Introduction To AI

What is AI?

- Intelligence is the ability to perceive or infer information, and to retain it as knowledge to be applied towards adaptive behaviors.
- Intelligence is the capacity for abstraction, logic, understanding, self-awareness, learning, emotional knowledge, reasoning, planning, creativity, critical thinking, and problem-solving.
- The term “artificial intelligence” may be confusing. Is artificial intelligence real intelligence?
- The study of how to make computers do things at which people are doing better [IEEE Neural Networks Council of 1996].

Foundations of AI

- **Philosophers** (back to 400 BCE) made AI conceivable by suggesting that the mind is in some ways like a machine, that it operates on knowledge encoded in some internal language, and that thought can be used to choose what actions to take.
- **Mathematicians** provided the tools to manipulate statements of logical certainty as well as uncertain, probabilistic statements.
- **Economists** formalized the problem of making decisions that maximize the expected utility to the decision maker.

Foundations of AI

- **Neuroscientists** discovered some facts about how the brain works and the ways in which it is similar to and different from computers.
- **Psychologists** adopted the idea that humans and animals can be considered information processing machines.
- **Computer engineers** provided the powerful machines that make AI applications possible, and software engineers made them more usable.

What is AI?

Views of AI fall into four categories:

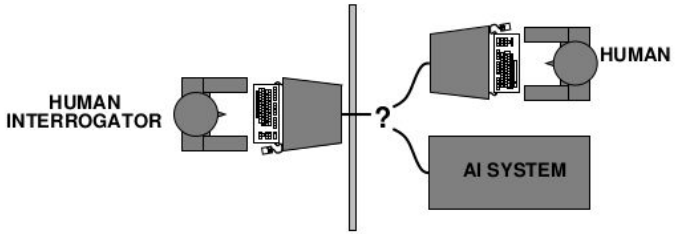
Thinking humanly	Thinking rationally
Acting humanly	Acting rationally

Examining these, we will plump for acting rationally (sort of)

Acting humanly: The Turing test

Turing (1950) "Computing machinery and intelligence":

- ♢ "Can machines think?" ⟶ "Can machines behave intelligently?"
- ♢ Operational test for intelligent behavior: the Imitation Game



Turing test

VOL. LIX. NO. 236.] [October, 1950

MIND

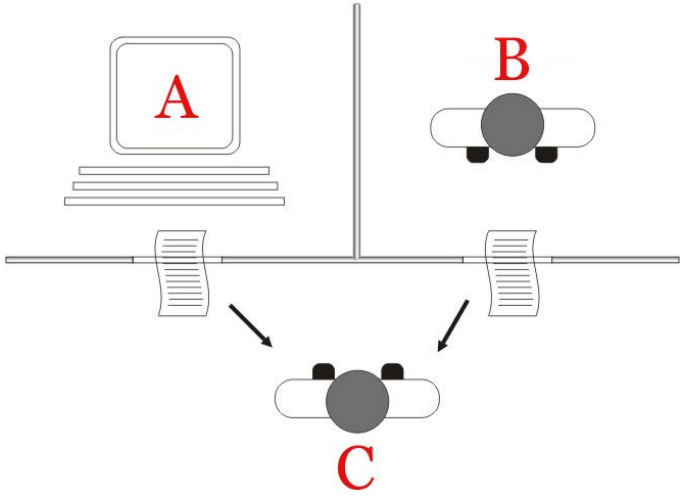
A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING



