

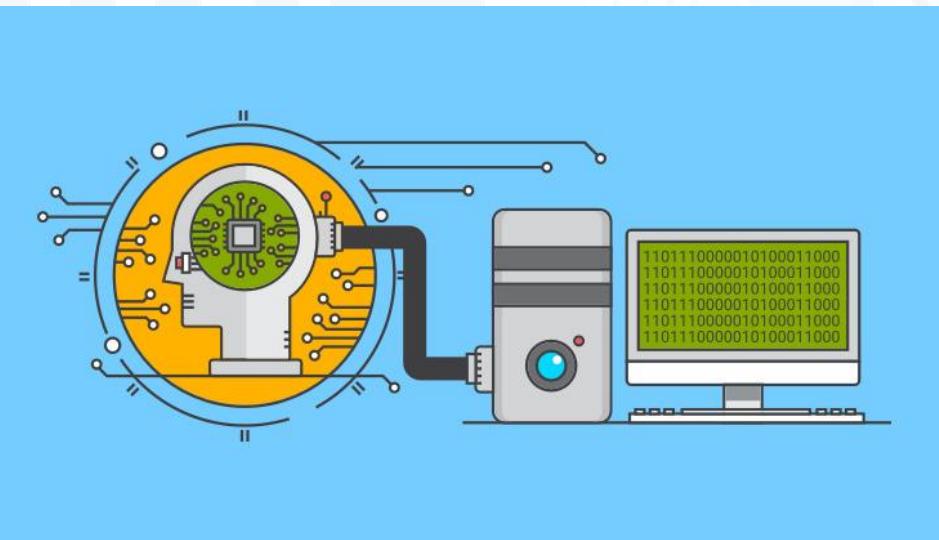


FACULTY OF INFORMATION TECHNOLOGY

Machine Learning (Máy Học)

Semester 2, 2022/2023

Chapter 1. Introduction



Content

- ▶ What is Machine Learning?
- ▶ Machine Learning Types
- ▶ Machine Learning Algorithms
- ▶ Applications of Machine Learning

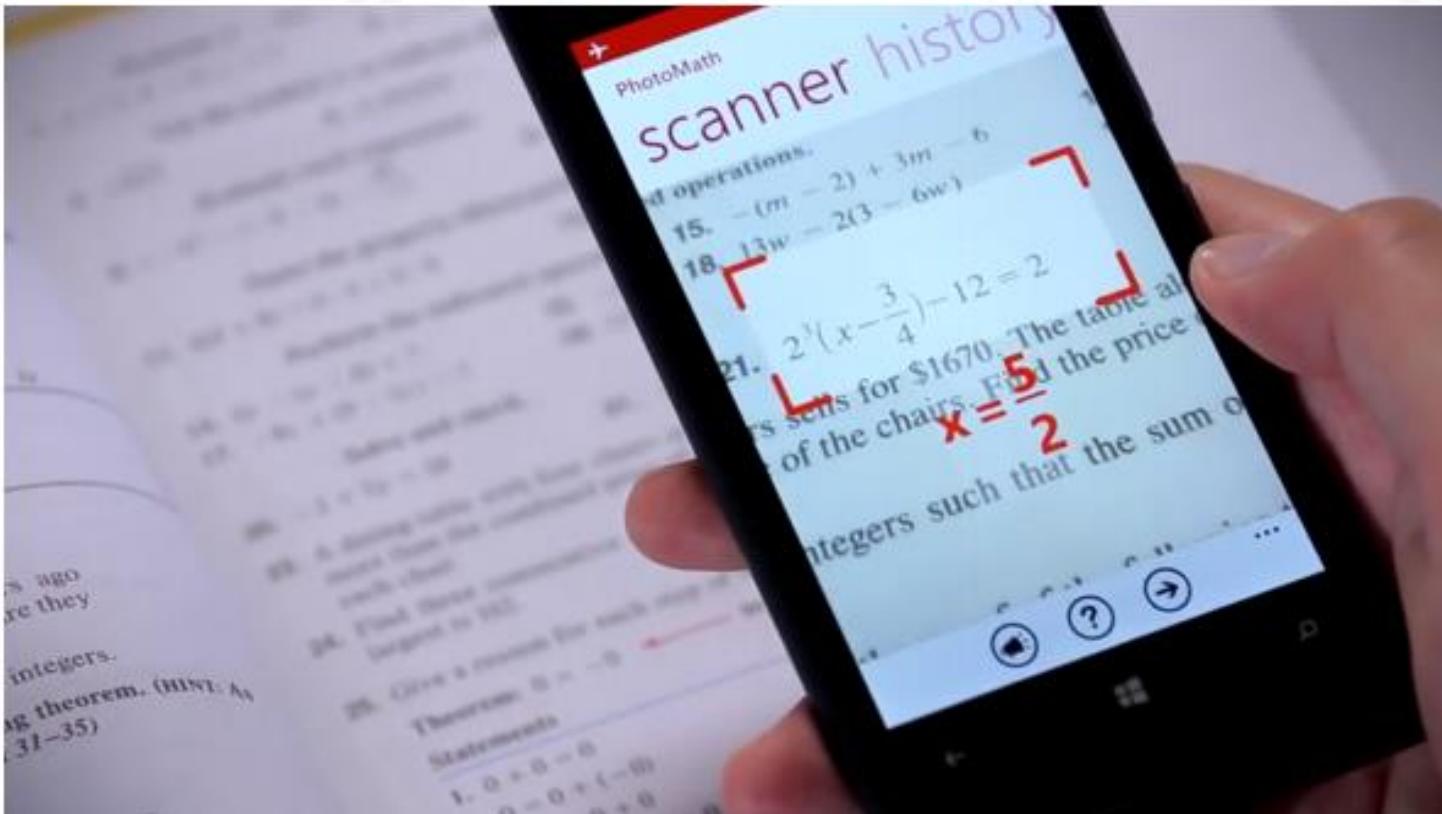
Situation 1

- ▶ How can we make a robot cook?



Situation 2

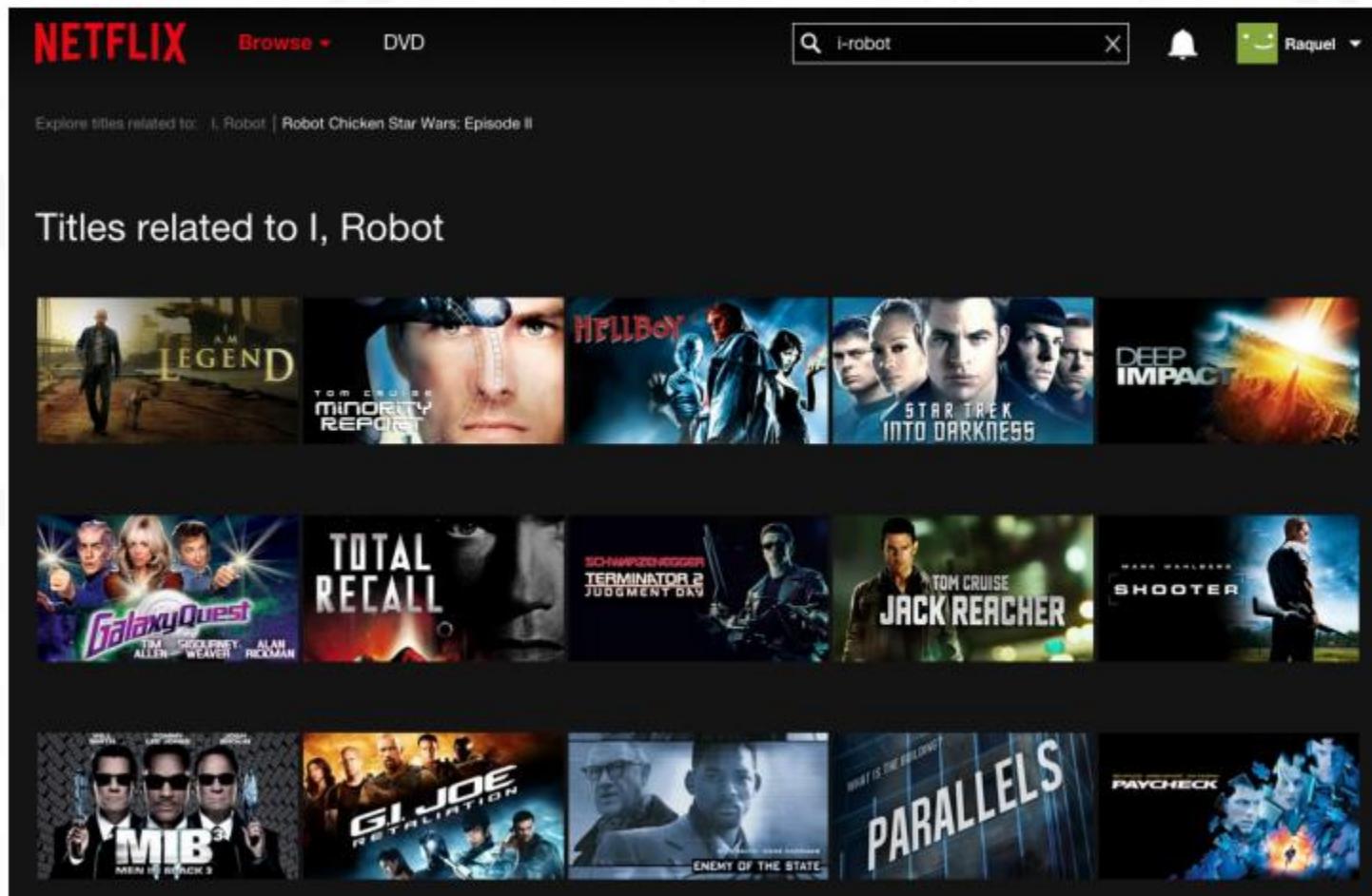
- ▶ How to recognize a math expression?



