TDA231 / DIT381 Algorithms for machine learning and inference

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Computer Science and Engineering

Chalmers University of Technology

People

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- Course Assistants:
  - Vasileios Athanasiou vasath@chalmers.se
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  - Emilio Jorge emilio.jorge@chalmers.se
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  - Aristide Tossou aristide@chalmers.se
  - Yuchong Zhang yuchong@chalmers.se
- Build your groups soon!

Resources

- Course Canvas page:

  https://chalmers.instructure.com/courses/4086

- Textbook, slides and other reading on the course page

S. Rogers and M. Girolami, A First Course in Machine Learning, 2nd edition , Chapman & Hall/CRC 2016, ISBN: 9781498738484.

Evaluation

- Five homework assignments (see course page for detail),
- Final take home 24 hour exam during the exam week (date to be fixed soon).
- **Weighting of the scores:**
  final_grade = 0.5 * take_home_exam + 0.5 * homework_assignments

Contact

- For general questions about the assignments contact
  - Divya Gover: divya.grover@chalmers.se
  - Aristide Tossou: aristide@chalmers.se
- Contact the responsible TAs about the specific assignments

- Contact me for questions/suggestions about the lectures, concepts, topics, etc.

Student representatives

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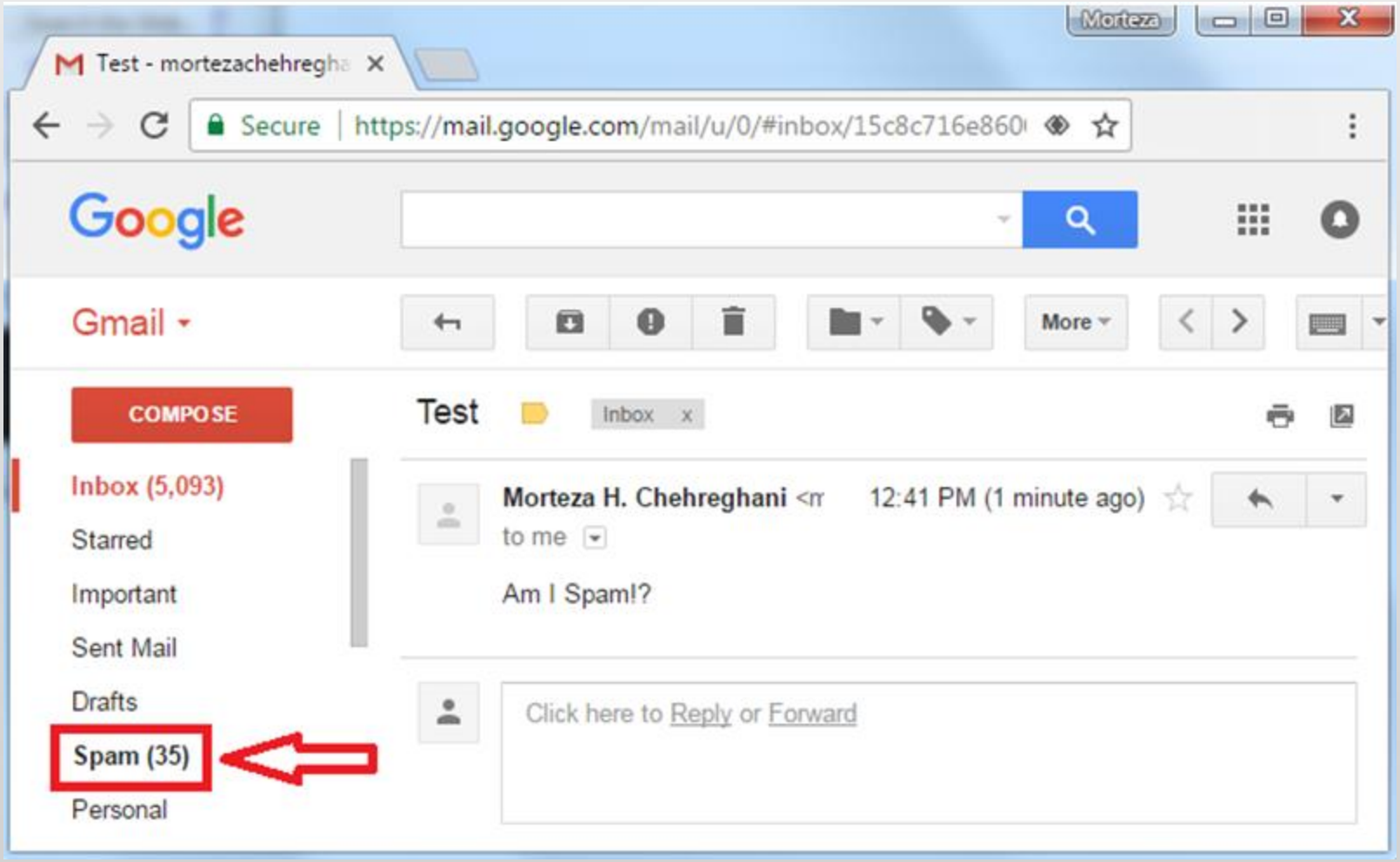
- Edin Tataragic, tedin@student.chalmers.se
- Felix Hulthén, felixhu@student.chalmers.se

W
OK
MODE
MENU


Morteza
Test - mortezachehregha
Secure
https://mail.google.com/mail/u/0/#inbox/15c8c716e860
Google
Gmail
More
COMPOSE
Test
Inbox x
Inbox (5,093)
Starred
Important
Sent Mail
Drafts
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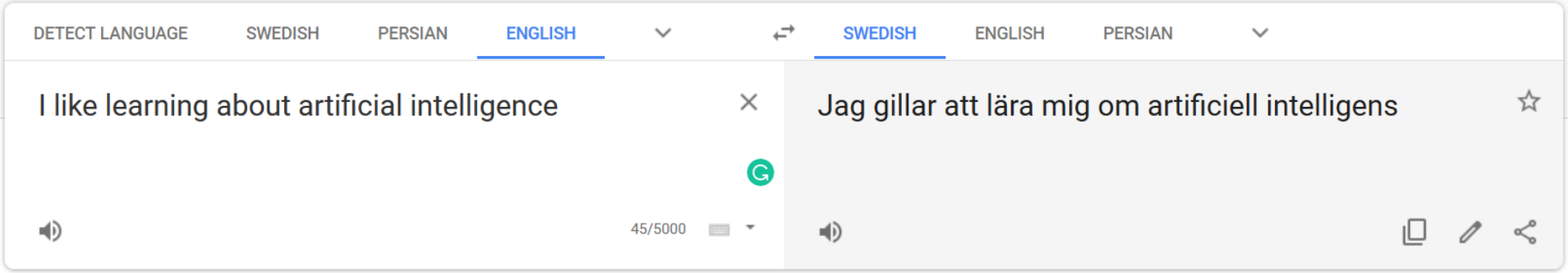
Personal
Morteza H. Chehreghani <m
12:41 PM (1 minute ago)
to me
Am I Spam!?
Click here to Reply or Forward

Google Translate


DETECT LANGUAGE
SWEDISH
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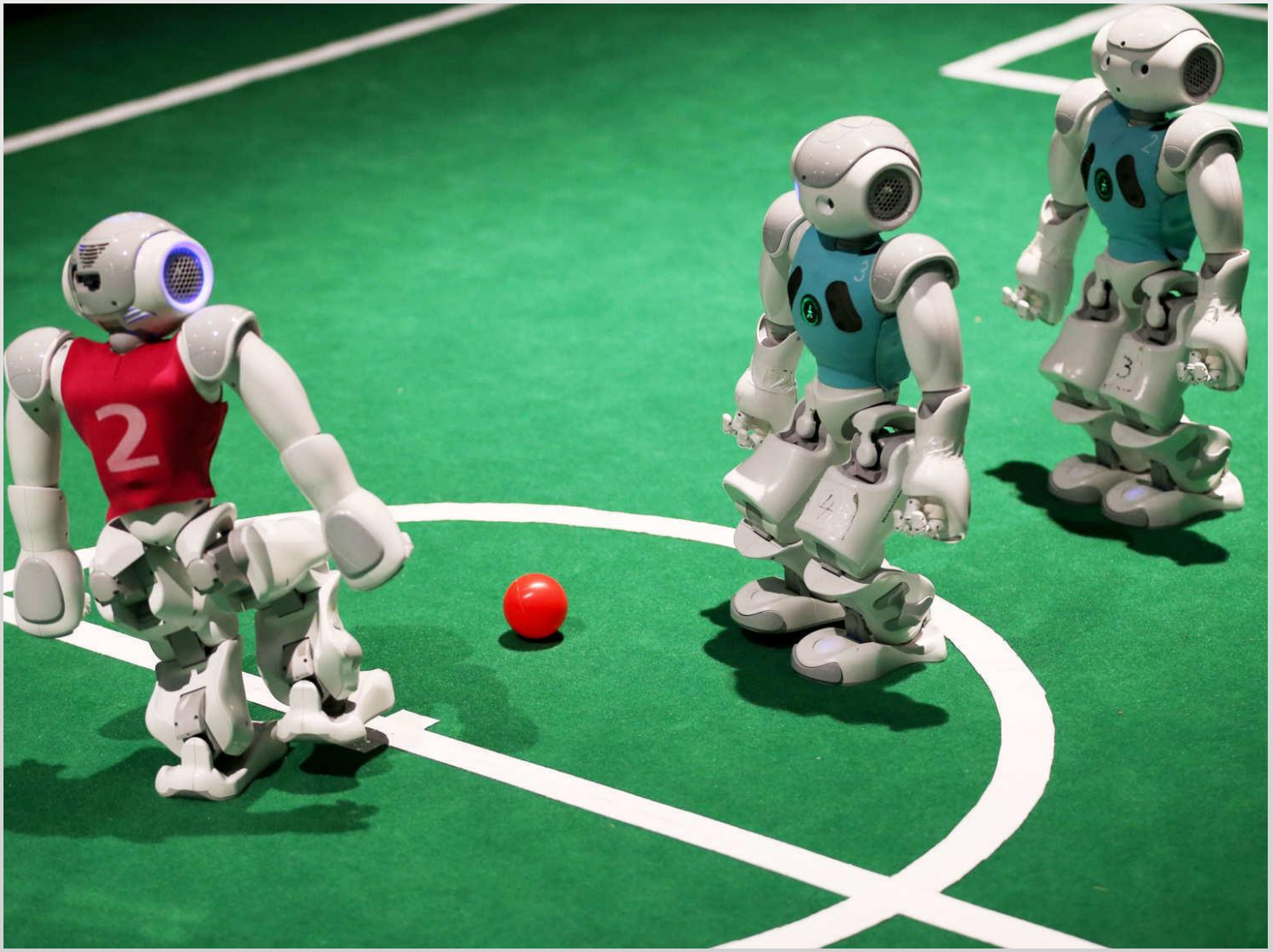
I like learning about artificial intelligence
45/5000
Jag gillar att lära mig om artificiell intelligens