Turing test

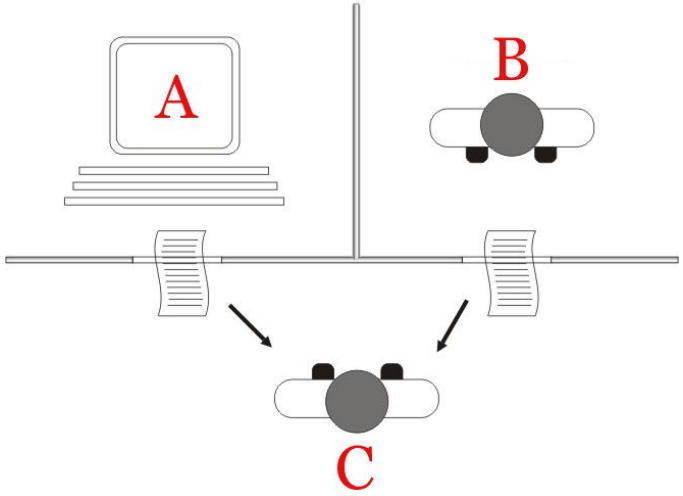
The computer would need the following capabilities:

Natural language processing to communicate successfully in a human language;

Knowledge representation to store what it knows or hears;

Automated reasoning to answer questions and to draw new conclusions;

Machine learning to adapt to new circumstances and to detect and extrapolate patterns.



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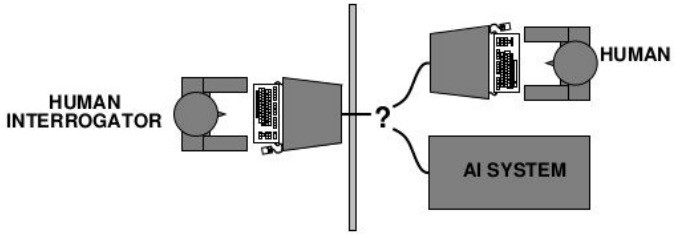
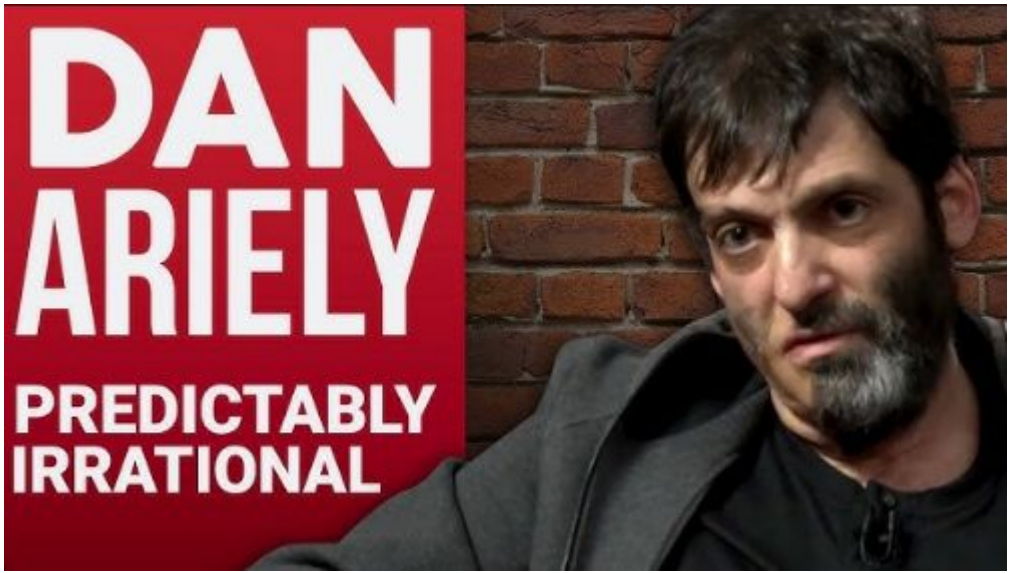


- ♢ Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
- ♢ Anticipated all major arguments against AI in following 50 years
- ♢ Suggested major components of AI: knowledge, reasoning, language understanding, learning

Problem: Turing test is not reproducible, constructive, or amenable to mathematical analysis

There are various reasons why trying to mimic humans might not be the best approach to AI



Thinking humanly: Cognitive modelling approach

To say that a program thinks like a human, we must know how humans think. We can learn about human thought in three ways:

- introspection—trying to catch our own thoughts as they go by;
- psychological experiments—observing a person in action;
- brain imaging—observing the brain in action.

