What is AI?

Four schools of thoughts (Russel & Norvig)

Thinking humanly	**Thinking rationally**
"The exciting new effort to make computers think... *machines with minds*, in the full and literal sense." (Haugeland, 1985)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985
Acting humanly	**Acting rationally**
"The study of how to make computers do things which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole et al., 1998)

What is AI?

Thinking humanly: cognitive approach

Requires to determine how humans think!

1960's "cognitive revolution".

Requires scientific theories of internal activities of the brain

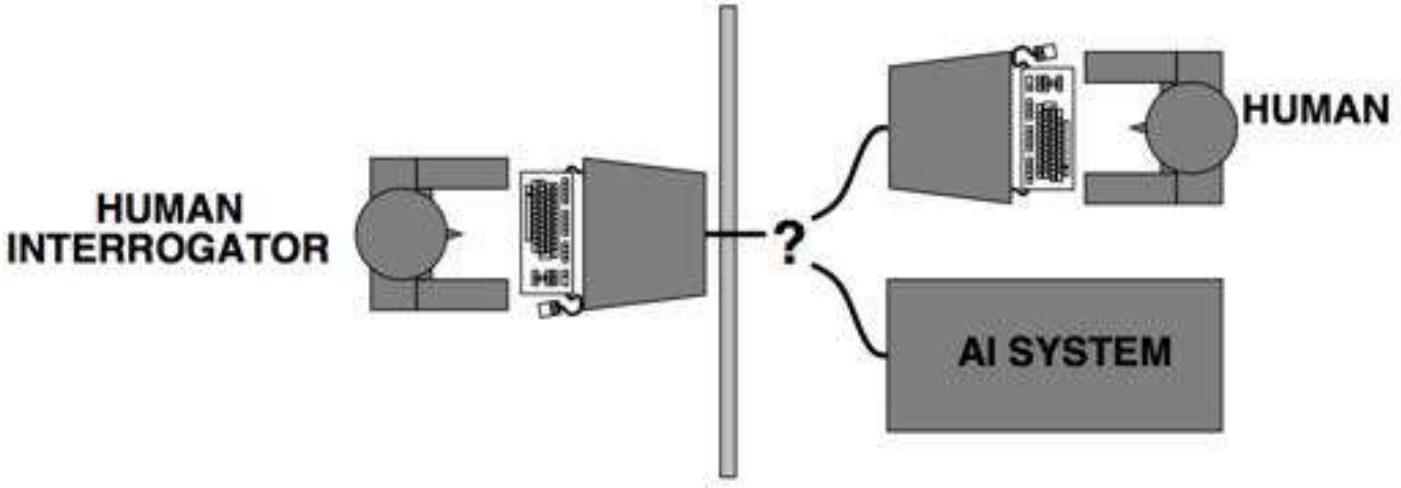
- What level of abstraction? "Knowledge" or "circuits"?
- How to validate?

Today, Cognitive Science and Artificial Intelligence are distinct disciplines.

What is AI?

Acting humanly:

- **Turing test (Alan Turing 1950)**: A computer passes the test of intelligence, if it can fool a human interrogator.



Credit: From Russel and Norvig slides.

- **Major components of AI:** knowledge, reasoning, language, understanding, learning.

What is AI?

Acting humanly:

What is AI?

Thinking rationally: Laws of thoughts.

- Codify "right thinking" with **logic**.
- Several Greek schools developed various forms of logic: *notation* and *rules of derivation* for thoughts.
- Problems:

  1. Not all knowledge can be expressed with logical notations.
  2. Computational blow up.

What is AI?

Acting rationally:

- The right thing: that which is expected to maximize goal achievement, given the available information.
- A **rational agent** is one that acts so as to achieve the best outcome, or when there is uncertainty, the best expected outcome.
- Aristotle (Nicomachean Ethics):
  "Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good."

What is AI?