2

6HCM166
Google
self-driving car

AI: the New Electricity

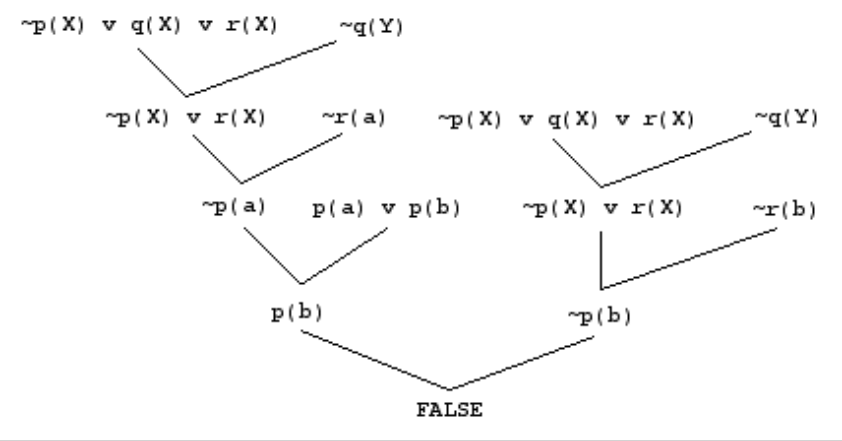
"AI is the new electricity.
Just as electricity transformed industry after industry 100 years ago, I think AI will do the same."

Andrew Ng, Stanford, Baidu, Coursera

- “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.”
  — Alan Turing, *Computing Machinery and Intelligence* (1950)

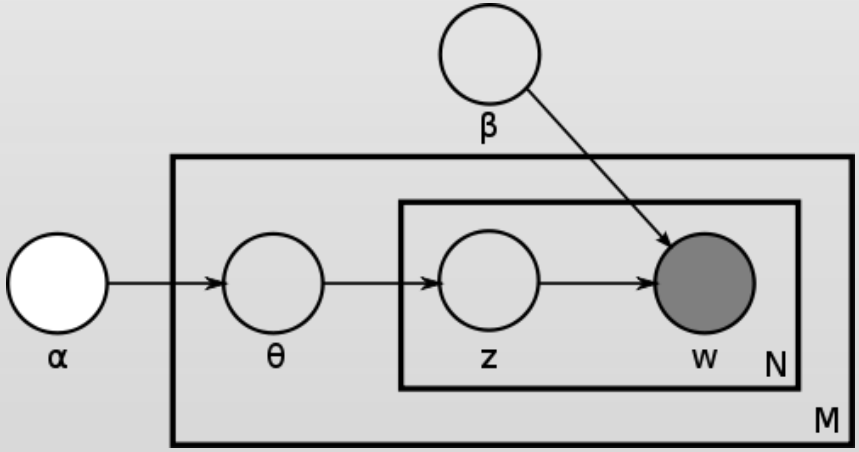
History: logic-based AI (1960-90)

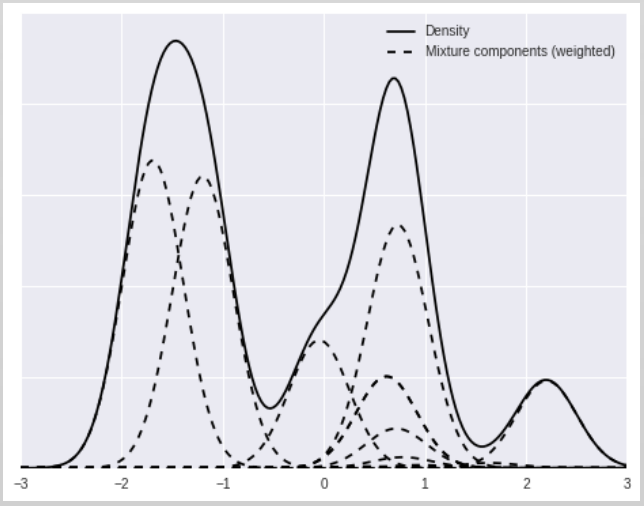
- Knowledge Representation
- First Order Logic and Theorem Proving



- at(restaurant,Alice)
- at(restaurant,Bob)
- at(restaurant,Carol)
- works_at(restaurant,Carol)
- has_job(restaurant,waitress,Carol)
- orders(Bob,pizza)
- orders(Alice,sushi)
- forall X,Y,Z. orders(X,Y) and has_job(restaurant,waitress,Z) -> serves(Z,X,Y)
- serves(Carol,Bob,pizza) serves(Carol,Alice,sushi)

Machine Learning 1990-



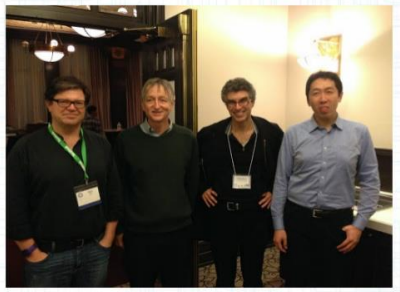


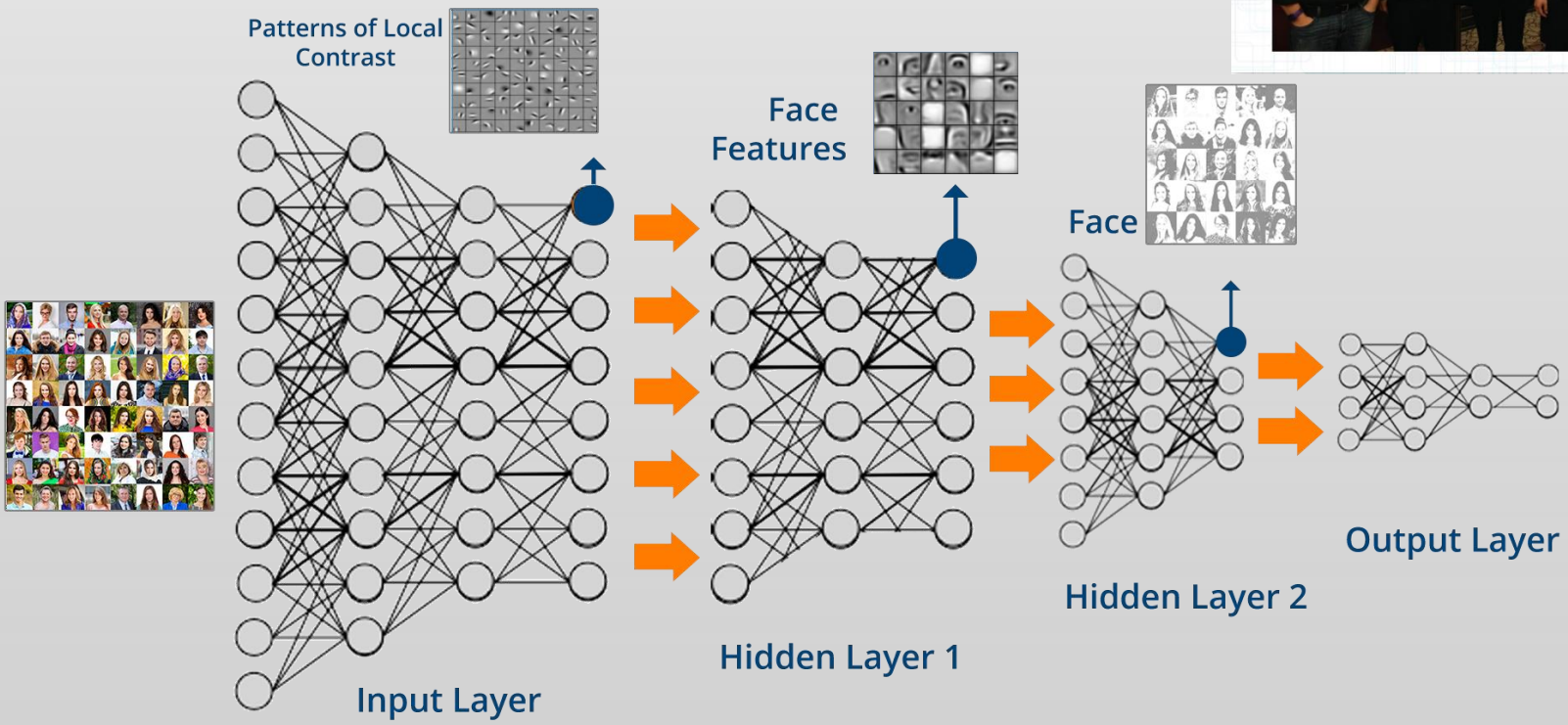
- Data driven
  (no hardcoded rules)
  [e.g., to estimate the parameters of the model]

- Probabilistic models
- Statistical learning and inference

Deep Learning 2005-

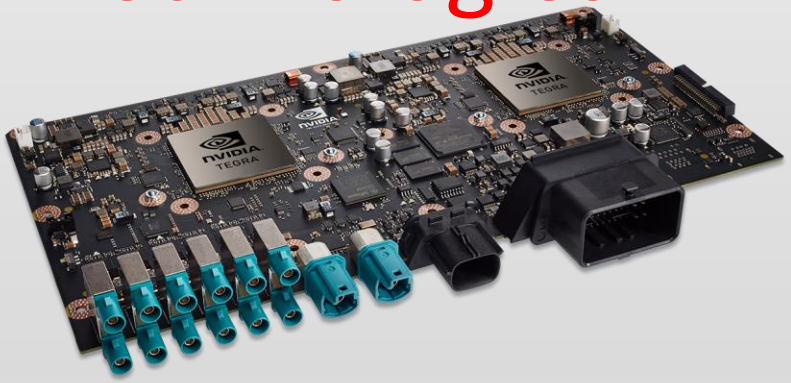
People Behind It :
LeCun, Hinton, Bengio & Ng