Cognitive science brings together computer models from AI and experimental techniques from psychology to construct **theories of mind.**

Rationality

- The alternative approach relies on the **notion of rationality**.
- Typically this is a precise mathematical notion of what it means to do the right thing in any particular circumstance. Provides
  - A precise mechanism for analyzing and understanding the properties of this **ideal behaviour** we are trying to achieve.
  - A precise **benchmark** against which we can measure the behaviour the systems we build
- Mathematical characterizations of rationality have come from diverse areas like logic, economics, and game theory.

Thinking rationally: The laws of thought approach

- The development of formal logic in the late nineteenth and early twentieth centuries, provided a precise notation for statements about all kinds of things in the world and the relations between them.
- By 1965, programs existed that take a description of a problem in logical notation and find the solution to the problem, if one exists.
- The so-called logicist tradition within artificial intelligence hopes to build on such programs to create **intelligent systems**.

Thinking rationally: The laws of thought approach

There are two main obstacles to this approach.

- First, it is not easy to take informal knowledge and state it in the formal terms required by logical notation, particularly when the knowledge is less than 100% certain.
- Second, there is a big difference between being able to solve a problem "in principle" and doing so in practice. Even problems with just a few dozen facts can exhaust the computational resources.

Acting rationally

Rational behavior: doing the right thing

The right thing: that which is expected to maximize goal achievement, given the available information

Doesn't necessarily involve thinking—e.g., blinking reflex—but thinking should be in the service of rational action

Acting rationally means acting so as to achieve one's goals, given one's beliefs.

Acting rationally: The rational agent approach

- In the "Thinking rationally" approach to AI, the whole emphasis was on correct inferences. However, there are often situations where there is no provably correct thing to do, yet something must still be done.
- The course will therefore concentrate on general principles of rational agents, and on components for constructing them.

AI History

The inception of artificial intelligence (1943–1956)

- McCulloch and Pitts proposed Artificial Neuron Model by mimicking the functionality of a biological neuron (1943).
- Marvin Minsky and Dean Edmonds, built first neural network computer (1950).

AI History

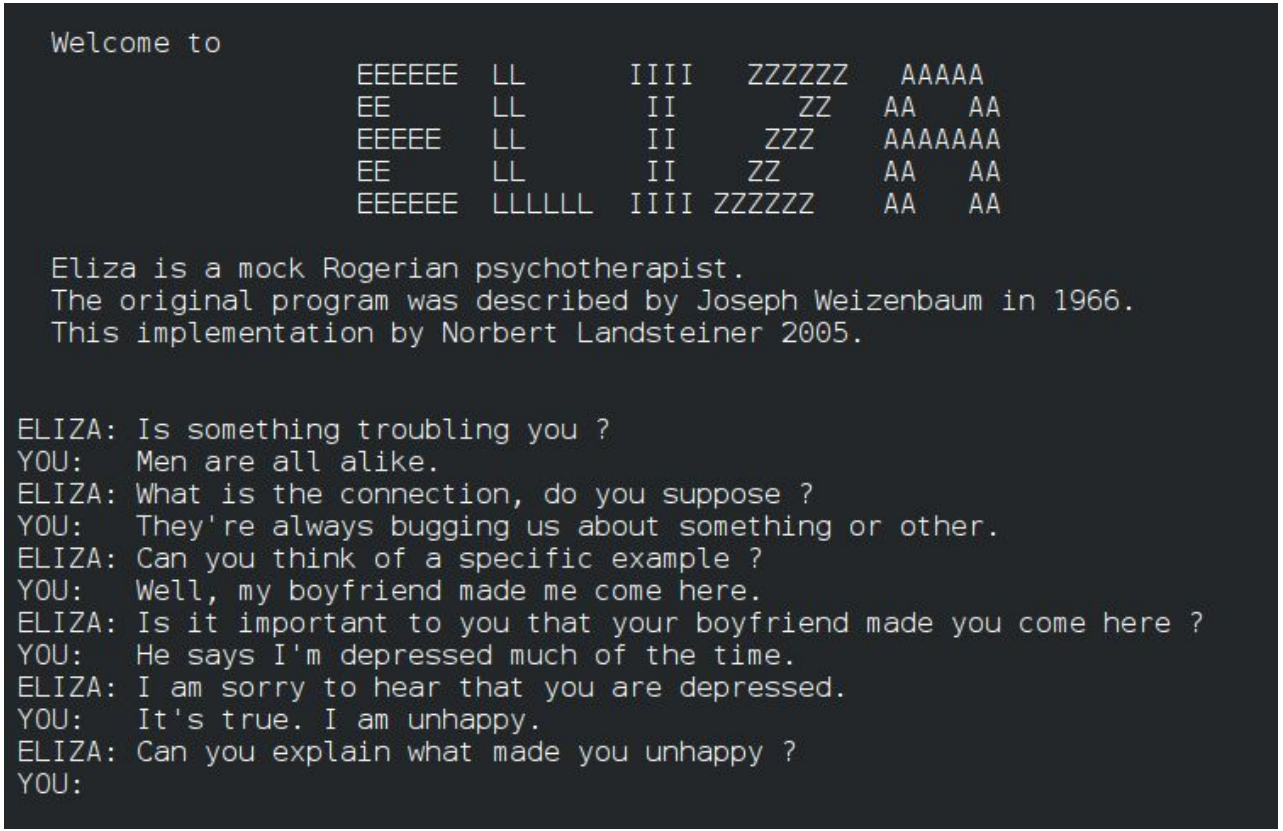
Early enthusiasm, great expectations (1952–1969)