Photomath: <https://photomath.net/>

Situation 3

- ▶ How does Netflix **recommend films** to a user?



Situation 4

- ▶ How to predict the price of a house?



Situation 5

Information Retrieval

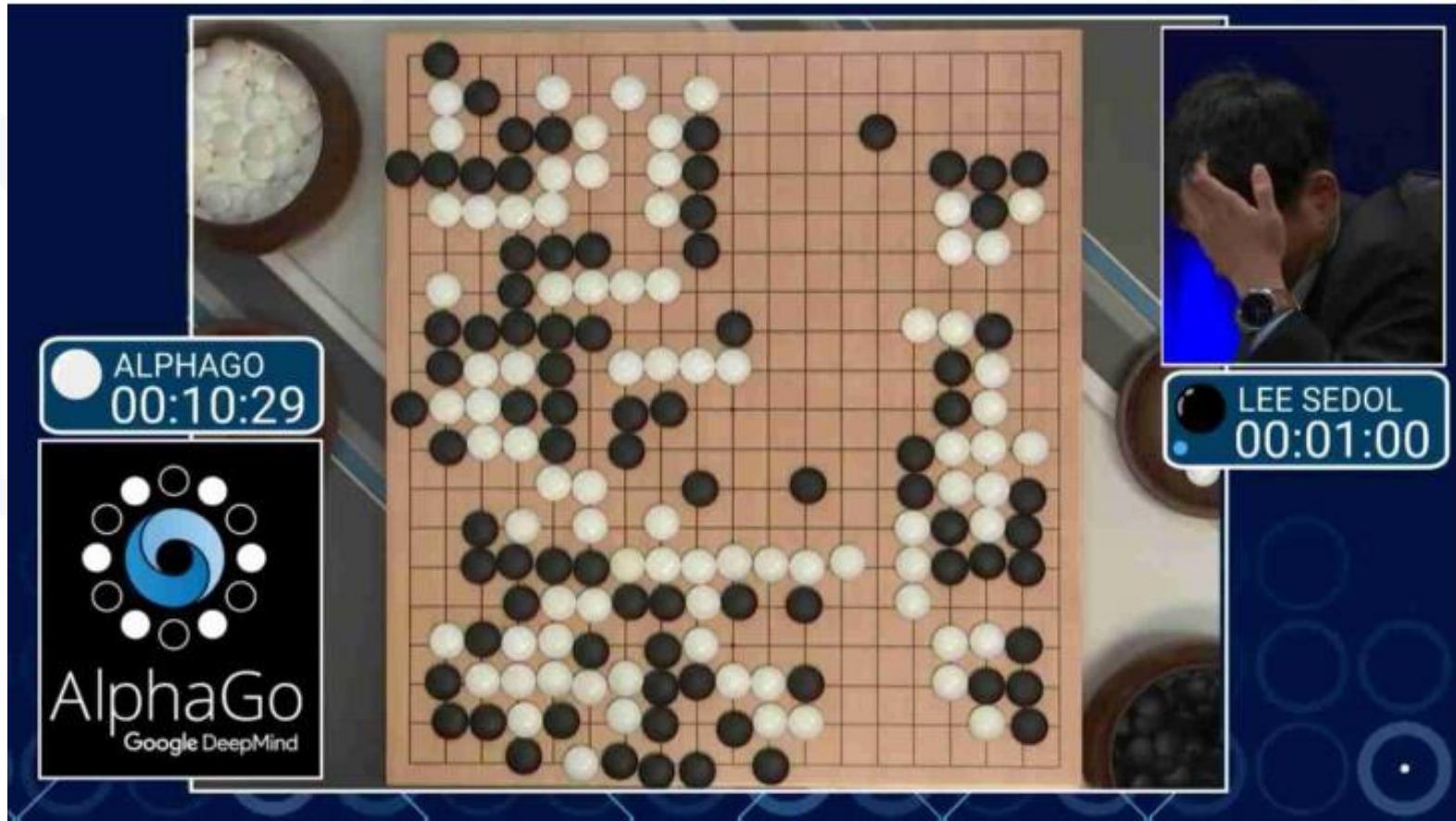
- ▶ How does Google search images based on a given text?

The screenshot shows a Google search results page for the query "machine learning". The search bar at the top contains "machine learning". Below it, the "Images" tab is selected, indicated by a blue underline. The search results are displayed in a grid format, each row containing five images. Each image has a caption below it.

Image	Caption	Source
	Why Machine Learning Needs Semantics ... forbes.com	
	Khóa học Machine Learning A-Z thực hành... imic.edu.vn	
	Machine Learning forbes.com	
	Machine Learning for Marketing - IE ... ie.edu	
	Machine Learning - Ngành học chưa có ... westernedu.vn	
	10 Companies Using Machine Learning i... primer.to ...	
	Machine Learning For Beginners. Machine ... MachineLearningGuru.com	
	How Machine Learning Optimizes th... westernedu.vn	

Situation 6

- ▶ How can AI play game?



Situation 7

- ▶ Am I going to pass the ML course?



Situation ...



What is Learning?

- ▶ Dictionary defines “**to learn**” as:
 - To get knowledge of something by study, experience, or being taught.
 - To become aware by information or from observation
 - To commit to memory
 - To be informed of or to ascertain
 - To receive instruction



What is Learning? (cont.)

- ▶ A learning program: learn from experience E on task T with respect to performance measure P, if its performance on T improves with experience E.
- ▶ A learning program:
 - produces a representation R (often called *a hypothesis h*) of what it has learned (or a model).
 - another program can use R to perform T.
 - uses a learning algorithm A to produce R from E.
 - many different algorithms can be used produce the same type of representation.