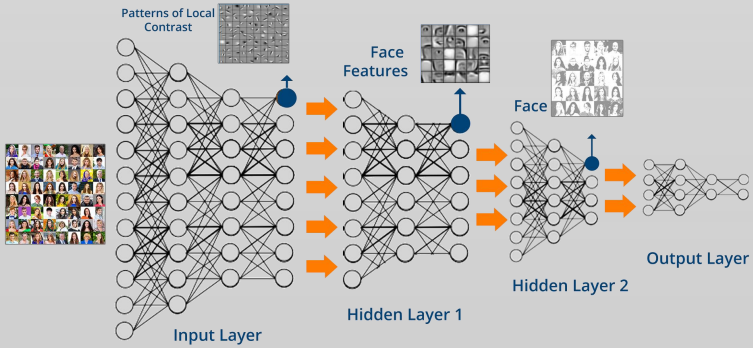


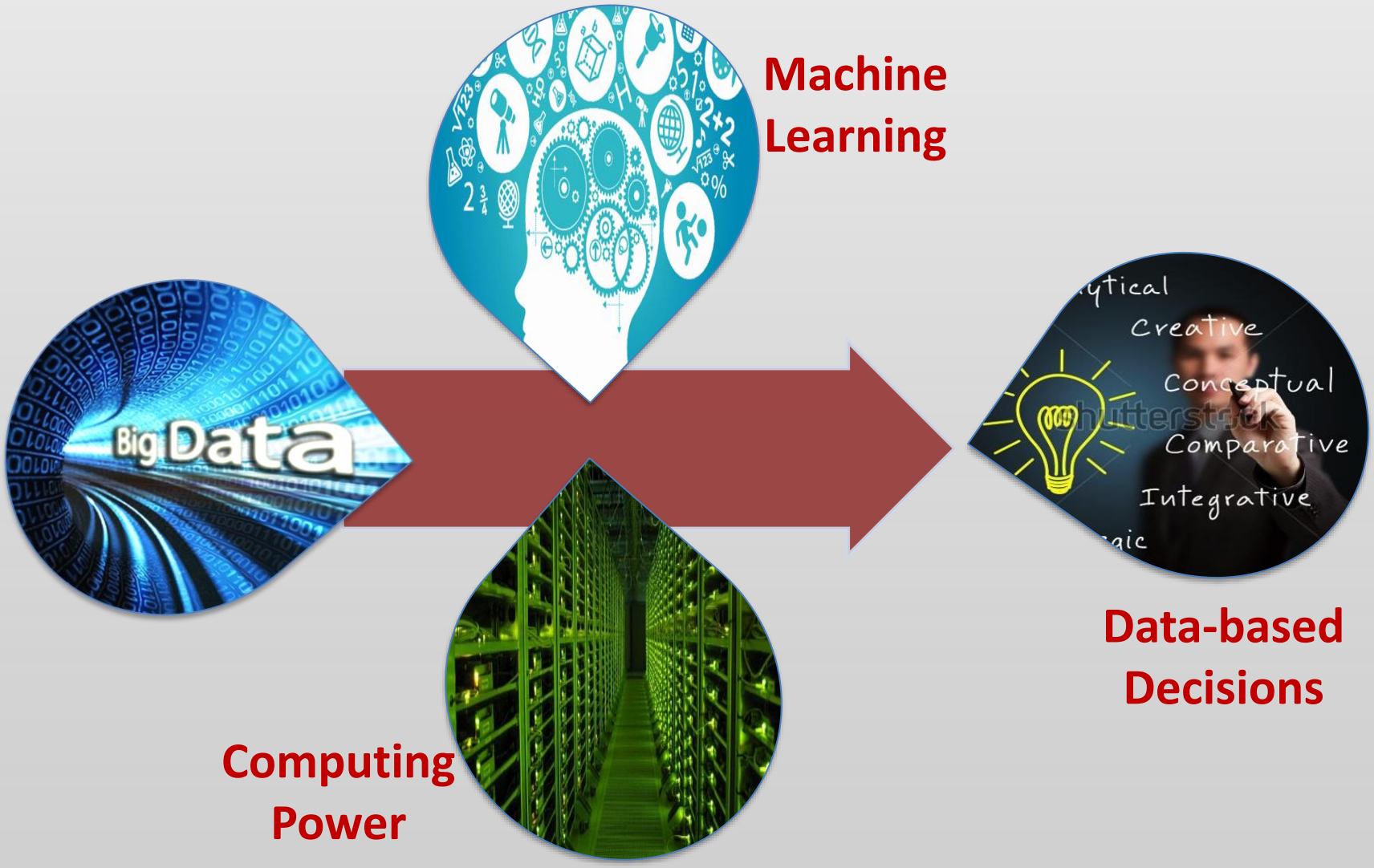


Why Now?
Convergence of Technologies

- Data sensing, acquisition revolution
- Rapid increase in computing power
- Novel algorithms
- Software frameworks

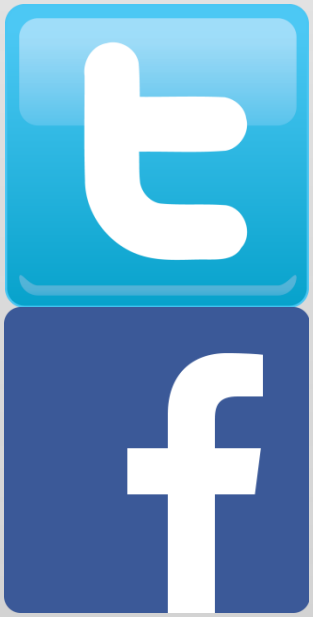





Machine Learning
Big Data
Creative
Conceptual
Comparative
Integrative
Data-based Decisions
Computing Power

How much data?

12+ TBs
of tweet data every day



25+ TBs **of log data every day**

4.6 billion
camera phones worldwide

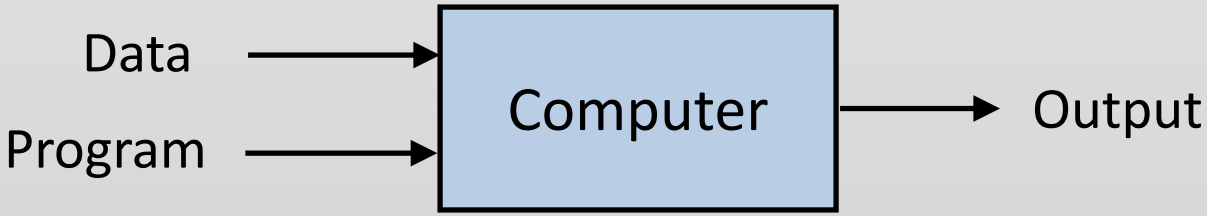
100s of millions of GPS enabled
devices sold annually

3.5+ billion
people on the Web

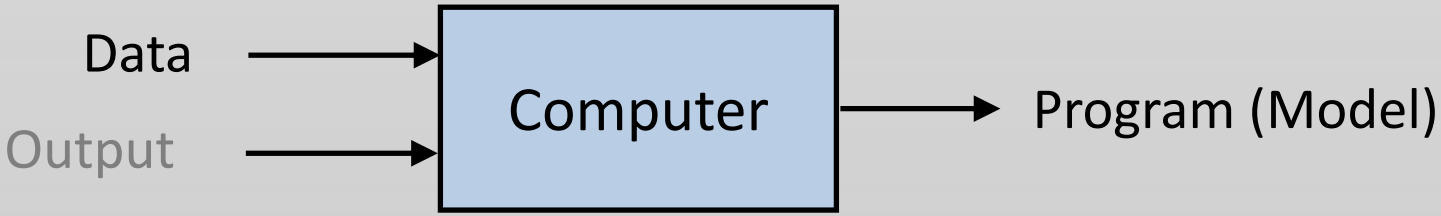
Machine learning definition (1)

- Arthur Samuel (1959): Field of study that gives computers the ability to learn without being explicitly programmed.

Programming



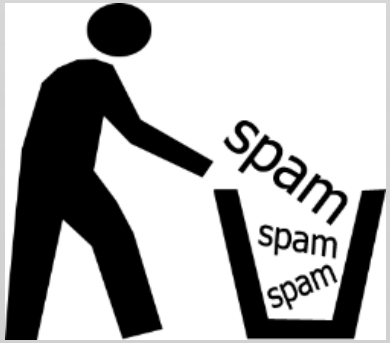
Machine Learning

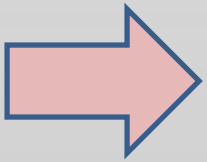


Machine learning definition (2)