- 1956, A new field was born:

  "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."

  —Dartmouth AI Project Proposal; J. McCarthy et al.; Aug. 31, 1955

1964: Eliza


Welcome to
EEEEEE LL IIII ZZZZZZ AAAAA
EE LL II ZZ AA AA
EEEEE LL II ZZZ AAAAAAA
EE LL II ZZ AA AA
EEEEEE LLLLLL IIII ZZZZZZ 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 troubling you ?
YOU: Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU: They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU: Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU: He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU: It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:

AI History

Early enthusiasm, great expectations (1952–1969)

- 1964: Eliza —the chatbot psychotherapist
  - — First attempt to interact with human
  - — Used “Pattern Matching ” and “Substitution” methodology
  - — no built in framework for contextualizing events
  - — Reasoning about physical objects, their relationships, actions and consequences

AI History

Early enthusiasm, great expectations (1952–1969)

- 1966: Shakey— general purpose mobile robot
  - — First mobile, intelligent robot
  - — Used the LISP programming language
  - — declared an "IEEE Milestone"
  - — combined research in robotics, *computer vision*, and *natural language processing*

AI History

- First AI Winter (1974-1980):
  - Failure of Machine Translation
  - Poor speech understanding
  - Negative results in neural nets

- 1980-88 Expert systems industry booms
  - A computer system emulating the decision-making ability of a human expert.
  - Expert systems are designed to solve complex problems by reasoning through bodies of knowledge, represented mainly as if–then rules.

AI History

- Second AI Winter (1987-1993):
  - Decline of LISP
  - Decline of specialized hardware for expert systems
- Statistical approaches (1990-):
  - Focus on uncertainty
  - e.g. SVM, KNN, regression, clustering etc.
  - Based on hand-crafted features