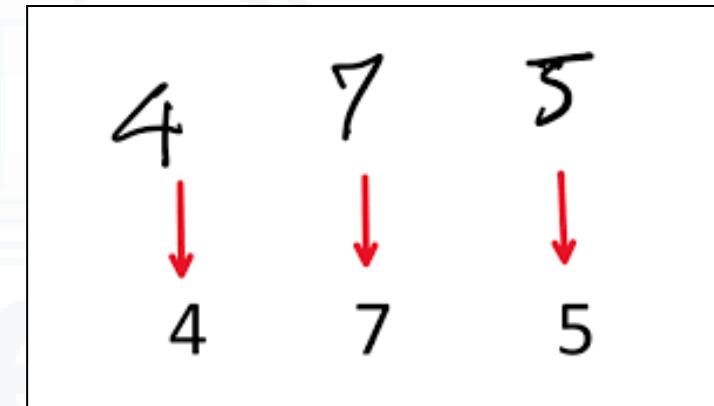
Example: Learning Checkers

- ▶ **Task T:**
 - playing checkers
- ▶ **Performance measure P:**
 - percent of games won against a set of players.
- ▶ **Training experience E:**
 - games played against the other players.
- ▶ **Representation R:**
 - an evaluation function that measures the goodness of the board.
- ▶ **Learning algorithm A:**
 - a variation of temporal difference (predicting the total reward expected over the future)



Example: Learning Handwriting

- ▶ **Task T:**
 - recognize handwritten letters.
- ▶ **Performance measure P:**
 - error rate on sample handwriting.
- ▶ **Training experience E:**
 - gray scale images of sample handwriting, all identified in advance.
- ▶ **Representation R:**
 - support vector machine, where each pixel is a separate attribute.
- ▶ **Learning algorithm A:**
 - SVMlight.



What is Machine Learning?

- ▶ Wikipedia: (ML introduced in 1980's)
 - *Machine learning is the subfield of computer science that “gives computers the ability to learn without being explicitly programmed”*
- ▶ Ability of computers to “learn” from “data” or “past experience”
 - **learn**: Make intelligent predictions or decisions based on data by optimizing a **model**
 - **data**: Comes from various sources such as sensors, domain knowledge, experimental runs, etc.

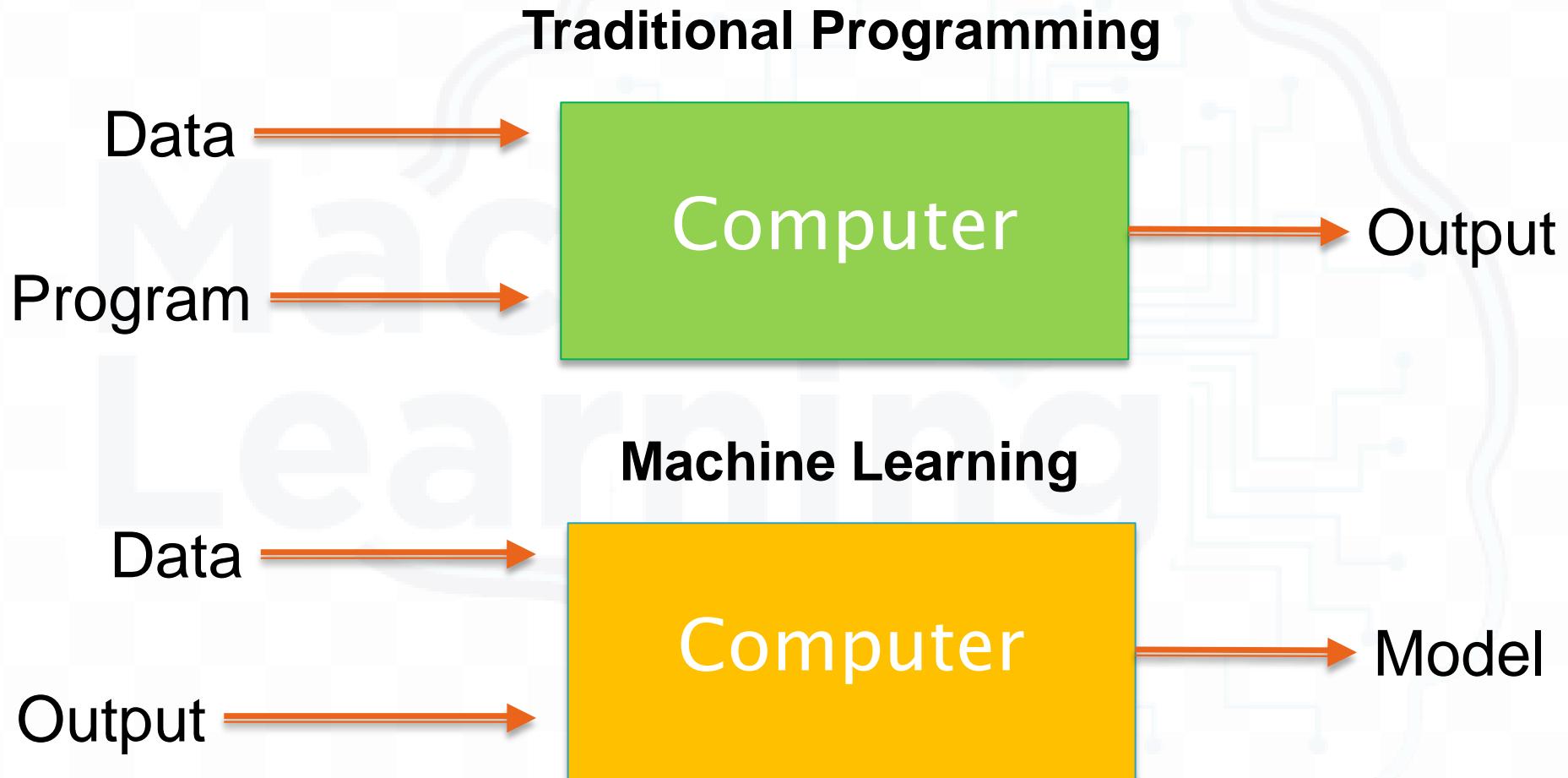
Why “Learning” ?

- ▶ Machine learning is **programming computers to optimize a performance criterion** using example data or past experience.
- ▶ There is no need to “**learn**” to calculate payroll
- ▶ **Learning is used when:**
 - Human expertise does not exist (navigating on Mars),
 - Humans are unable to explain their expertise (speech recognition)
 - Solution changes in time (routing on a computer network)
 - Solution needs to be adapted to particular cases (user biometrics)

What We Talk About When We Talk About “Learning”?

- ▶ Learning general models from data of particular examples
- ▶ Data is cheap and abundant (data warehouses, data marts); knowledge is expensive and scarce.
- ▶ Example in retail: Customer transactions to consumer behavior:
People who bought “Blink” also bought “Outliers” (www.amazon.com)
- ▶ Build a model that is *a good and useful approximation* to the data.

Machine Learning vs Traditional Programming

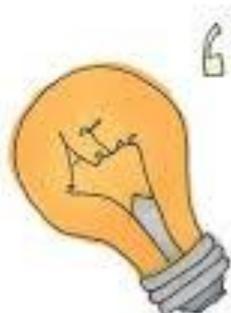


Artificial Intelligence vs Machine Learning vs Deep Learning



Artificial Intelligence

- ▶ Human intelligence exhibited by machines
 - empowers computers to mimic human intelligence such as decision making, text processing, and visual perception.

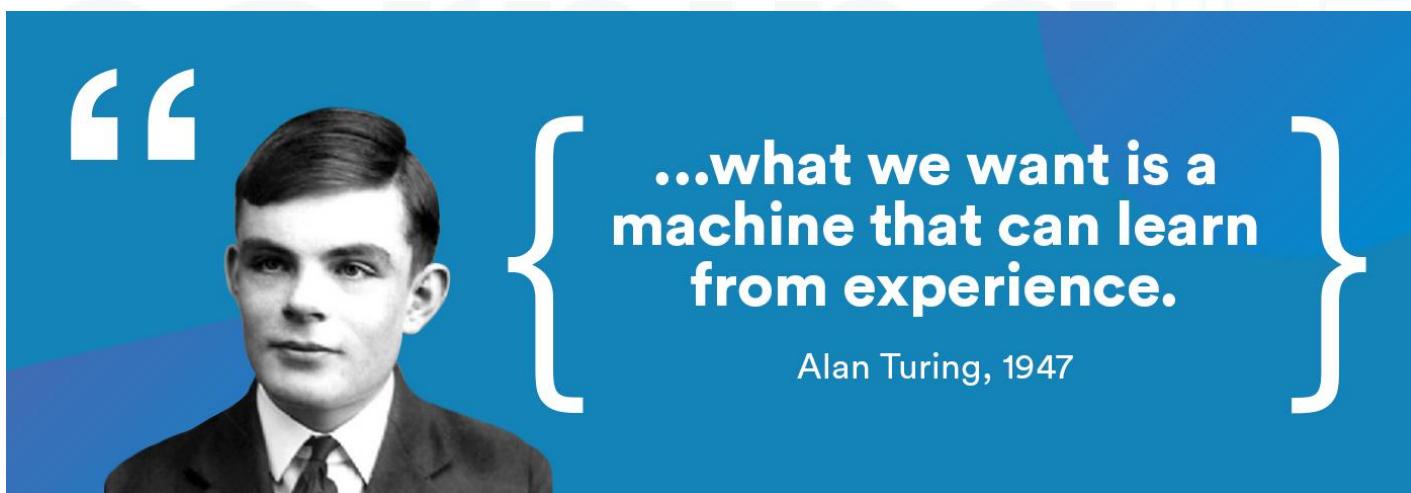


“AI is the new
electricity
- Andrew Ng”