Four schools of thoughts (Russel & Norvig)

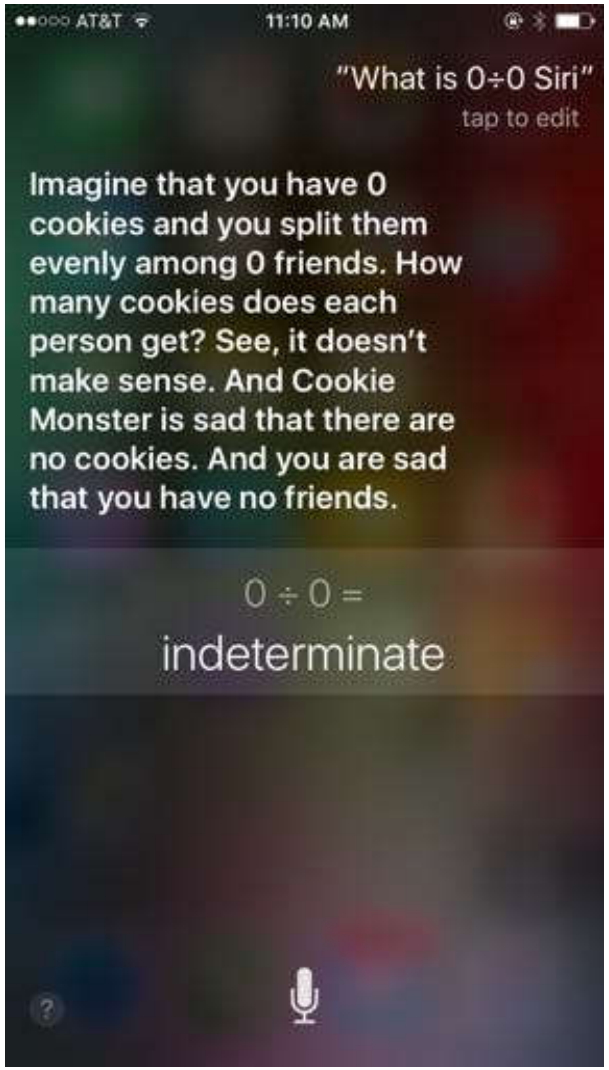
Thinking humanly	**Thinking rationally**
"The exciting new effort to make computers think... *machines with minds*, in the full and literal sense." (Haugeland, 1985)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985
Acting humanly	**Acting rationally: Our approach**
"The study of how to make computers do things which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole et al., 1998)

Applications of AI

Applications of AI

Speech recognition

- Virtual assistants: Siri (Apple), Echo (Amazon), Google Now, Cortana (Microsoft).
- "They" helps get things done: send an email, make an appointment, find a restaurant, tell you the weather and more.
- Leverage deep neural networks to handle **speech recognition** and **natural language understanding**.



Applications of AI

Handwriting recognition (check, zipcode)

Applications of AI

Machine translation

- Historical motivation: translate Russian to English.
- First systems using **mechanical translation** (one-to-one correspondence) failed!
- "Out of sight, out of mind" $\Rightarrow$ "Invisible, imbecile".

Applications of AI

Machine translation

- Historical motivation: translate Russian to English.
- First systems using **mechanical translation** (one-to-one correspondence) failed!
- "Out of sight, out of mind" $\Rightarrow$ "Invisible, imbecile".

Oops!