1997: Chess

IBM’s Deep Blue beats chess grandmaster Garry Kasparov

AI History

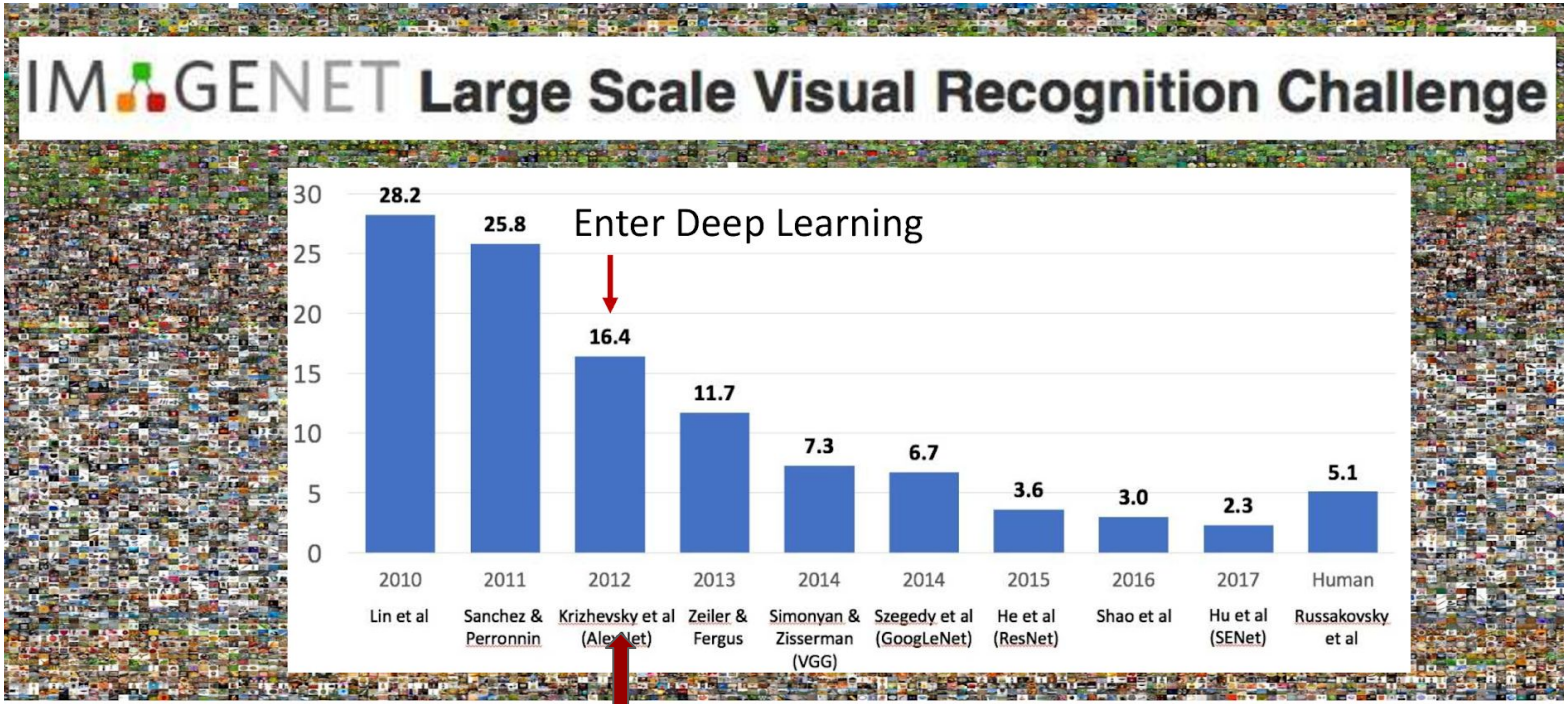
1998 :- Dave Hampton and Caleb Chung create Furby, the first domestic or pet robot.

1998 :- Yann LeCun, Yoshua Bengio and others publish papers on the application of neural networks to handwriting recognition and on optimizing backpropagation.

2006 :- Geoffrey Hinton publishes “Learning Multiple Layers of Representation,” summarizing the ideas that have led to “multilayer neural networks that contain top-down connections and training them to generate sensory data rather than to classify it,” i.e., the new approaches to deep learning.

2005: DARPA Grand Challenge – Stanford autonomous vehicle drives 131 miles along an unrehearsed desert trail

2007 :- Fei Fei Li and colleagues at Princeton University start to assemble ImageNet, a large database of annotated images designed to aid in visual object recognition software research.