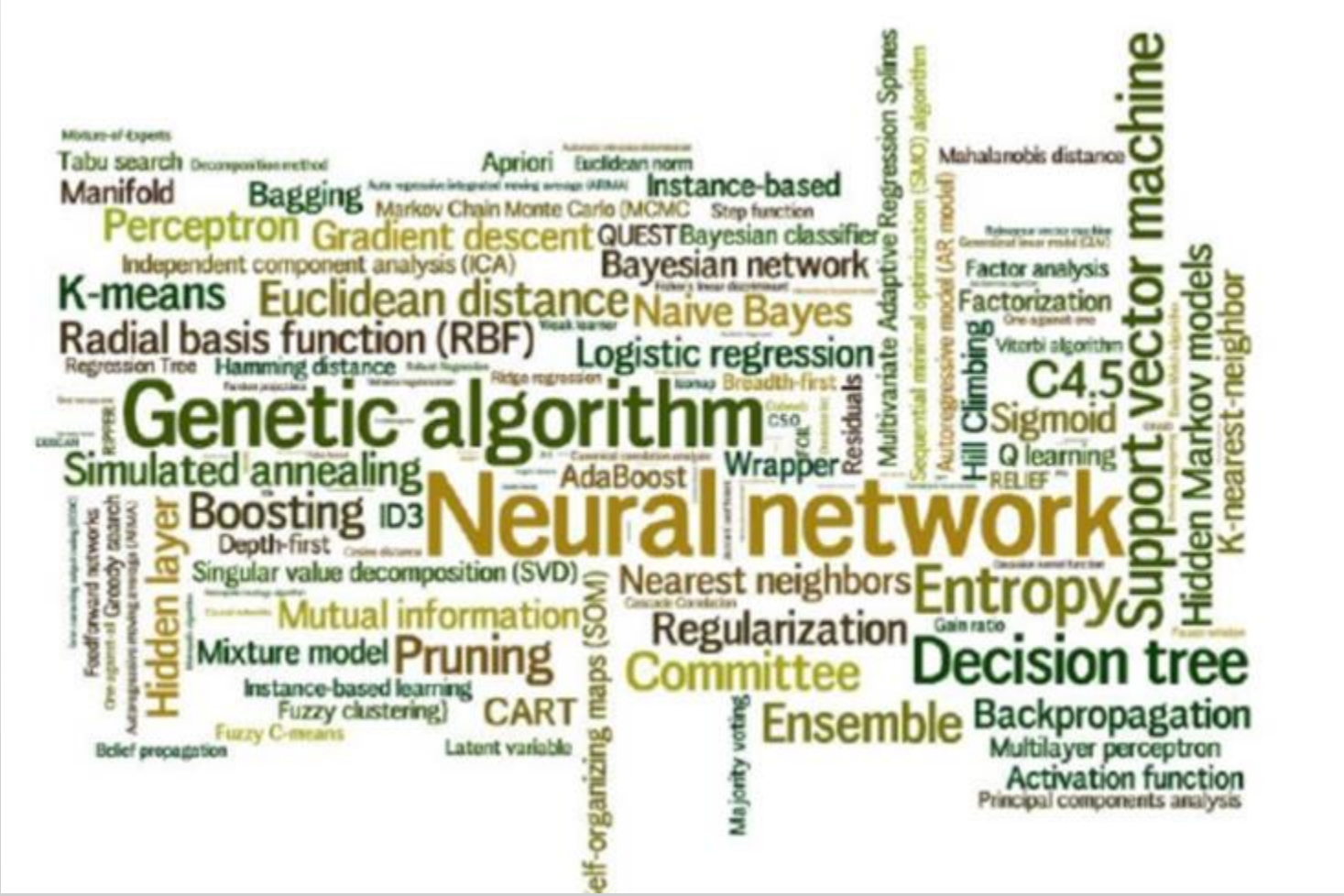
- Herbert A. Simon (1957): Learning is any process by which a system improves performance from experience.

- Tom Mitchell (1997): A computer program is said to learn from experiences with respect to some class of tasks and performance measures, if its performance at the tasks improves with the experiences.





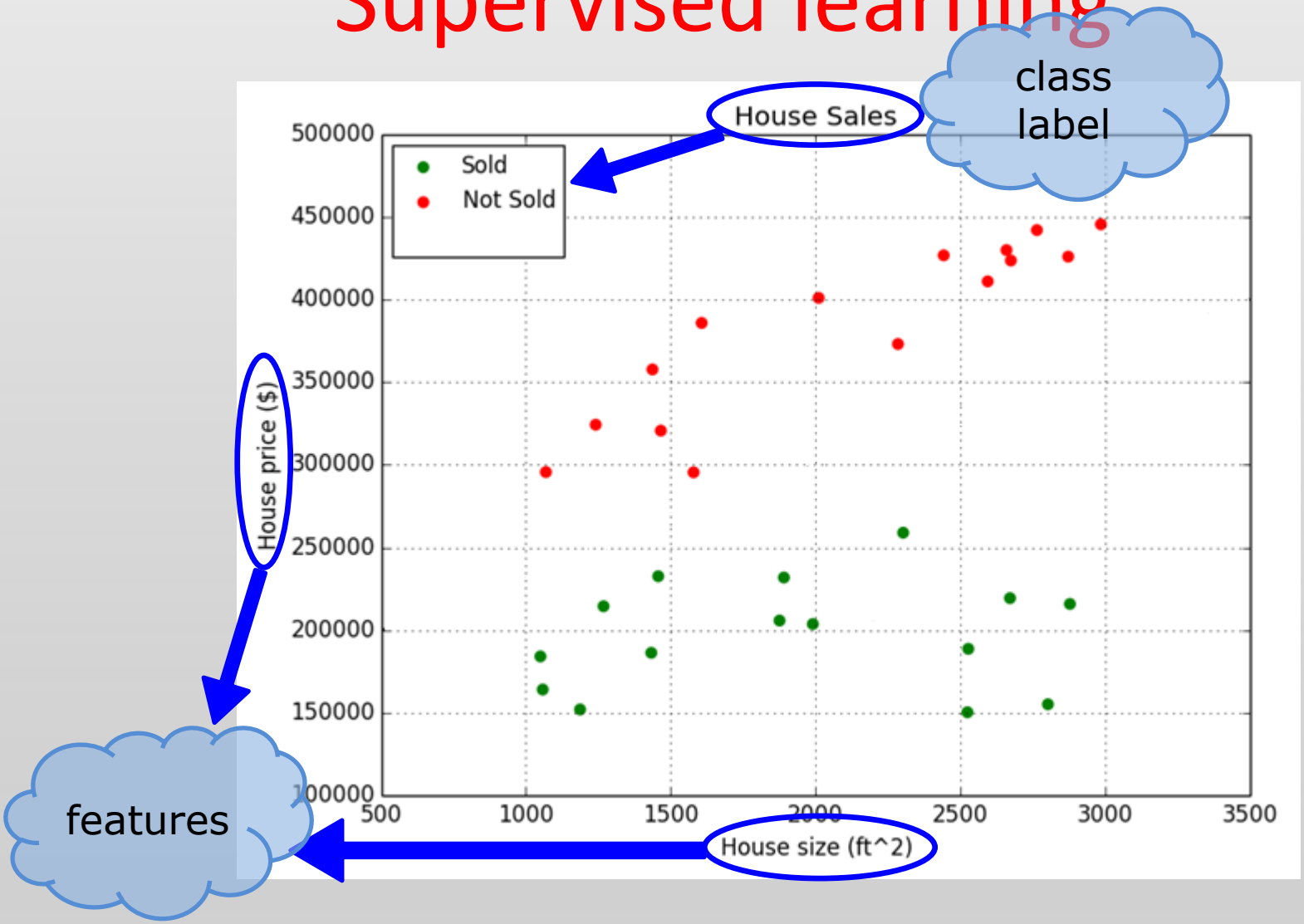
Machine learning algorithms



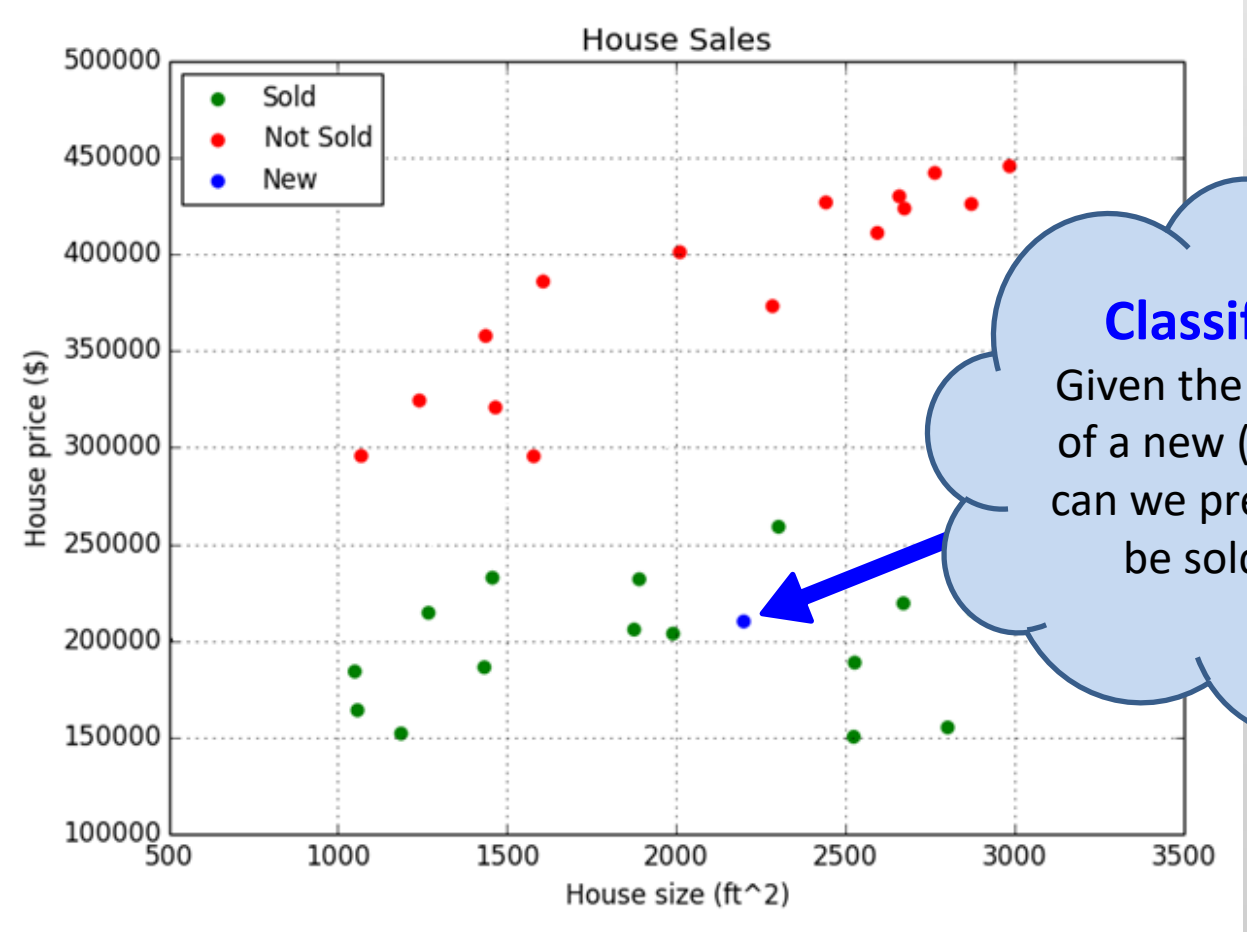
Types of learning

- **Supervised learning**
  - Learning in presence of training (labeled) data
- **Unsupervised learning**
  - Learning when no training data is available
- **Reinforcement learning**
  - Interactive learning in an environment