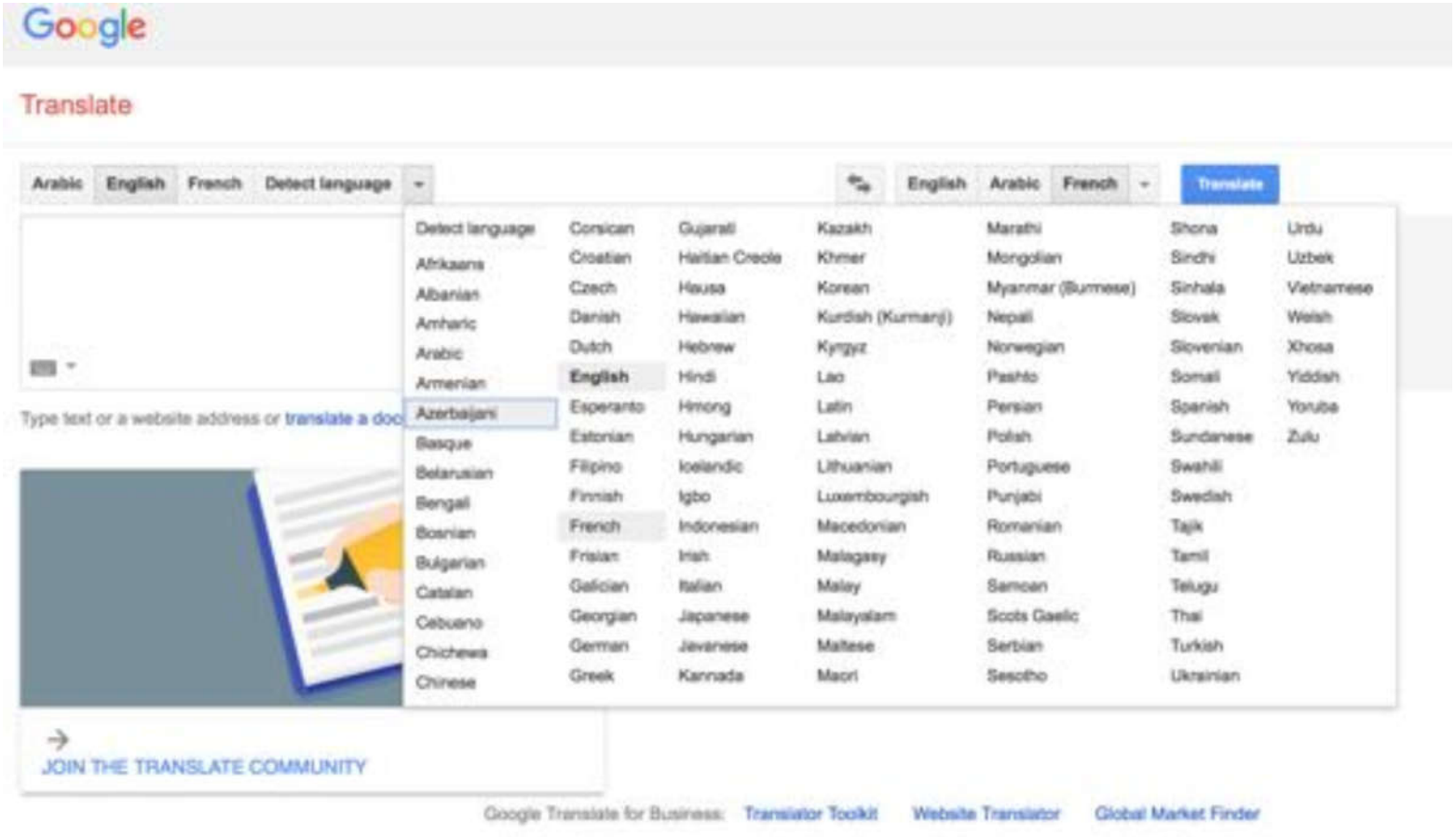
Applications of AI

Machine translation

- MT has gone through ups and downs.
- Today, **Statistical Machine Translation** leverages the vast amounts of **available translated corpuses**.
- While there is room for improvement, machine translation has made significant progress.