Machine Learning

- ▶ An approach to achieve Artificial Intelligence.
 - a subfield of Artificial Intelligence that **enables machines to improve at a given task with experience**

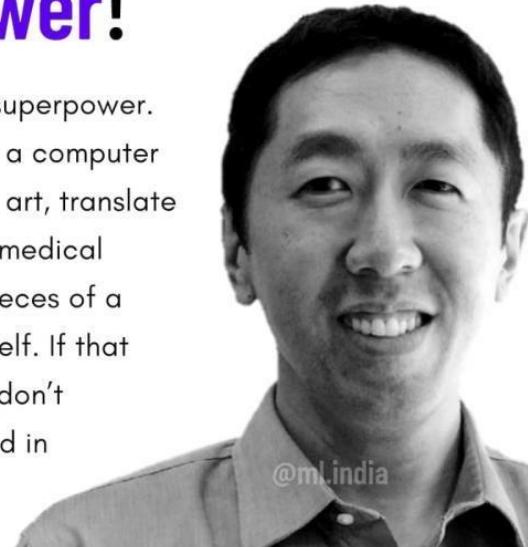


Deep Learning

- ▶ A technique for implementing machine learning
 - a specialized field of Machine Learning that relies on training of Deep Artificial Neural Networks (ANNs) using a large dataset such as images or texts

Andrew Ng compares deep learning to a superpower!

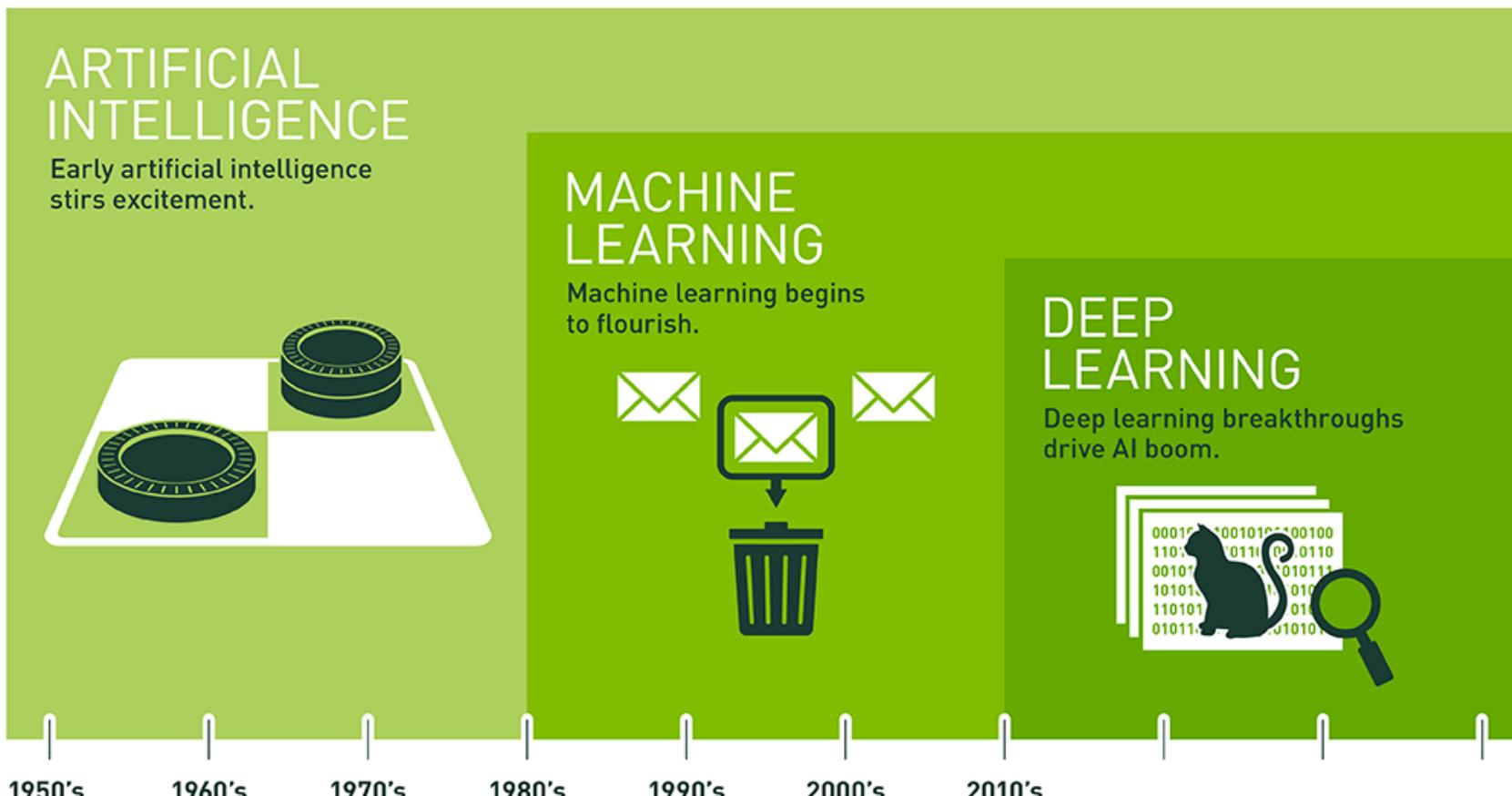
"Deep Learning is a superpower. With it you can make a computer see, synthesize novel art, translate languages, render a medical diagnosis, or build pieces of a car that can drive itself. If that isn't a superpower, I don't know what is", he said in an interview.



AI vs ML vs DL

- ▶ AI: Human intelligence exhibited by machines
 - empowers computers to mimic human intelligence such as decision making, text processing, and visual perception.
 - ▶ ML: An approach to achieve Artificial Intelligence.
 - a subfield of Artificial Intelligence that enables machines to improve at a given task with experience
 - ▶ DL: A technique for implementing machine learning
 - a specialized field of Machine Learning that relies on training of Deep Artificial Neural Networks (ANNs) using a large dataset such as images or texts
- Thanks to Deep Learning, AI has a bright future

AI vs ML vs DL (cont.)



Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

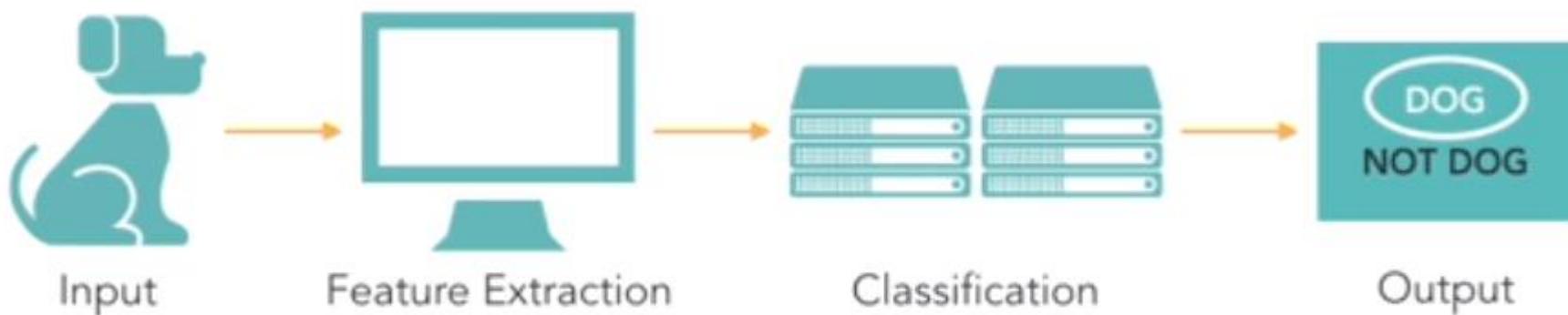
ML vs DL

	Machine Learning	Deep Learning
Data Dependencies	Excellent performances on a small/medium dataset	Excellent performance on a big dataset
Hardware dependencies	Work on a low-end machine.	Requires powerful machine, preferably with GPU: DL performs a significant amount of matrix multiplication
Feature engineering	Need to understand the features that represent the data	No need to understand the best feature that represents the data
Execution time	From few minutes to hours	Up to weeks. Neural Network needs to compute a significant number of weights
Interpretability	Some algorithms are easy to interpret (logistic, decision tree), some are almost impossible (SVM, XGBoost)	Difficult to impossible

ML vs DL (cont.)

Ex. Classification task

TRADITIONAL MACHINE LEARNING

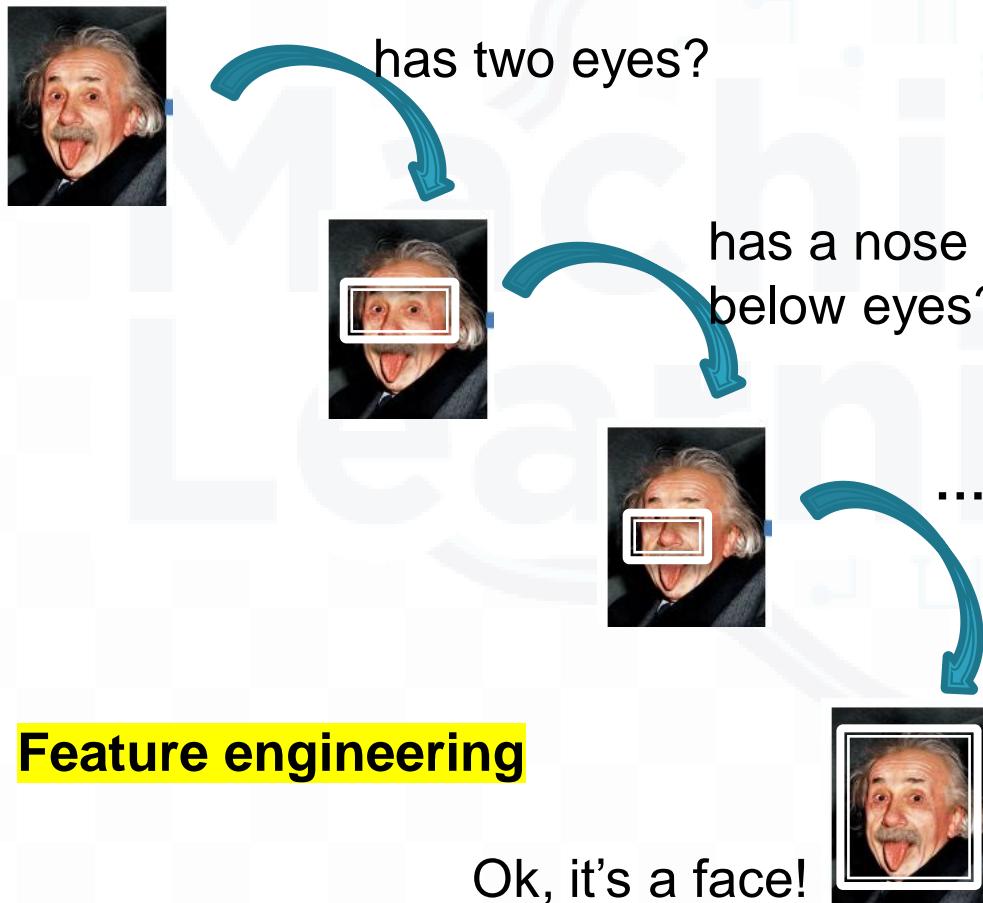


DEEP LEARNING

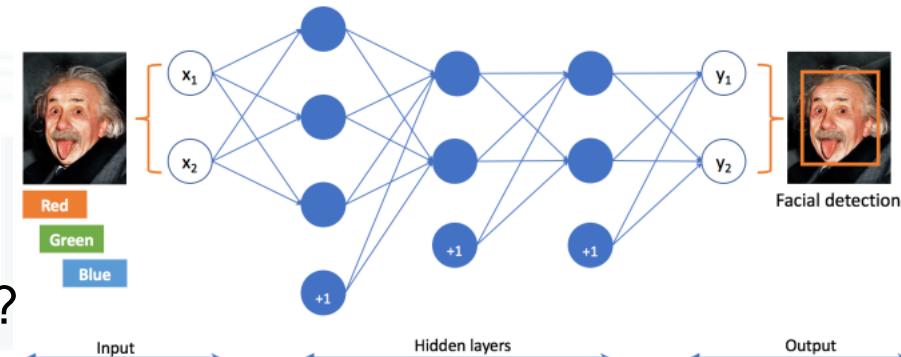


ML vs DL (cont.)

Traditional approach



Deep learning approach



No feature engineering

ML vs DL (cont.)

► When to use ML or DL?

	Machine learning	Deep learning
Training dataset	Small	Large
Choose features	Yes	No
Number of algorithms	Many	Few
Training time	Short	Long

ML vs Statistics

- ▶ Both machine learning and statistics have the same objective
- ▶ The same concepts have different names in the two fields

Statistics	Machine Learning
Estimation	Learning
Classifier	Hypothesis
Data Point	Example/ Instance
Regression	Supervised Learning
Classification	Supervised Learning
Covariate	Feature
Response	Label

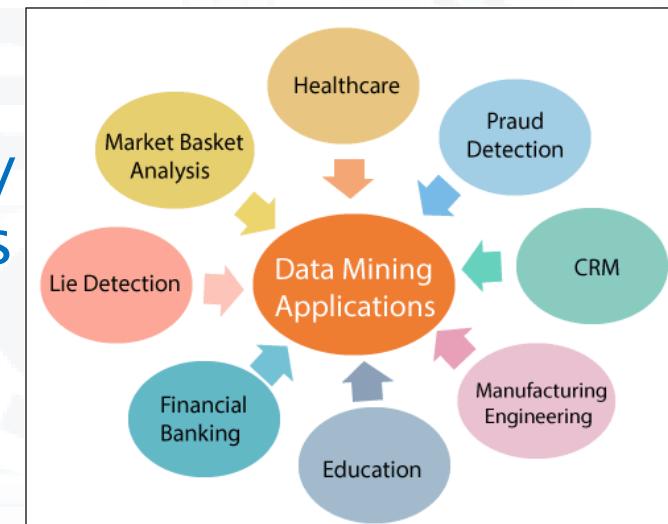
ML vs Statistic (cont.)

- ▶ **Machine Learning**: a subfield of **Computer Science** and **Artificial Intelligence**.
 - Deals with building systems that can **learn from data**, instead of **explicitly programmed instructions**.
 - A new field.
- ▶ **Statistic**: a subfield of **Mathematics**.
 - Cheap computing power and availability of large amounts of data allowed data scientists to train computers to learn by **analyzing data**.
 - Statistical modeling existed long before computers were invented.

Data Mining

- ▶ The process of **extracting useful information** from a huge amount of data.

