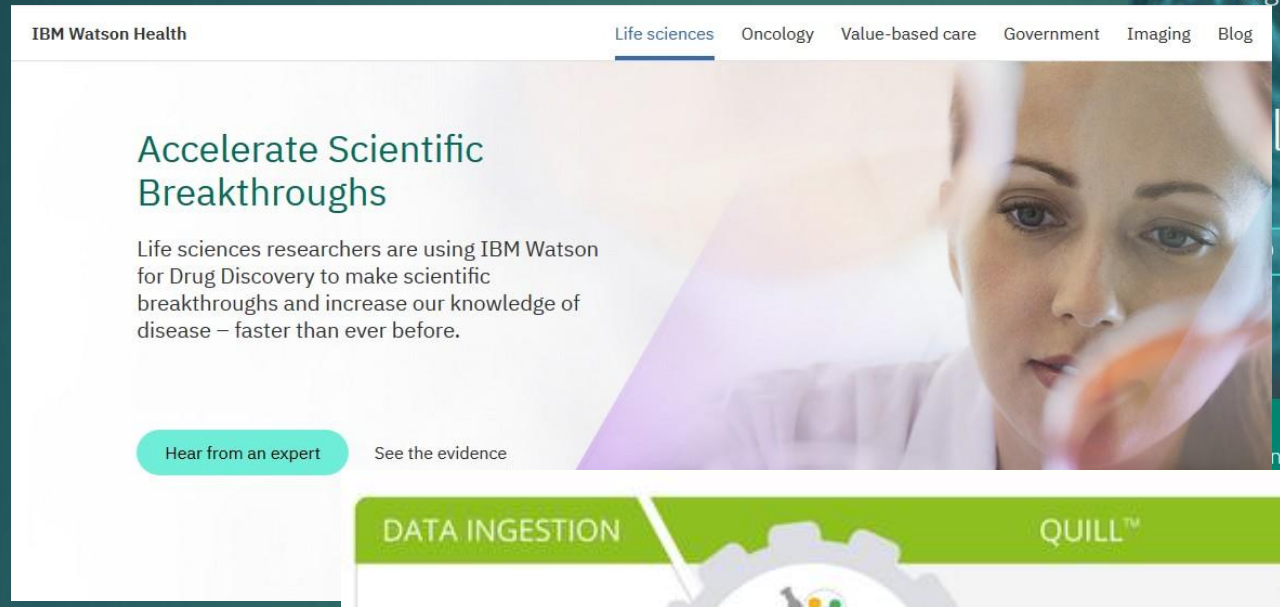
Social Robots

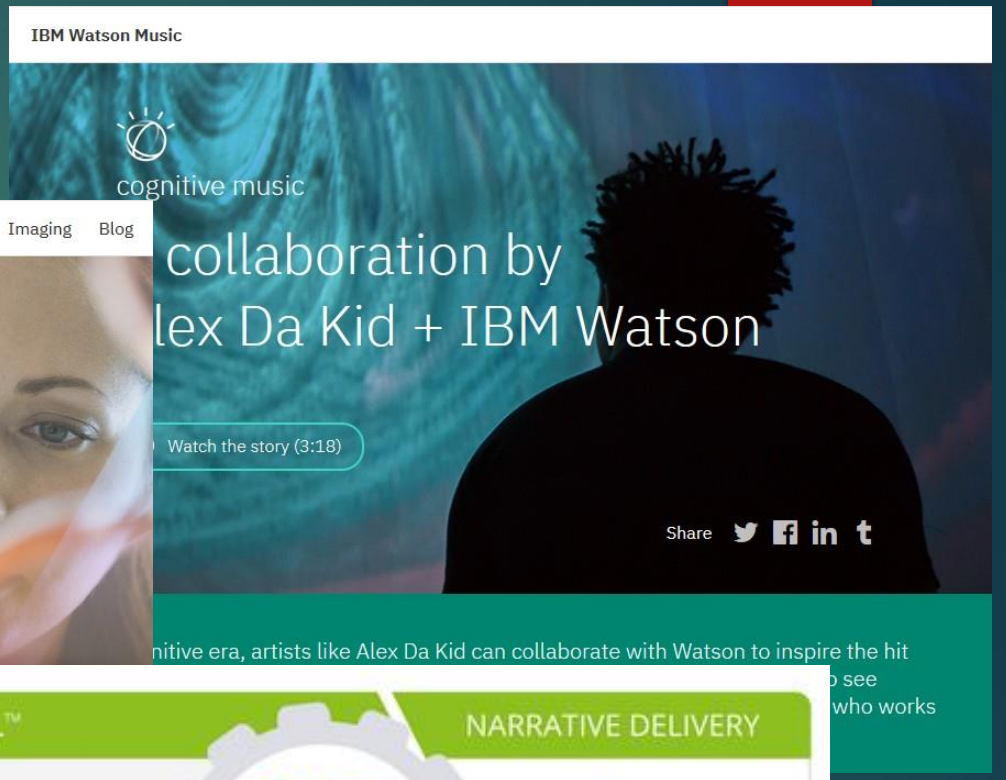
Examples/Applications

2. Speech Recognition and NLP

Examples/Applications

4. Computational Creativity





Today

- NLP & Computational Creativity
  - Intro to Communication & AI - ch.5-6
  - Amper & Taryn Southern - Break Free (videos)
  - Sunspring (video)

Preview

- Social Robots
  - Intro to Communication & AI - ch.7
  - Jibo - Promotional Video
  - Breazeal - Personal Robots (video)