Applications of AI

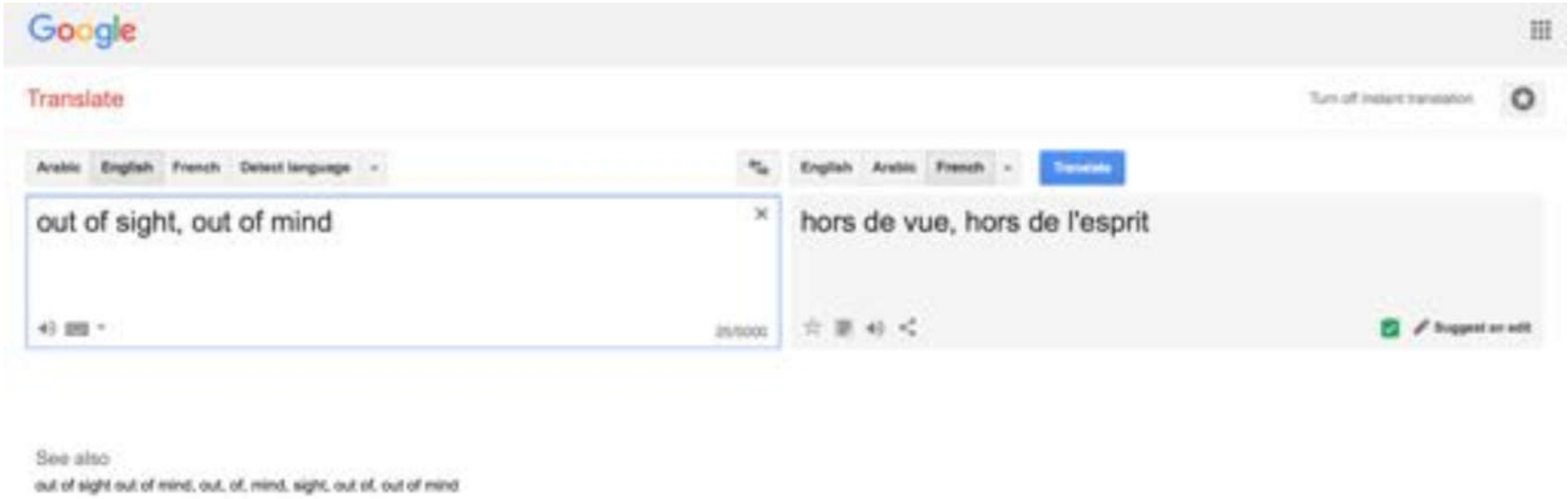
Machine translation



100+ languages

Applications of AI

Machine translation



Applications of AI

Robotics: Awesome robots today! NAO, ASIMO, and more!

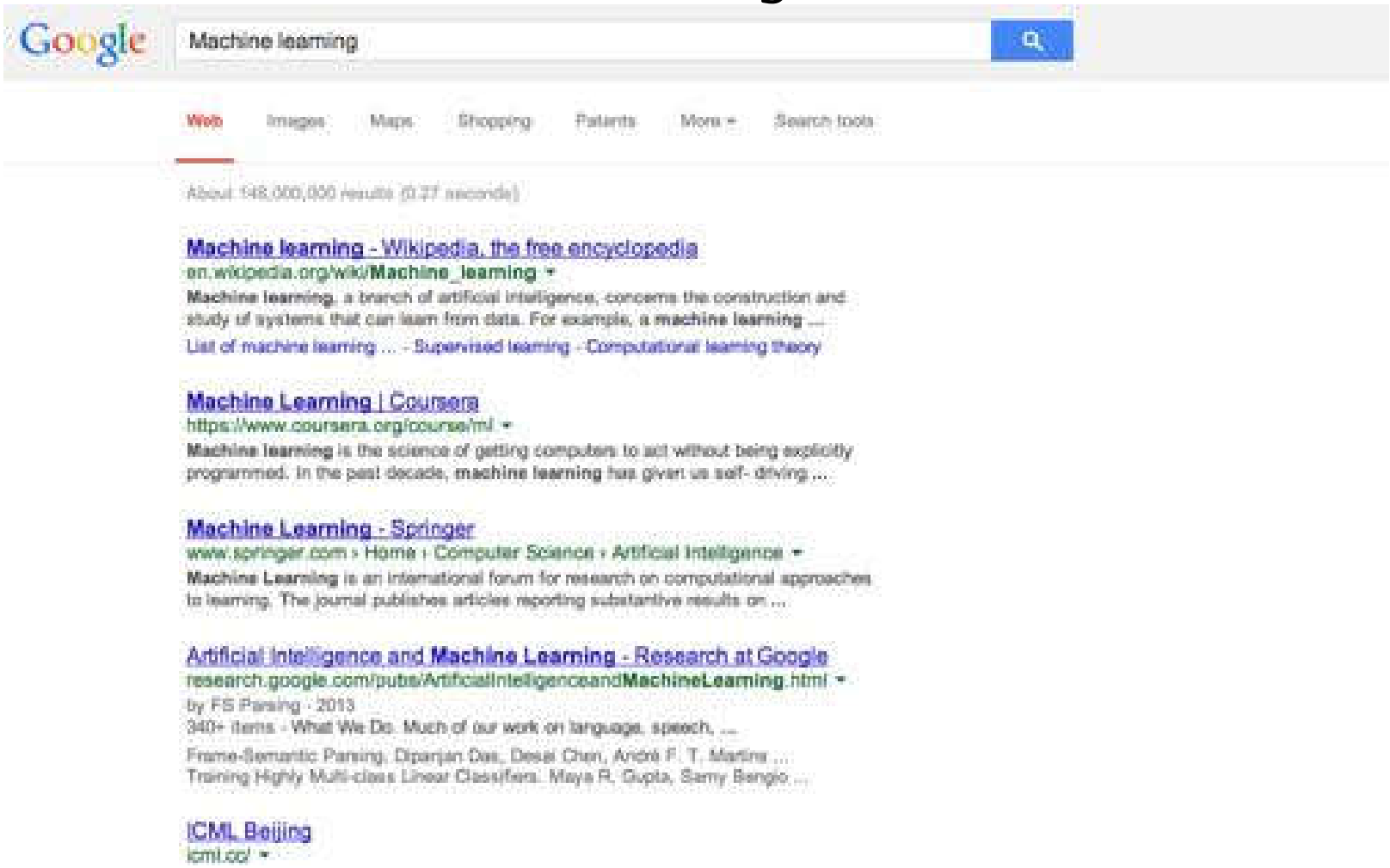
Credit: By Momotarou2012, via Wikimedia Commons.