- Focused on **discovery of previously unknown and important properties in data**.
- Used for **extracting patterns from data**

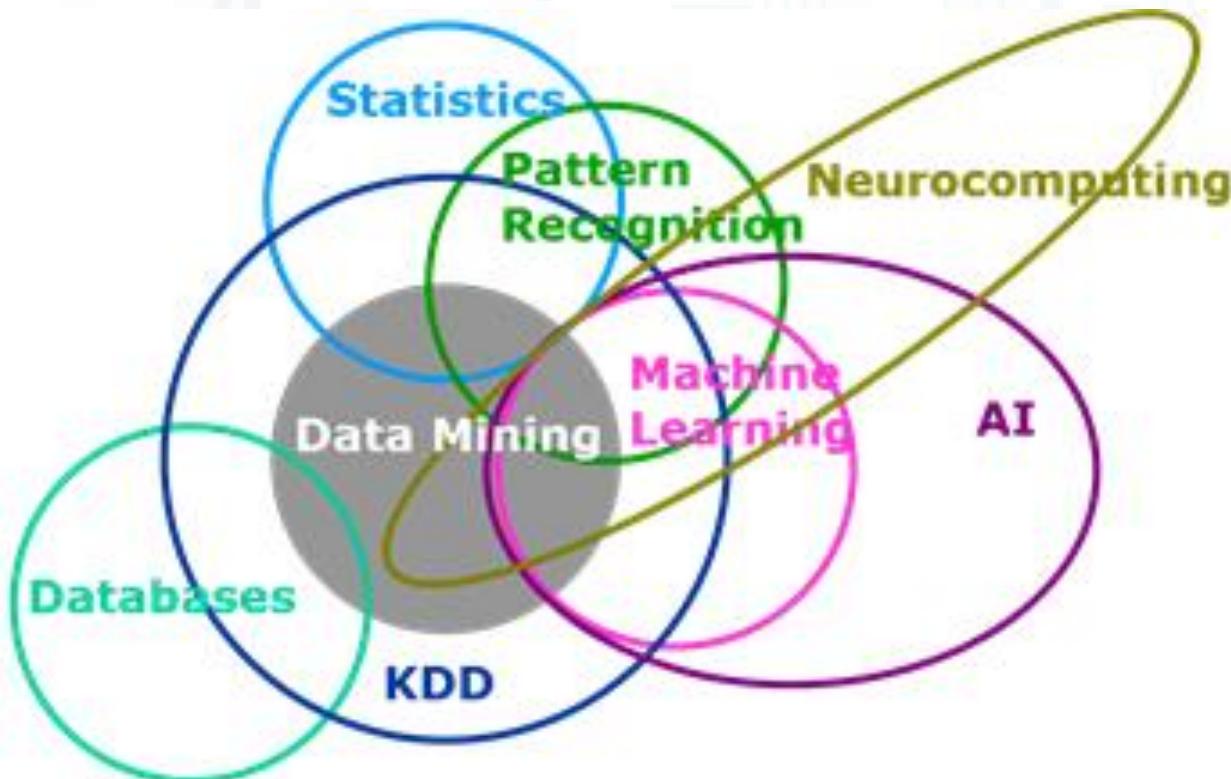


Data Mining (cont.)

- ▶ **Retail:** Market basket analysis, Customer relationship management (CRM)
- ▶ **Finance:** Credit scoring, fraud detection
- ▶ **Manufacturing:** Control, robotics, troubleshooting
- ▶ **Medicine:** Medical diagnosis
- ▶ **Telecommunications:** Spam filters, intrusion detection
- ▶ **Bioinformatics:** Motifs, alignment
- ▶ **Web mining:** Search engines
- ▶ ...

ML vs other Fields

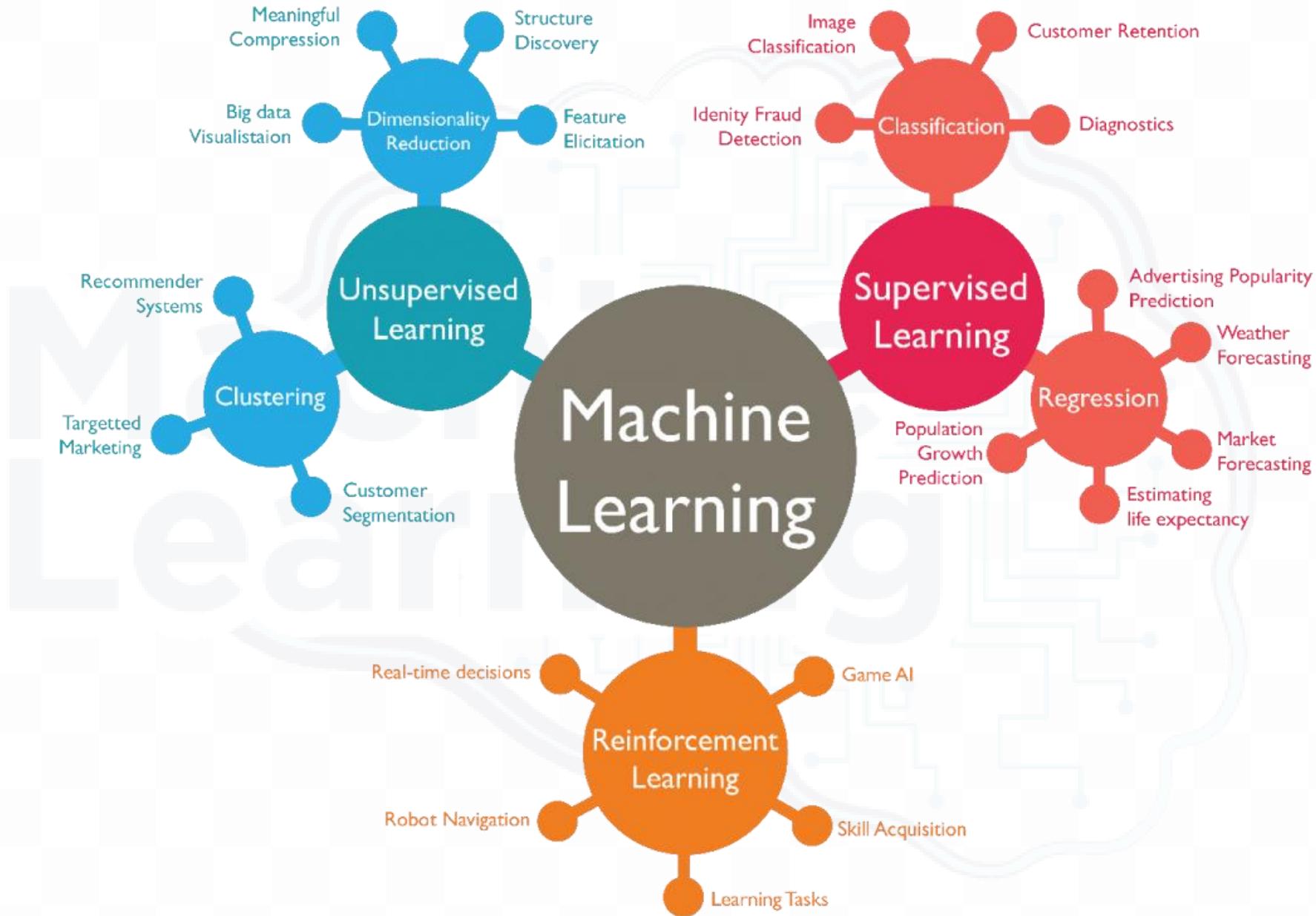
- ▶ A Venn diagram that shows how machine learning and statistics are related