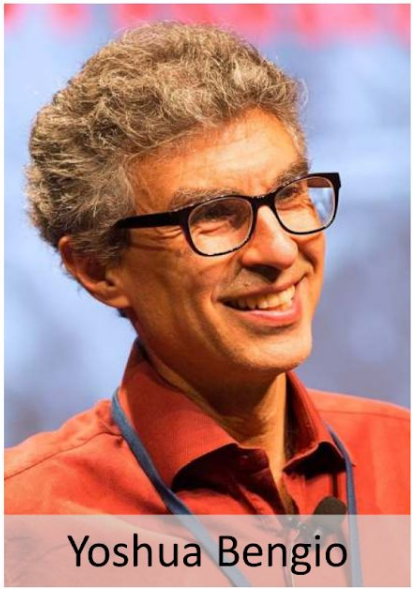
AI History

2009 :- Google starts developing, in secret, a driverless car. In 2014, it became the first to pass, in Nevada, a U.S. state self-driving test.

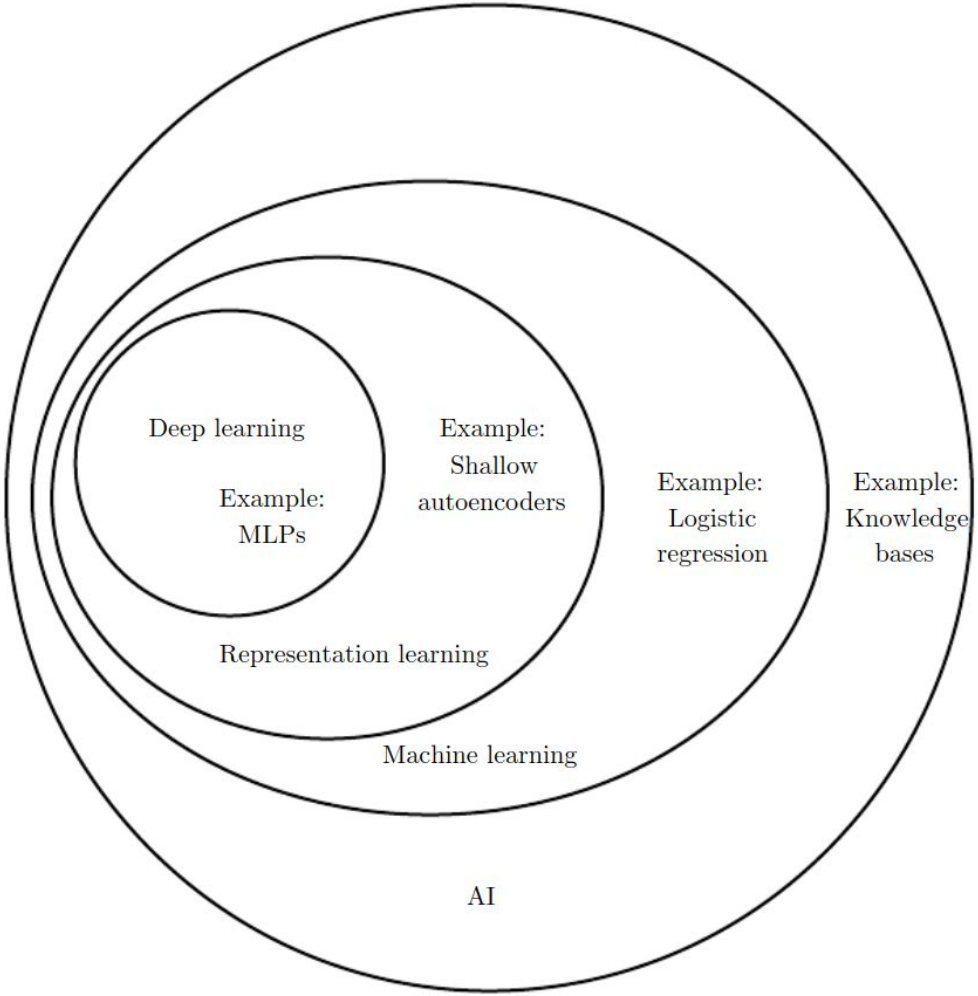
2013:- Geoffrey Hinton's NIPS 2012 paper "ImageNet Classification with Deep Convolutional Neural Networks" reduces the error rate for correctly classifying objects in images by 18 percent.