Applications of AI

Recommendation systems (collaborative filtering)

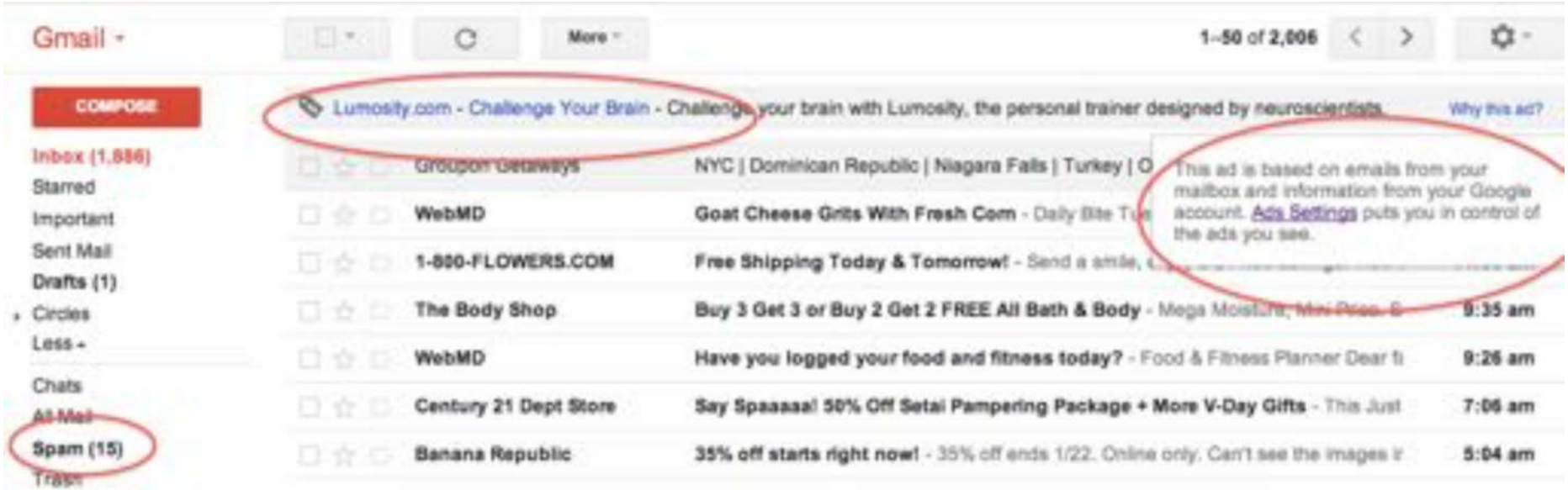
Applications of AI

Search engines



Applications of AI

Email



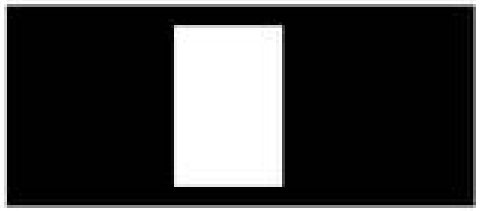
Applications of AI

Face detection

Viola-Jones method.