Supervised learning

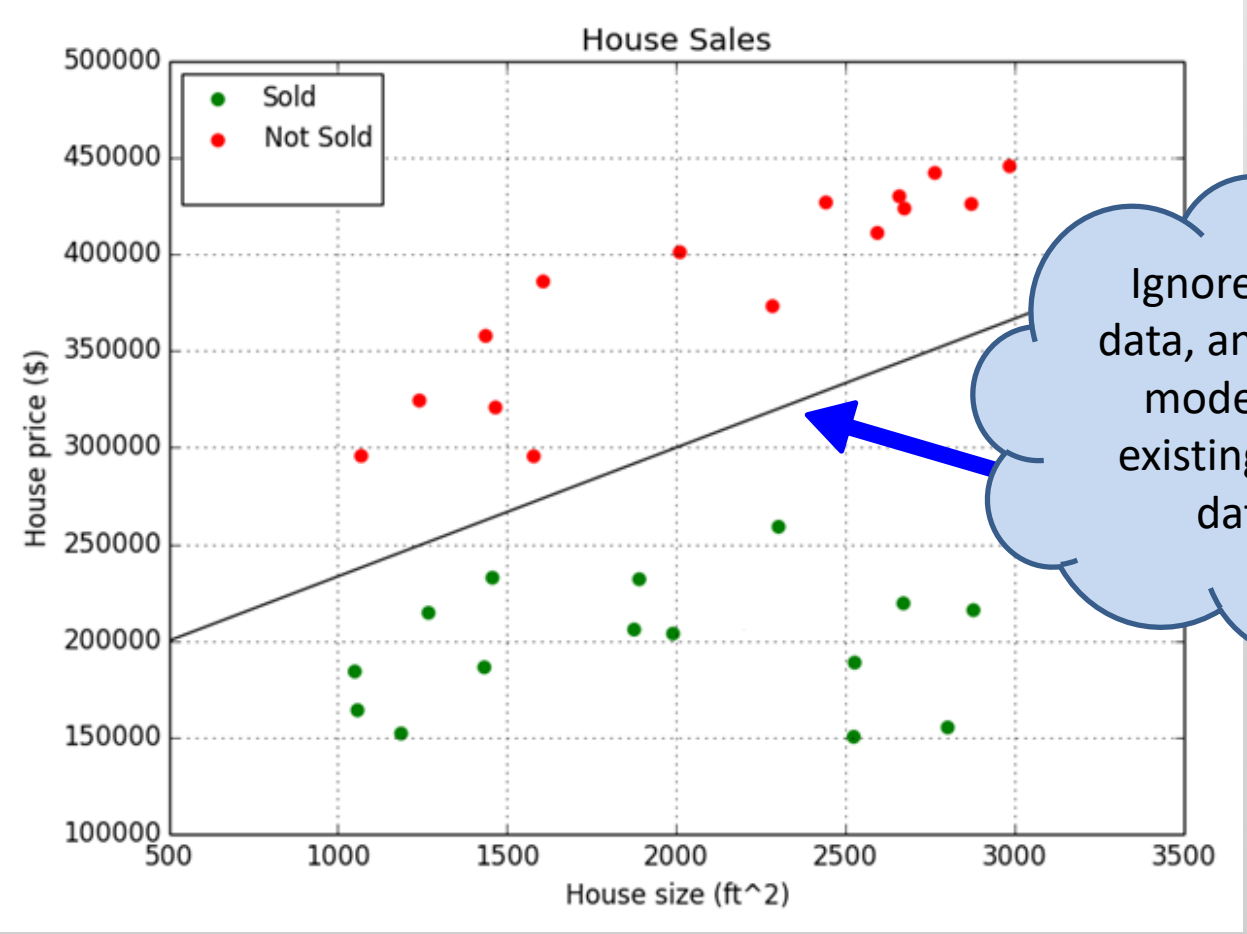


Supervised learning



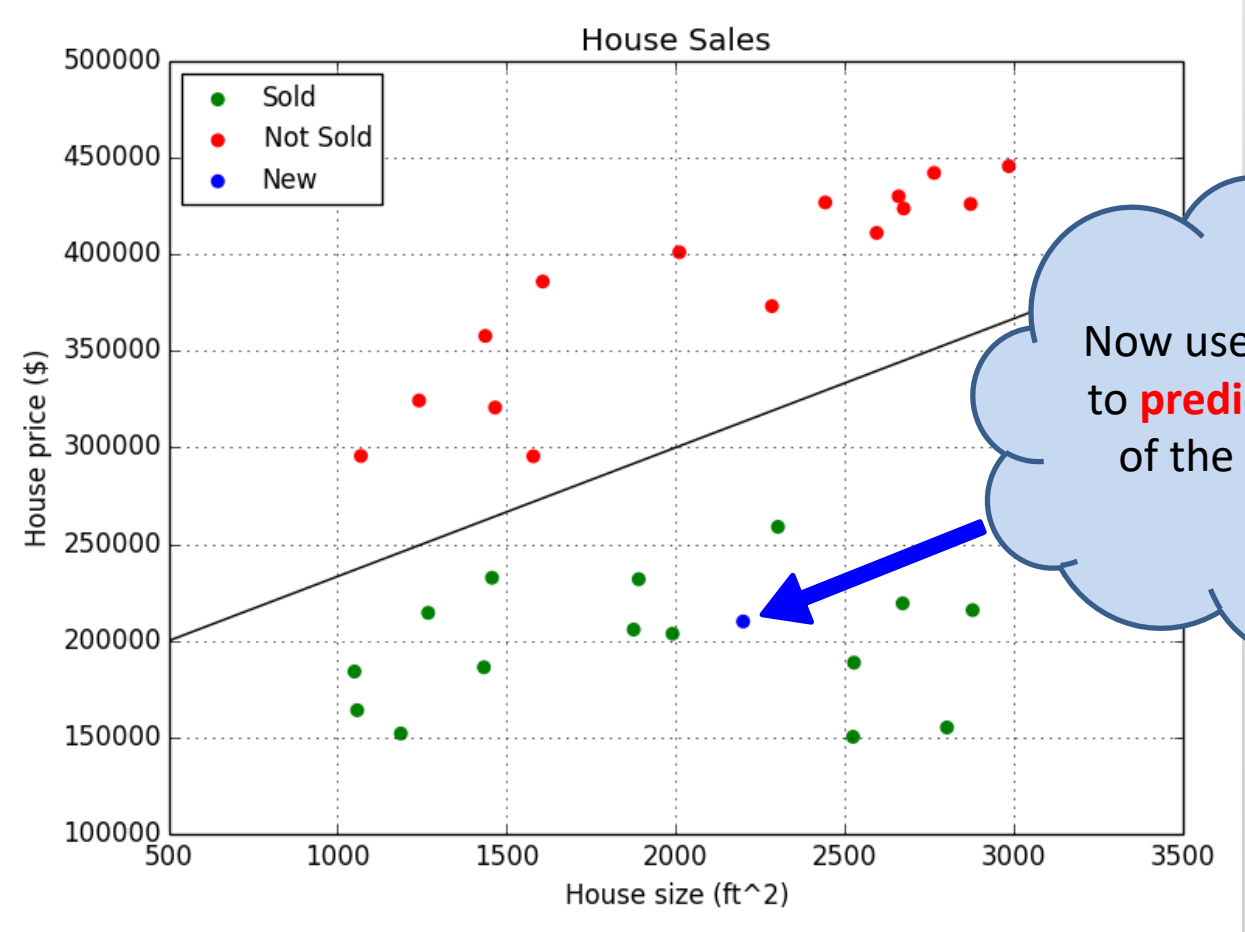
Classification:
Given the information of a new (**test**) house, can we predict if it will be sold or not?

Supervised learning



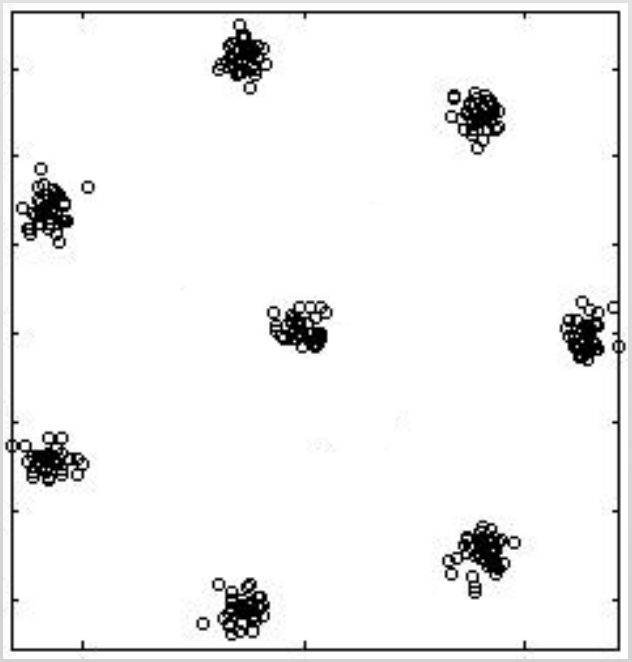
Ignore the **test** data, and obtain a model on the existing **training** dataset.

Supervised learning



Now use the **model** to **predict** the label of the **test** data.