2017 :- AlphaGo, a deep learning network program, beats Ke Jie, the world champion at Go.

2018 Turing Award



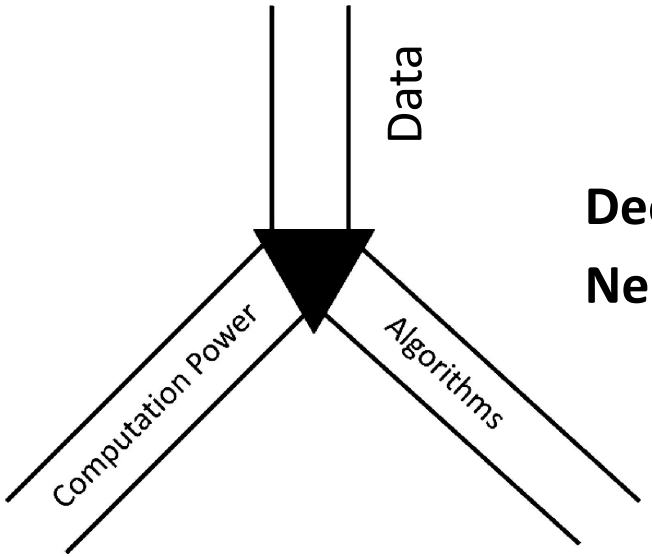
The 2018 Turing Award was awarded jointly to Yoshua Bengio, Geoffrey Hinton, and Yann LeCun for their pioneering work on deep learning


Deep learning
Example:
MLPs
Example:
Shallow
autoencoders
Representation learning
Example:
Logistic
regression
Machine learning
Example:
Knowledge
bases
AI

Current State of AI

- Progress in AI research and computation led to solving more complex problems related to perception (vision, speech), natural language processing, medical diagnosis etc.
  - Image recognition (ImageNet training database-2012)
  - Language translation (Google Translate)
  - Game playing system such as AIphZero (chess champion), AIphaGo(go champion)
  - Deep learning

What Changed?

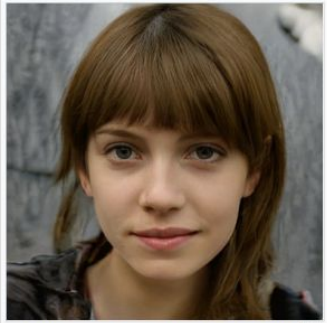


Deep Learning

Neural networks

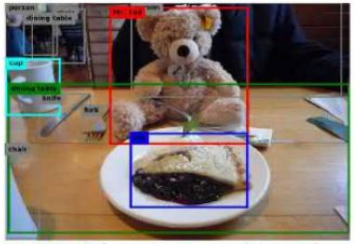
Computer Vision Tasks

Image Restoration



An image generated by a StyleGAN

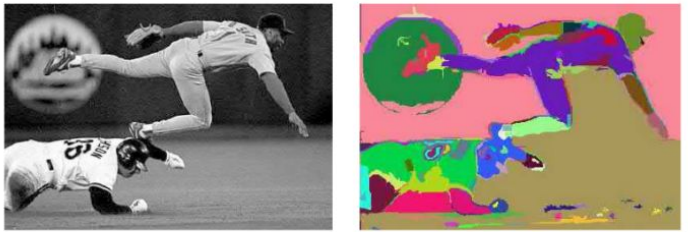
Image Synthesis



A Mr. Ted sitting at a table with a pie and a cup of coffee.