Applications of AI

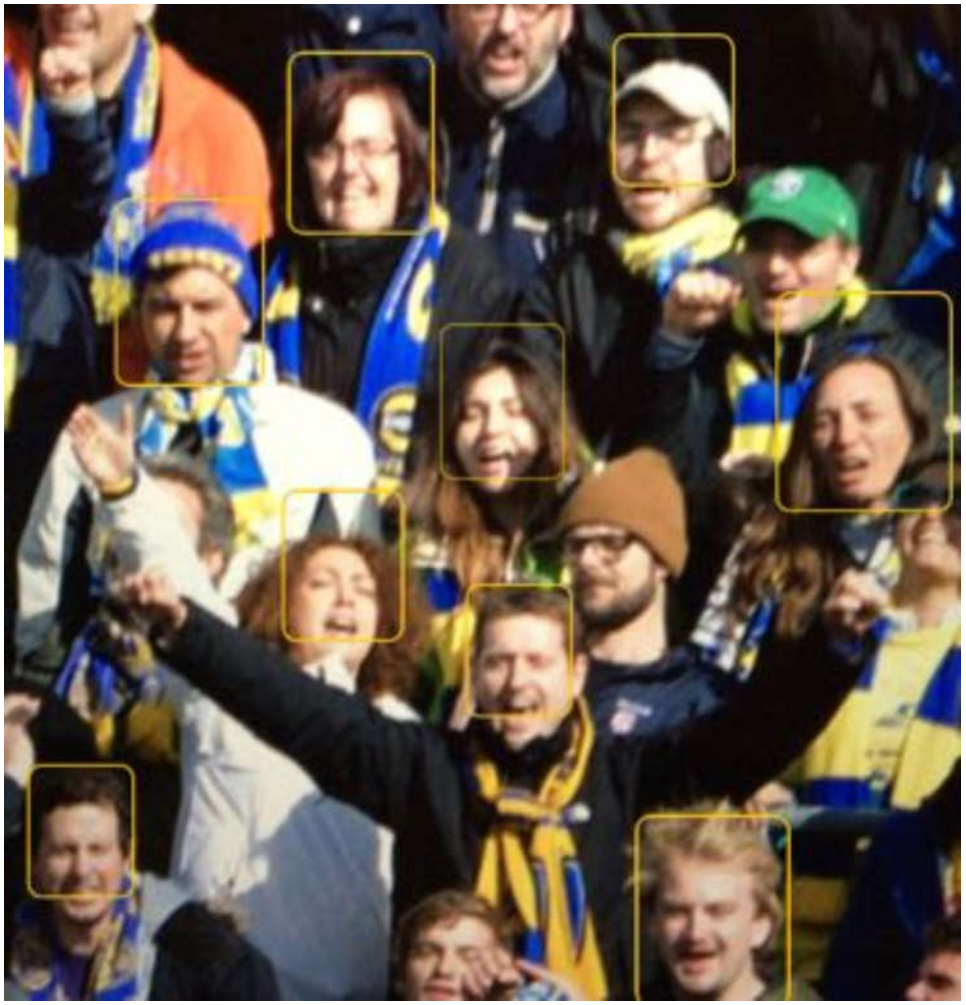
Face detection



Viola-Jones method.