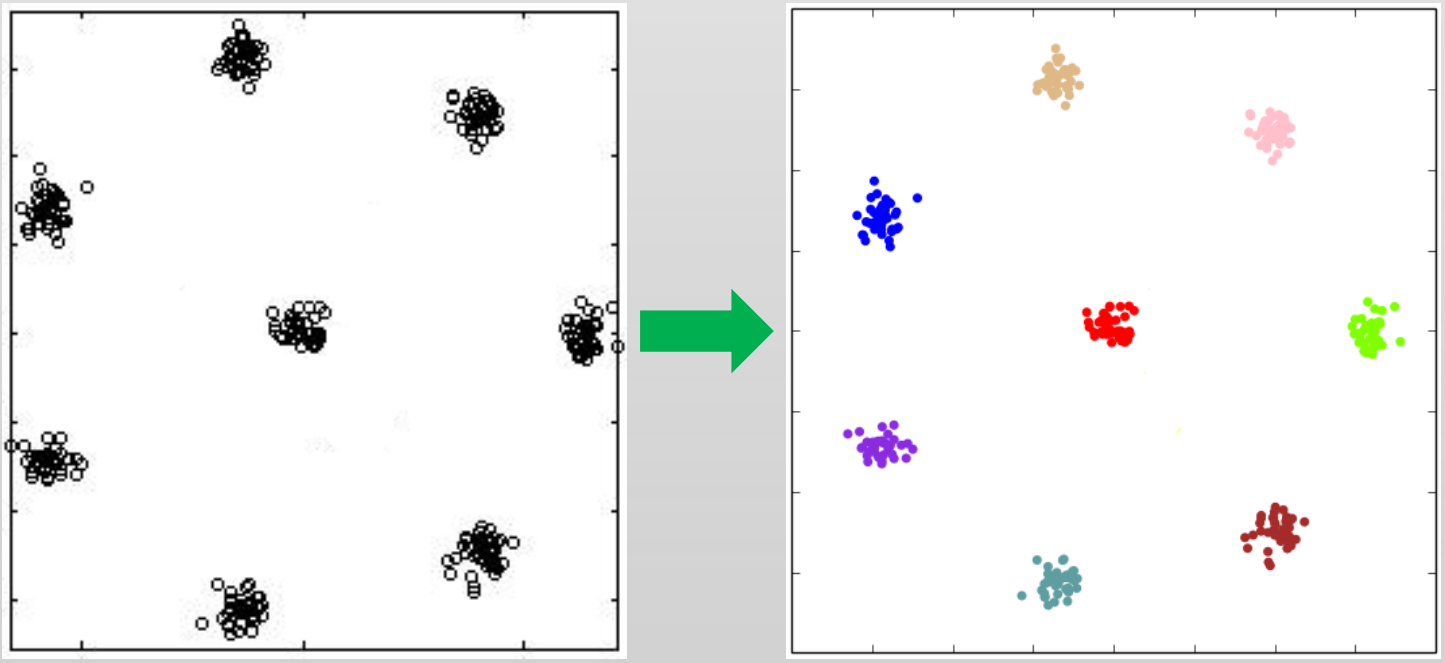
Unsupervised learning



No **training** data
is available!

Unsupervised learning

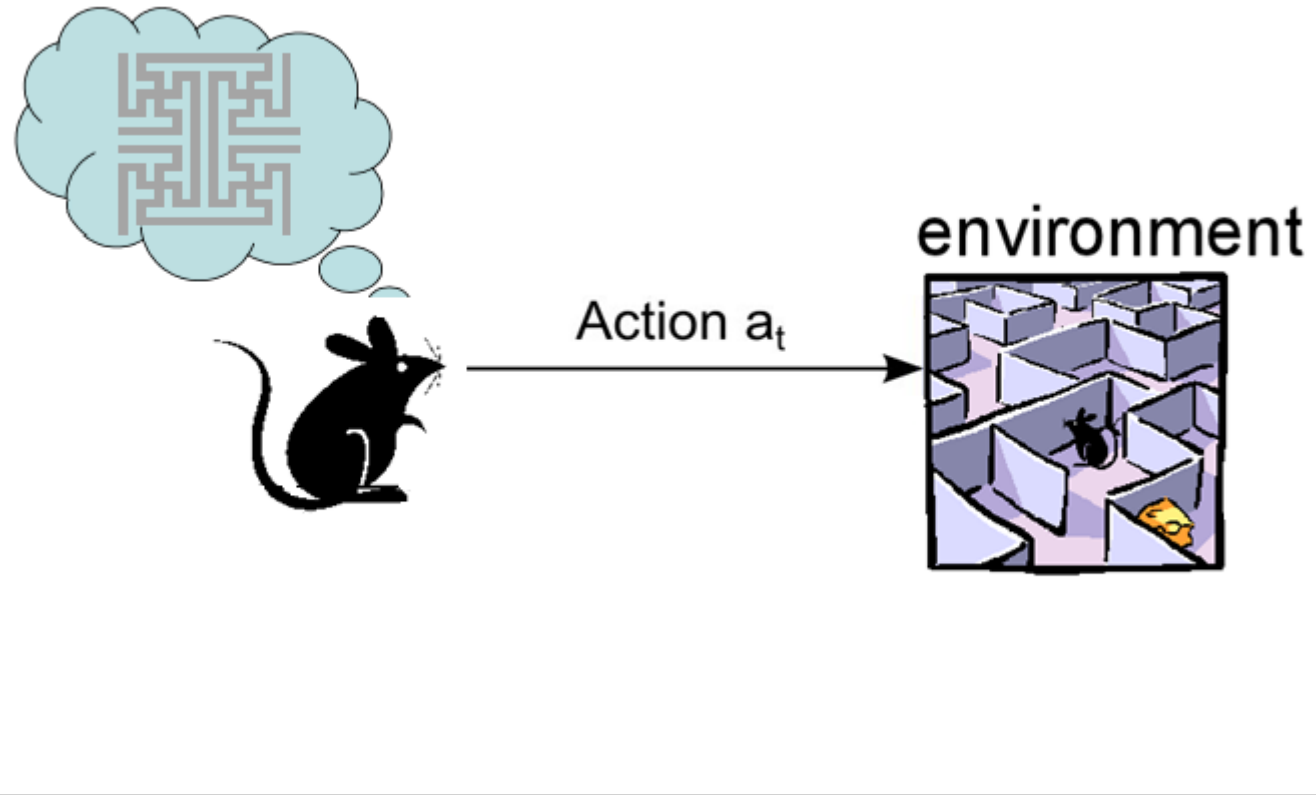
Clustering: Partition the data into groups of similar objects.