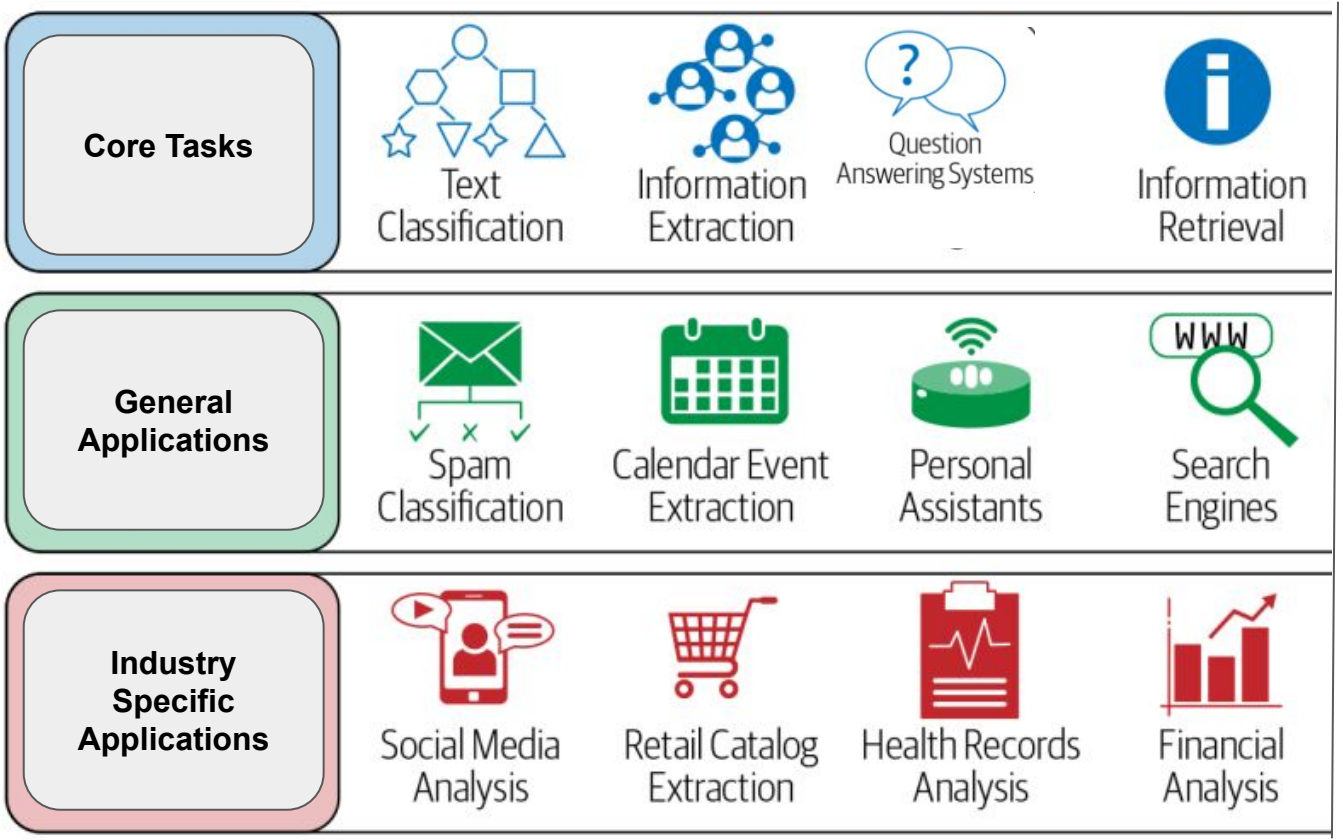
Object Detection

Figure 5. Use of deep learning to transfer facial expressions from human input



segmentation

NLP Tasks


Core Tasks
Text Classification
Information Extraction
Question Answering Systems
Information Retrieval
General Applications
Spam Classification
Calendar Event Extraction
Personal Assistants
WWW
Search Engines
Industry Specific Applications
Social Media Analysis
Retail Catalog Extraction
Health Records Analysis
Financial Analysis