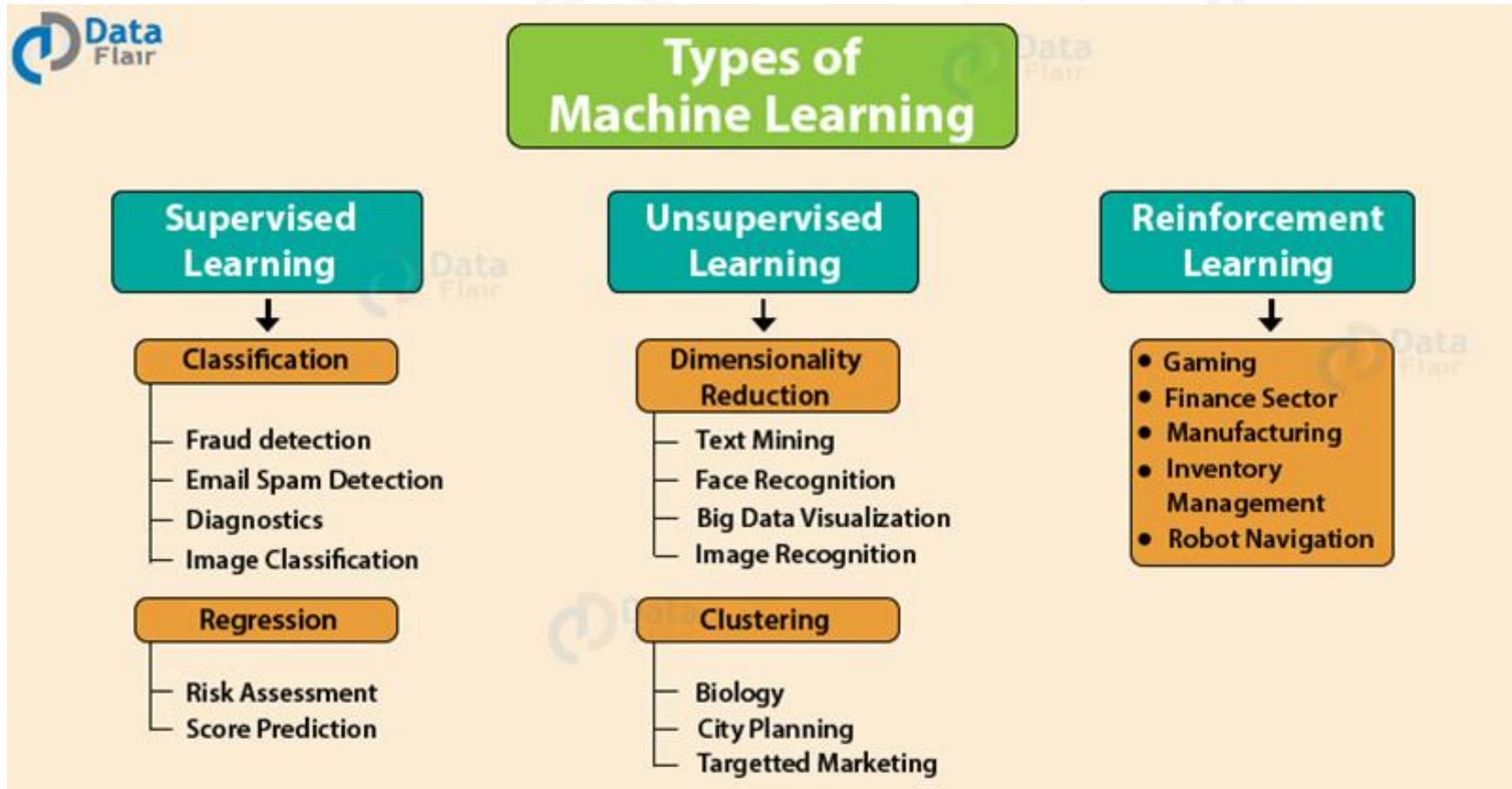
Types of Machine Learning



Types of Machine Learning



Types of Machine Learning (cont.)



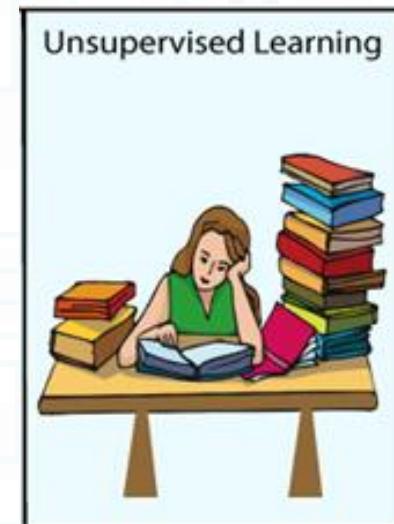
Supervised Learning

- ▶ Supervision: The training data (observations, measurements, etc.) are accompanied by labels indicating **the class of the observations**
 - New data is classified based on the training set
- ▶ Example:
 - **Spam Detection**
 - Map email to {Spam, Not Spam}
 - **Digit recognition**
 - Map pixels to {0,1,2,3,4,5,6,7,8,9}
 - **Stock Prediction**
 - Map new, historic prices, etc. to (the real numbers)