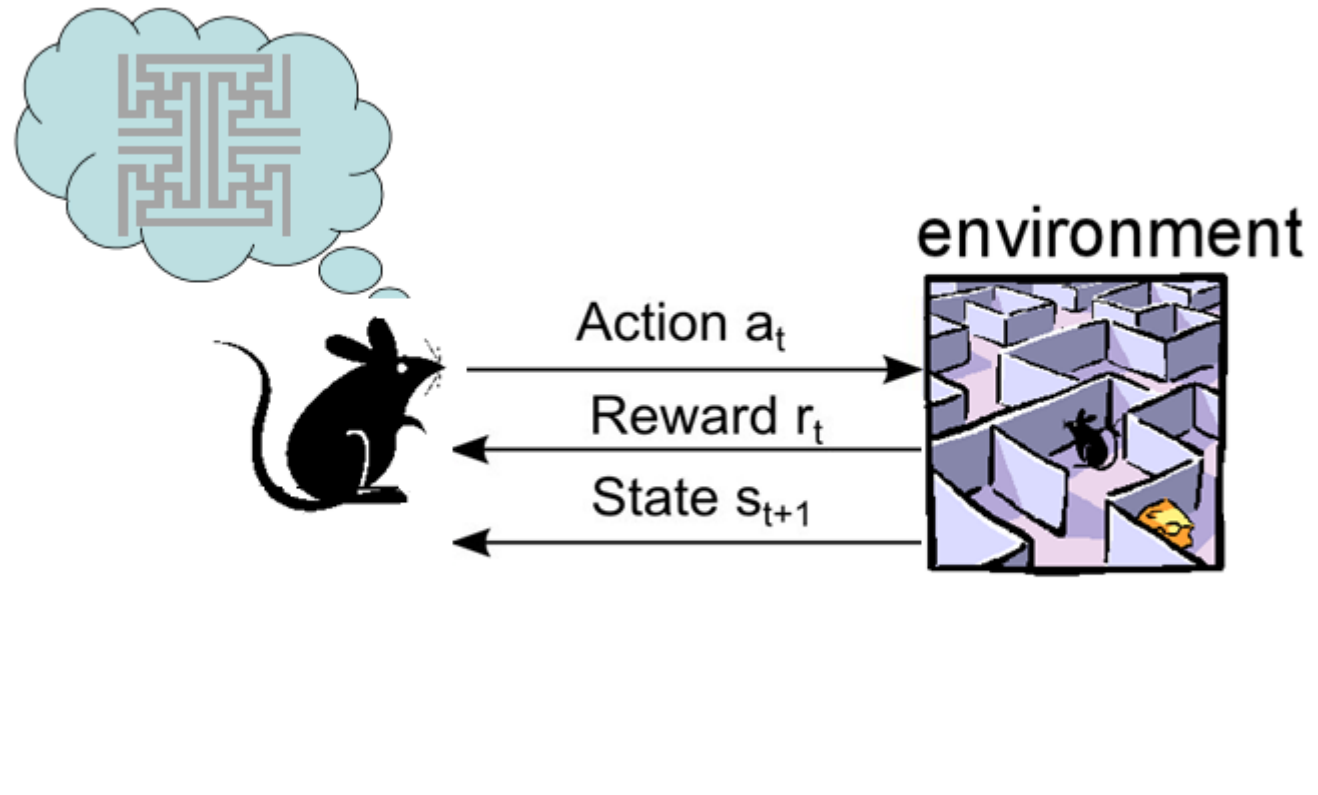
Reinforcement learning

environment

Reinforcement learning



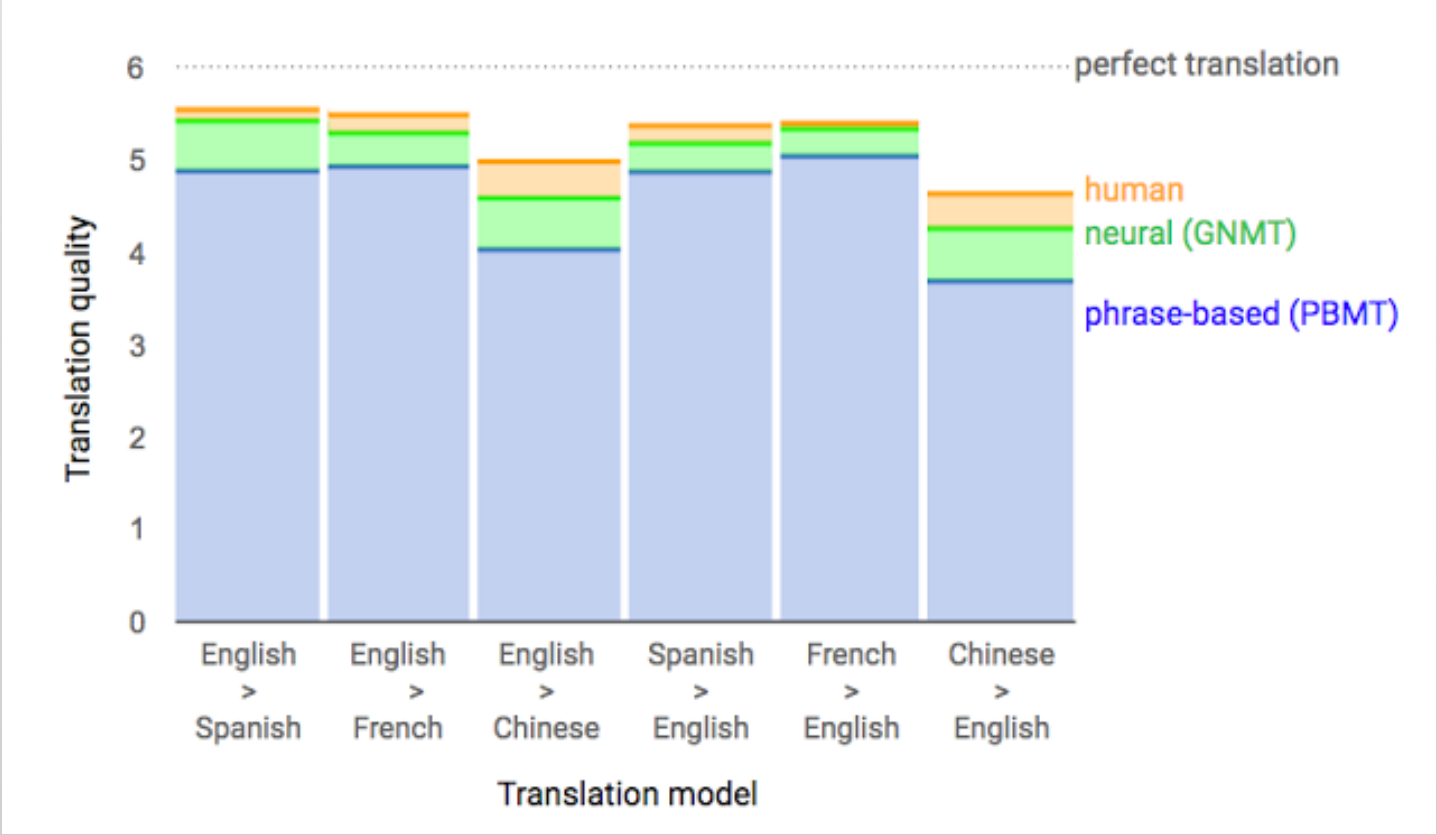
Reinforcement learning



Yann LeCun, NIPS 2016

- **"Pure" Reinforcement Learning (cherry)**
  - The machine predicts a scalar reward given once in a while.
  - **A few bits for some samples**
- **Supervised Learning (icing)**
  - The machine predicts a category or a few numbers for each input
  - Predicting human-supplied data
  - **10→10,000 bits per sample**
- **Unsupervised/Predictive Learning (cake)**
  - The machine predicts any part of its input for any observed part.
  - Predicts future frames in videos
  - **Millions of bits per sample**

AI Revolution in NLP

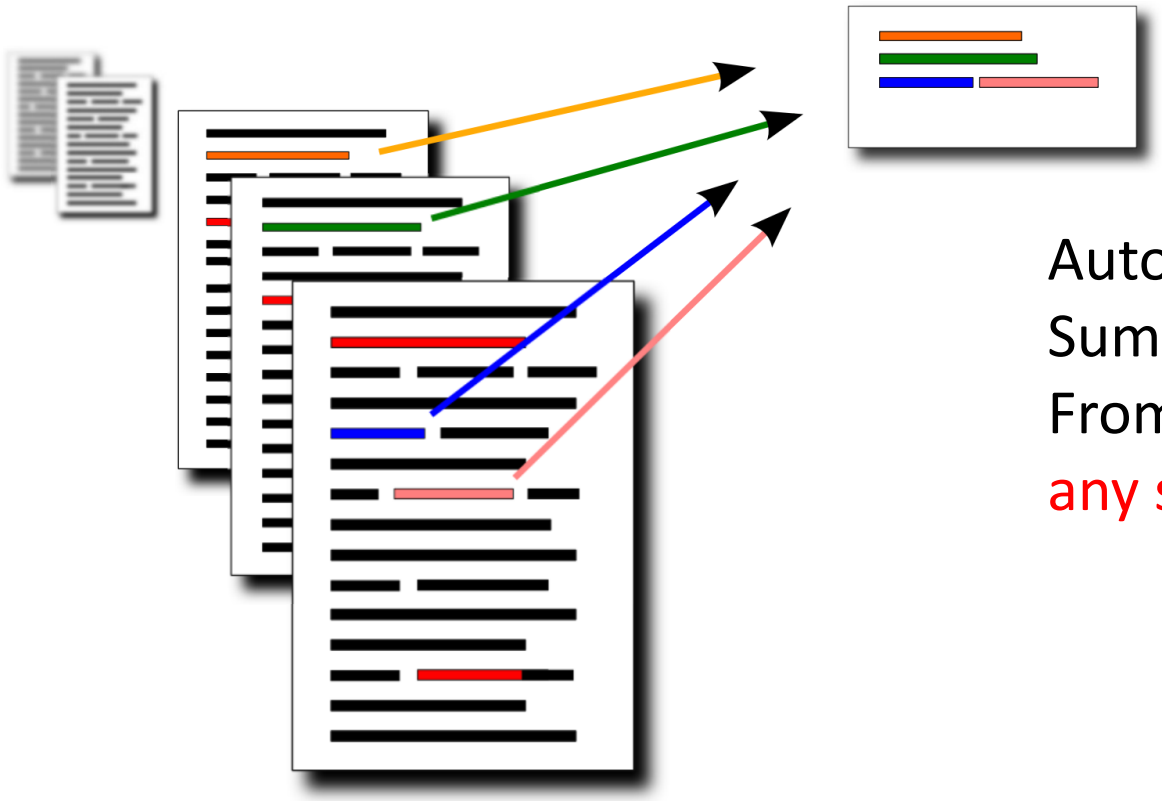


Google Translate

Input sentence:	*Translation (PBMT):*	*Translation (GNMT):*	*Translation (human):*
李克強此行將啟動中加總理年度對話機制，與加拿大總理杜魯多舉行兩國總理首次年度對話。	Li Keqiang premier added this line to start the annual dialogue mechanism with the Canadian Prime Minister Trudeau two prime ministers held its first annual session.	Li Keqiang will start the annual dialogue mechanism with Prime Minister Trudeau of Canada and hold the first annual dialogue between the two premiers.	Li Keqiang will initiate the annual dialogue mechanism between premiers of China and Canada during this visit, and hold the first annual dialogue with Premier Trudeau of Canada.

GOOD MORNING, MR. JONES. HOW ARE YOU TODAY?
おはようございます。
ジョーンズさん
元気ですか。

Document summarization



Automatically extract a Summary of documents From raw text without any supervision.

Document Summarization

Summaries

(Approx. 40 words)

[Multiple Kernel Learning]

The report said Andreas Lubitz repeatedly set the plane for an unauthorised descent earlier that day. He had locked the flight captain out of the cockpit. Five minutes on the Duesseldorf-Barcelona flight 07:21:10 - Plane told to descend to 21,000ft

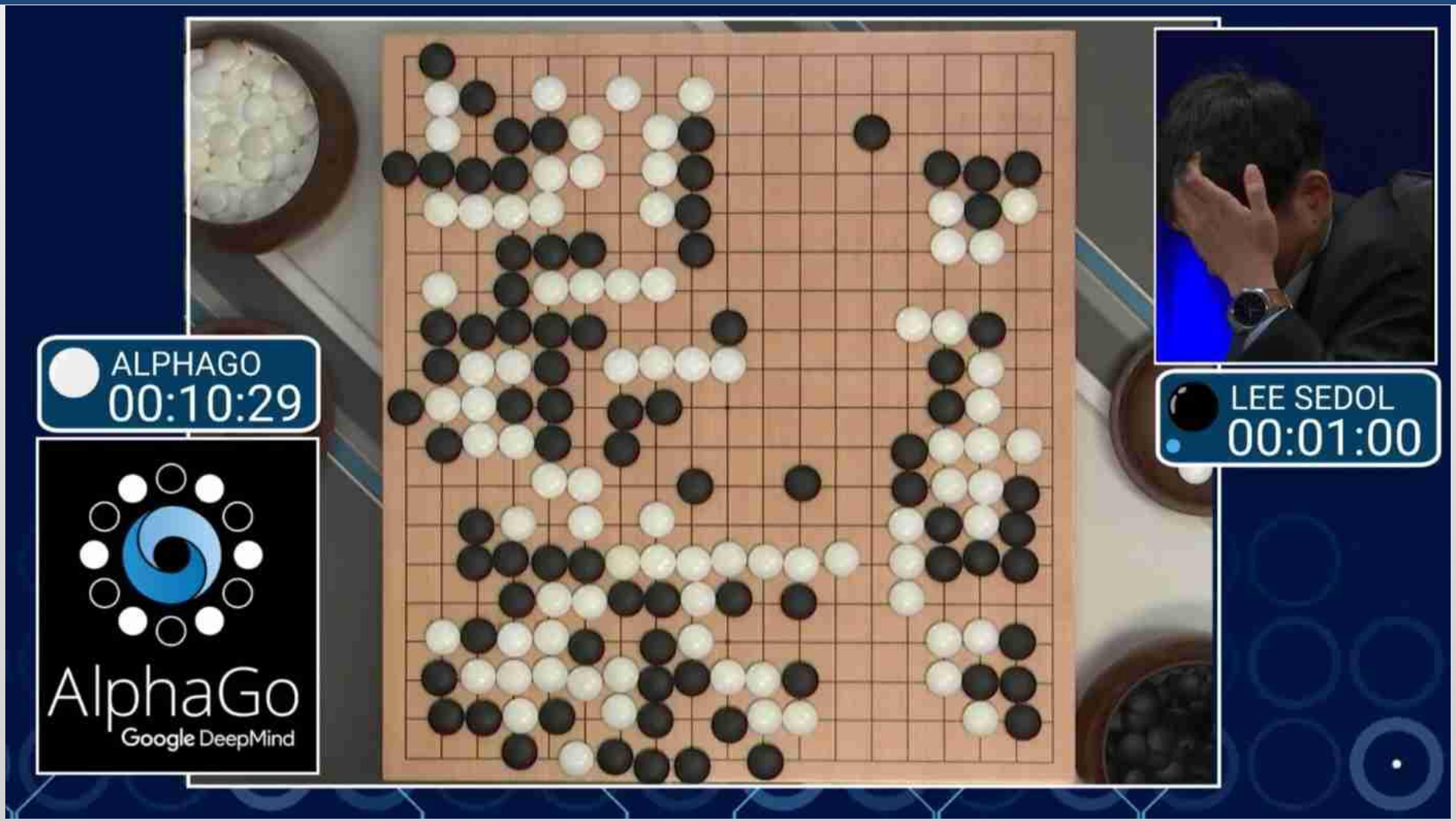
[TextRank]