Applications of AI

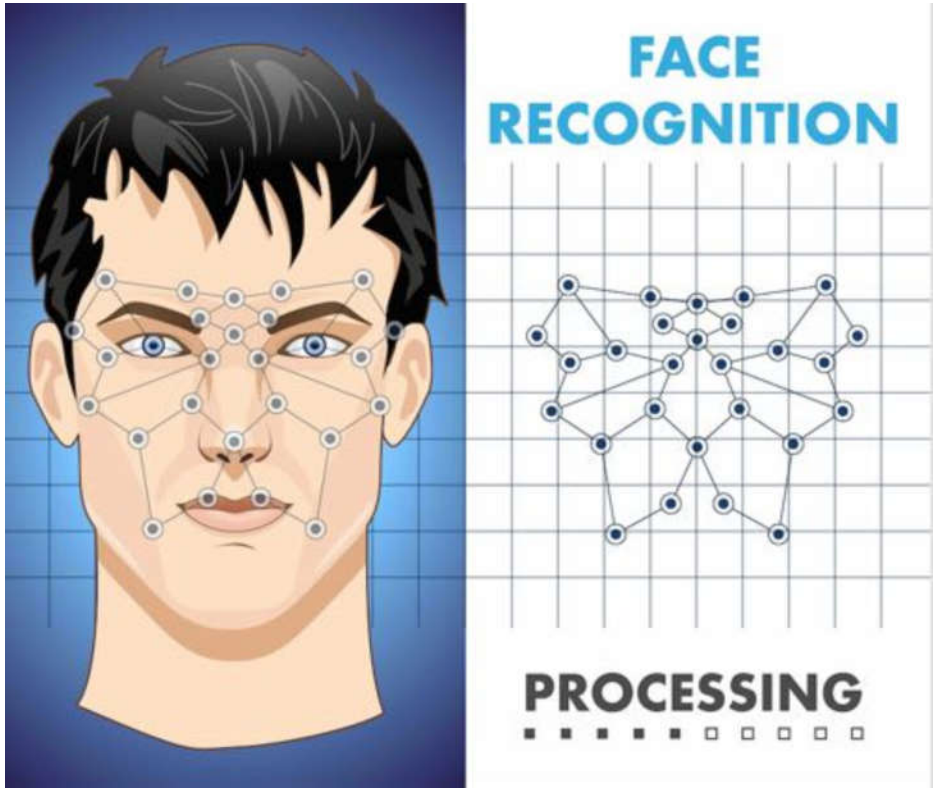
Face detection



Viola-Jones method.

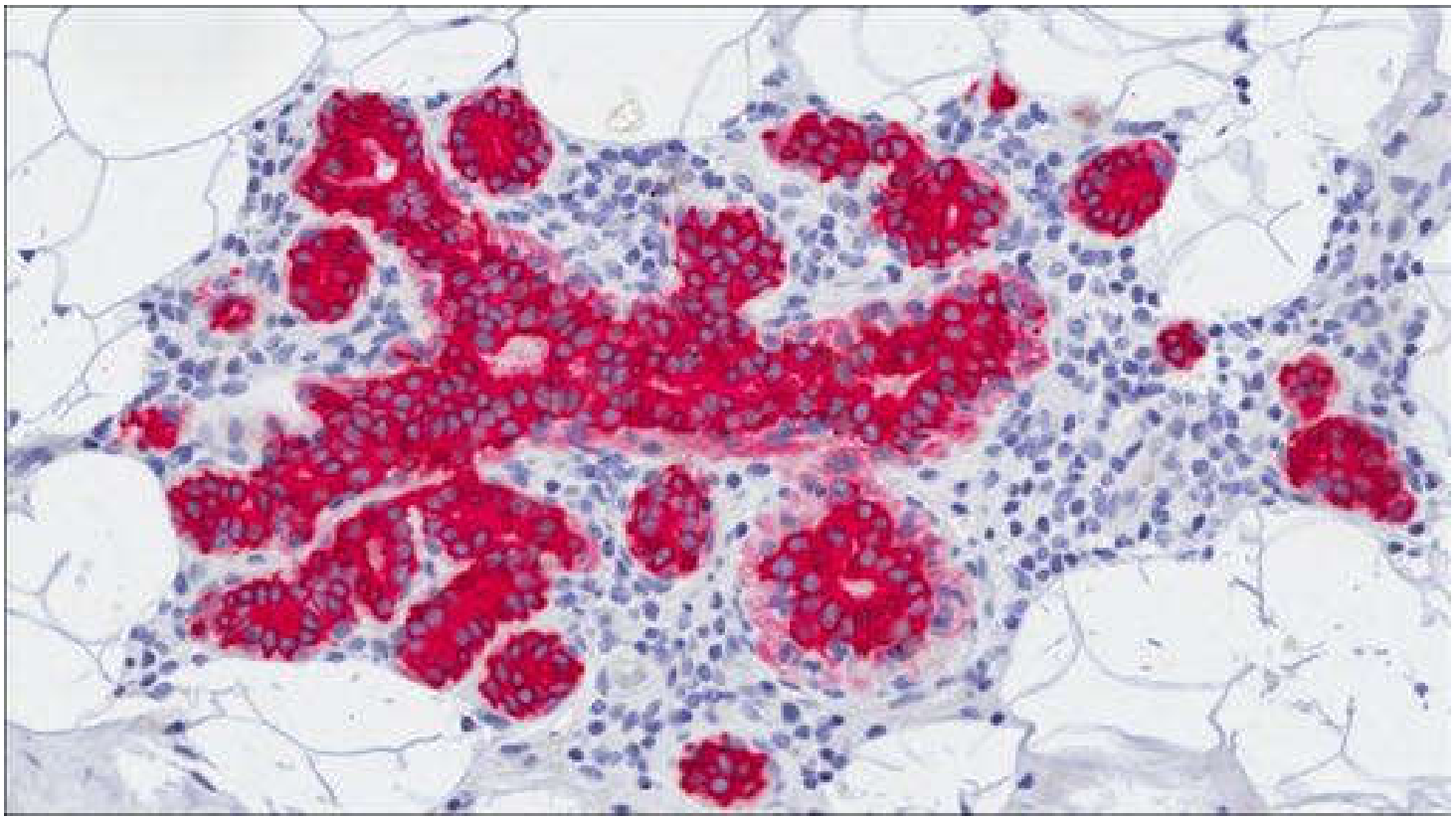
Applications of AI

Face recognition



Applications of AI

Detection of breast cancer in mammography images



Applications of AI

Chess (1997): Kasparov vs. IBM Deep Blue

(Left) Copyright 2007, S.M.S.I., Inc. - Owen Williams, The Kasparov Agency, via Wikimedia Commons (Right) By James the photographer, via Wikimedia Commons

Powerful search algorithms!

Applications of AI

Jeopardy! (2011): Humans vs. IBM Watson

By Rosemaryetoufee (Own work), via Wikimedia Commons

Natural Language Understanding and information extraction!

Applications of AI

Go (2016): Lee Sedol versus Google AlphaGo

AlphaGo

(Left) By LG Electronics, via Wikimedia Commons (Right) By Google DeepMind, via Wikimedia Commons

Deep Learning, reinforcement learning, and search algorithms!

Applications of AI

Autonomous driving

By User Spaceape on en.wikipedia, via Wikimedia Commons

- DARPA Grand Challenge
  - 2005: 132 miles
  - 2007: Urban challenge
  - 2009: Google self-driving car

State-of-the-art applications

- Speech recognition
- Autonomous planning and scheduling
- Financial forecasting
- Game playing, video games
- Spam fighting
- Logistics planning
- Robotics (household, surgery, navigation)
- Machine translation
- Information extraction
- VLSI layout
- Automatic assembly
- Sentiment analysis
- Fraud detection
- Recommendation systems
- Web search engines
- Autonomous cars
- Energy optimization
- Question answering systems
- Social network analysis
- Medical diagnosis, imaging
- Route finding
- Traveling salesperson
- Protein design
- Document summarization
- Transportation/scheduling
- Computer animation

State-of-the-art applications

- Speech recognition
- Autonomous planning and scheduling
- Financial forecasting
- Game playing, video games
- Spam fighting
- Logistics planning
- Robotics (household, surgery, navigation)
- Machine translation
- Information extraction
- VLSI layout
- Automatic assembly
- Sentiment analysis
- Fraud detection
- Recommendation systems
- Web search engines
- Autonomous cars
- Energy optimization
- Question answering systems
- Social network analysis
- Medical diagnosis, imaging
- Route finding
- Traveling salesperson
- Protein design
- Document summarization
- Transportation/scheduling
- Computer animation

Many more!