The co-pilot of the Germanwings plane that

Original Text

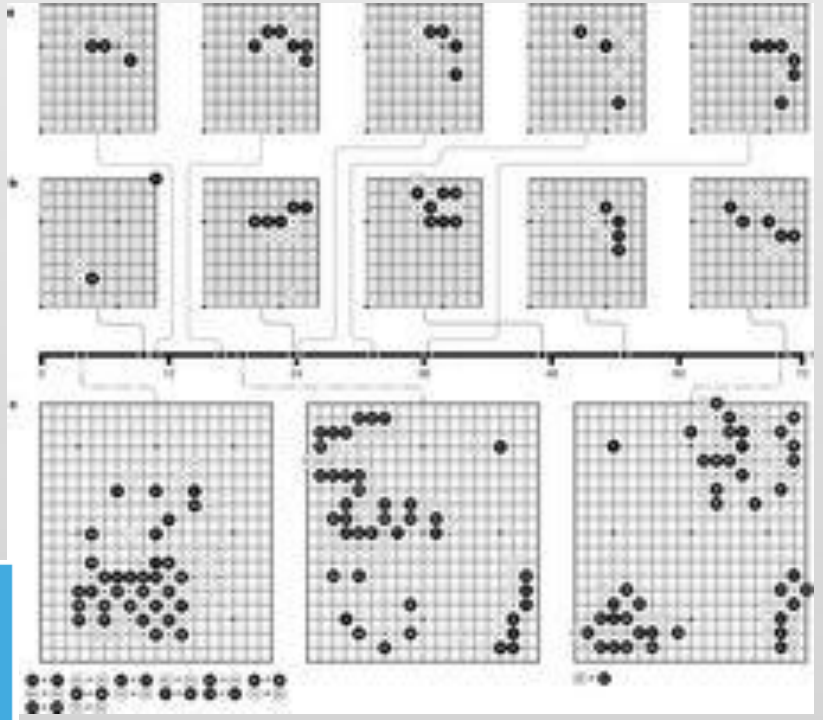
ness Tech Science Magazine Entertainment & Arts Health In Pictures World selected Africa Asia Australia Europe selected Latin America Middle East US & Canada [**Germanwings crash: Co-pilot Lubitz 'practised rapid descent'**] 21 minutes ago From the section Europe [**Germanwings co-pilot Andreas Lubitz is known to have suffered depression in the past**] [**Alps plane crash**] What drives people to murder-suicide? The victims of the Germanwings plane crash Germanwings: Unanswered questions Flight 4U 9525: The final 30 minutes [[**The co-pilot of the Germanwings plane that crashed in the French Alps in March appears to have practised a rapid descent on a previous flight, a report by French investigators says.**]] [**The report said Andreas Lubitz repeatedly set the plane for an unauthorised descent earlier that day.**] Lubitz is suspected of deliberately crashing the Airbus 320, killing all 150 people on board. [[**He had locked the flight captain out of the cockpit.**]] The plane had

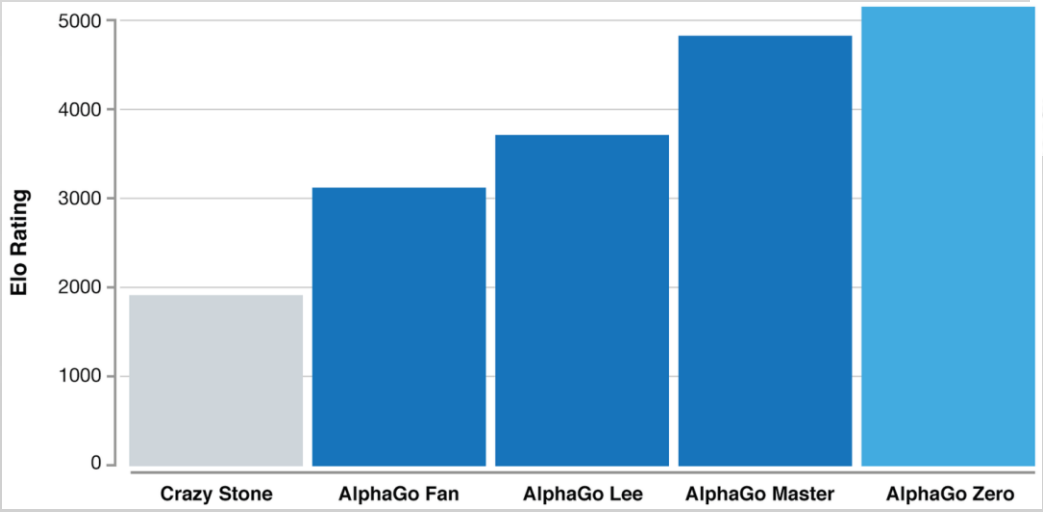
Reinforcement Learning



A recent documentary:
https://www.youtube.com/watch?v=l9sztL9FQto&fbclid=IwAR2dHG0payilRIdLyHVgy3GHJs8aX_sJ-NywXAX01rdkRApDMKpHoJ2VZSI

AlphaGoZero



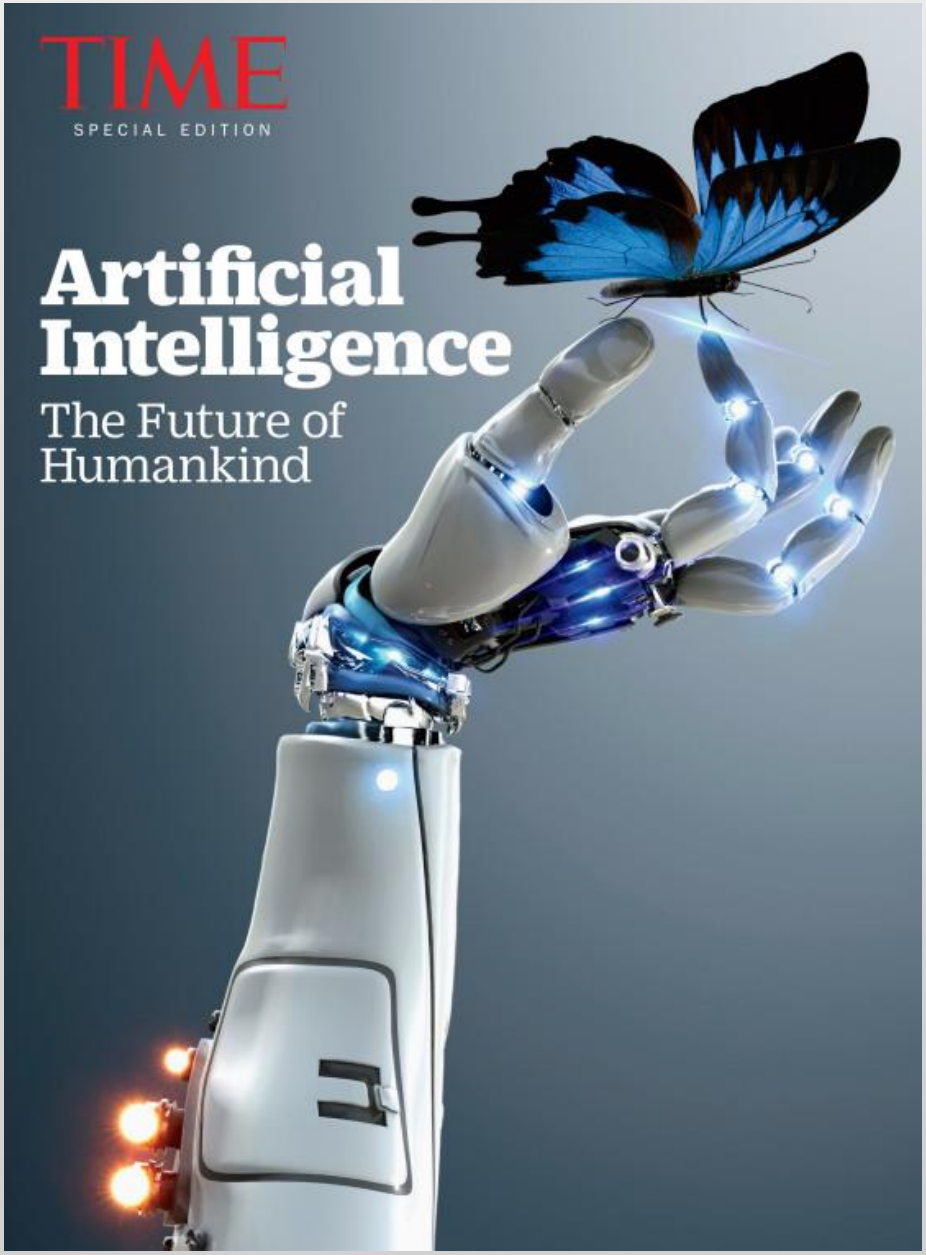


Trained from scratch without any Human input only for 36 hours and beat the previous version 100-0!

learning
mobility
communication & media
energy
web services
public services
retail
self measurement
banking & finance
health

Easy to Use and Improve

- AI will contribute as much as $15.7 trillion to the world economy by 2030 (PwC)
- $6.6 trillion from increased productivity as businesses automate processes and augment with new AI technology, and $9.1 trillion from consumption side-effects as shoppers snap up personalized and higher-quality goods


TIME
SPECIAL EDITION
Artificial Intelligence
The Future of Humankind