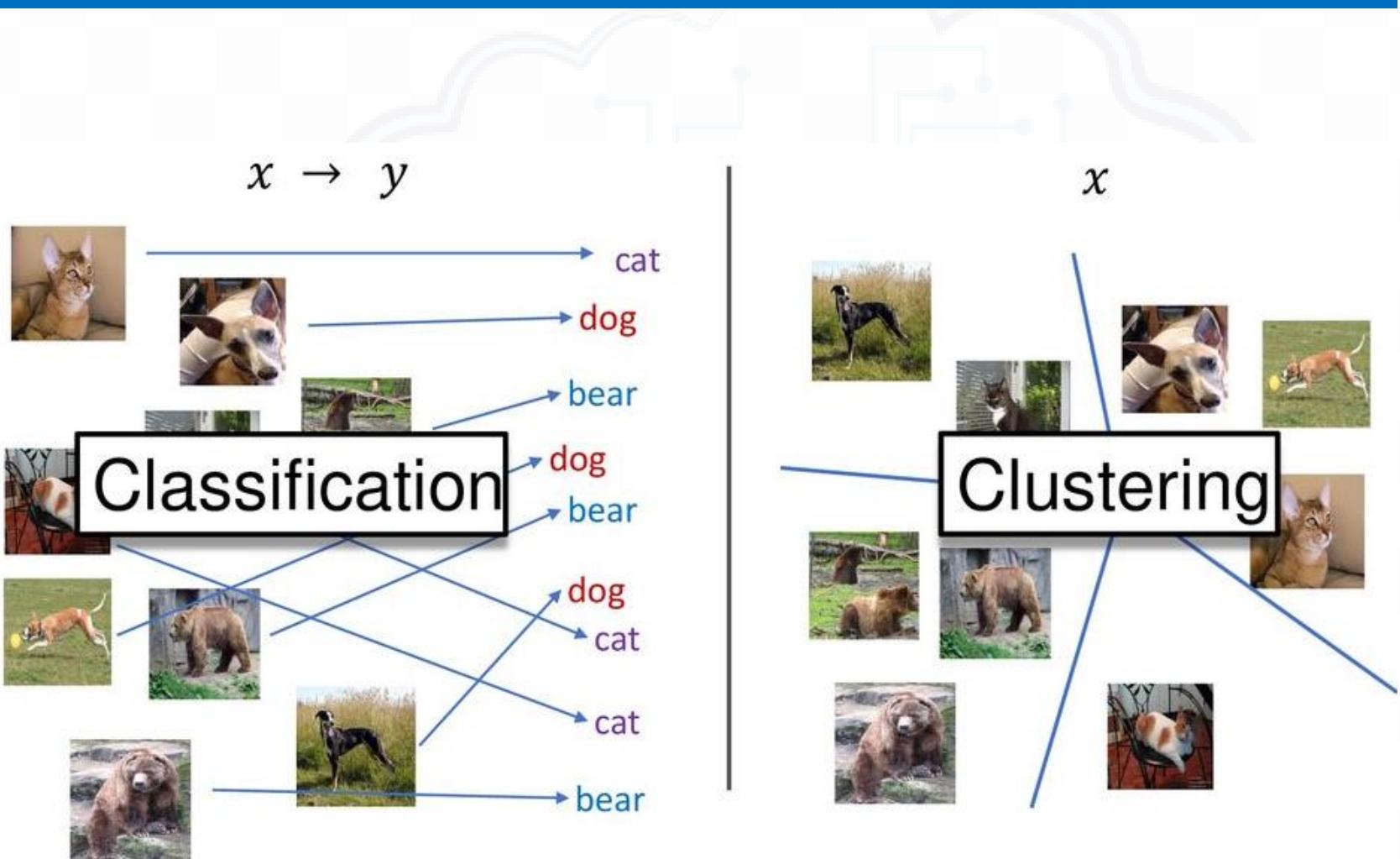


Unsupervised Learning

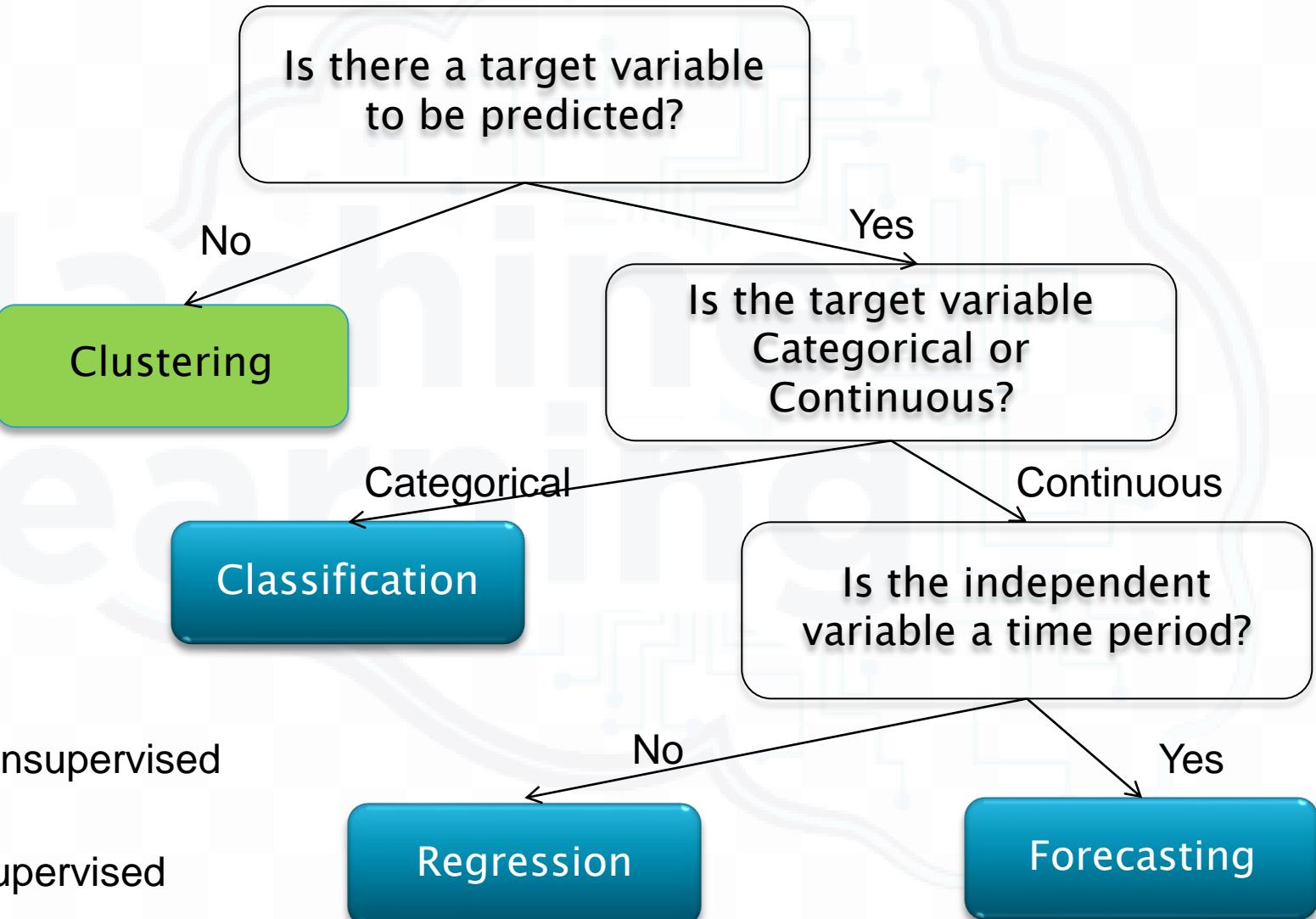
- ▶ The **class labels of training data is unknown**
- ▶ Given a set of measurements, observations, etc. with the aim of **establishing the existence of classes or clusters in the data**
- ▶ **Example:**
 - Customer segmentation in CRM
 - Image compression: Color quantization
 - Bioinformatics: Learning motifs



Supervised vs Unsupervised Learning



Supervised vs Unsupervised Learning



Reinforcement Learning

- ▶ Learning a policy: A **sequence** of outputs
- ▶ **No supervised output** but delayed reward
 - Credit assignment problem
 - Game playing
 - Robot in a maze
 - Multiple agents, partial observability, ...

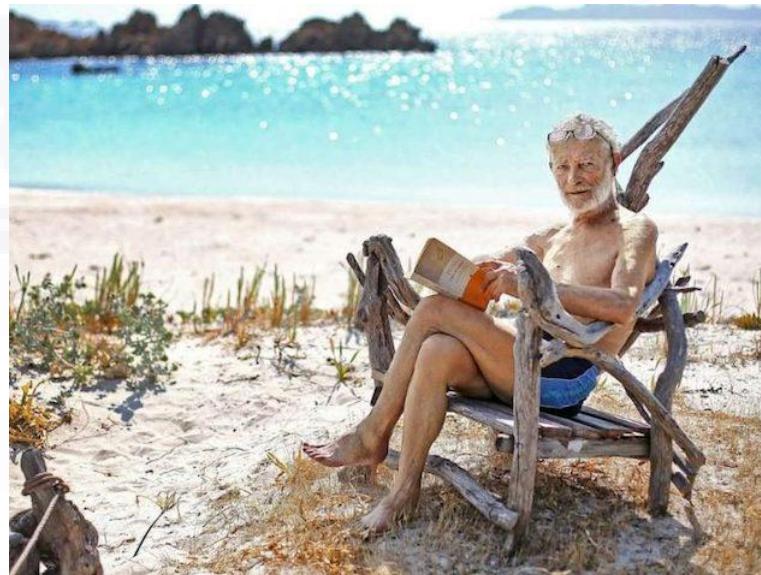
Reinforcement Learning (cont.)

- ▶ Imagine that you were dropped off at an isolated island!
- ▶ What would you do?
- ▶ Panic? Yes, of course, initially we all would.



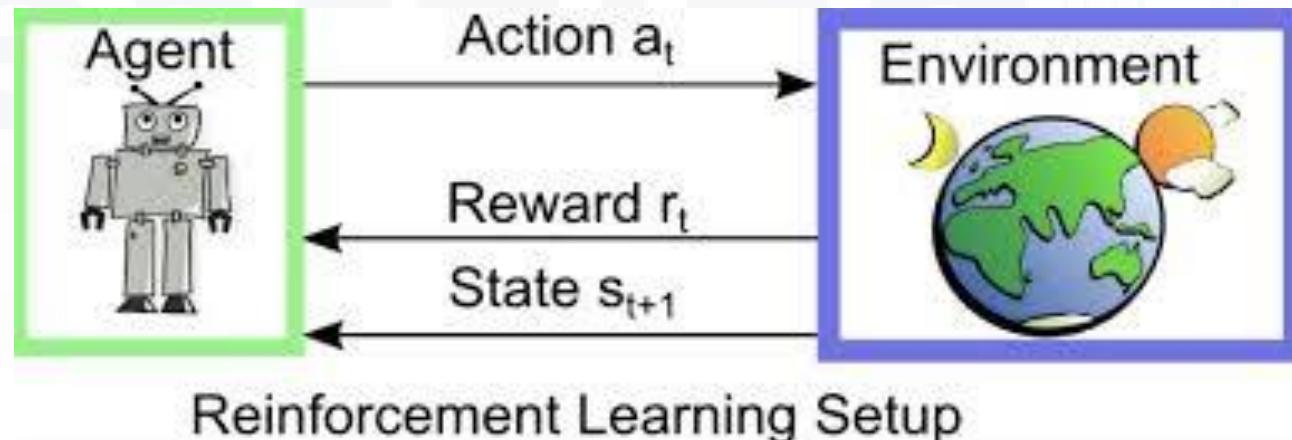
Reinforcement Learning (cont.)

- ▶ Later, you will **learn how to live on the island** by:
 - exploring the environment,
 - understanding the climate condition, the type of food that grows there, the dangers of the island, etc.



Reinforcement Learning (cont.)

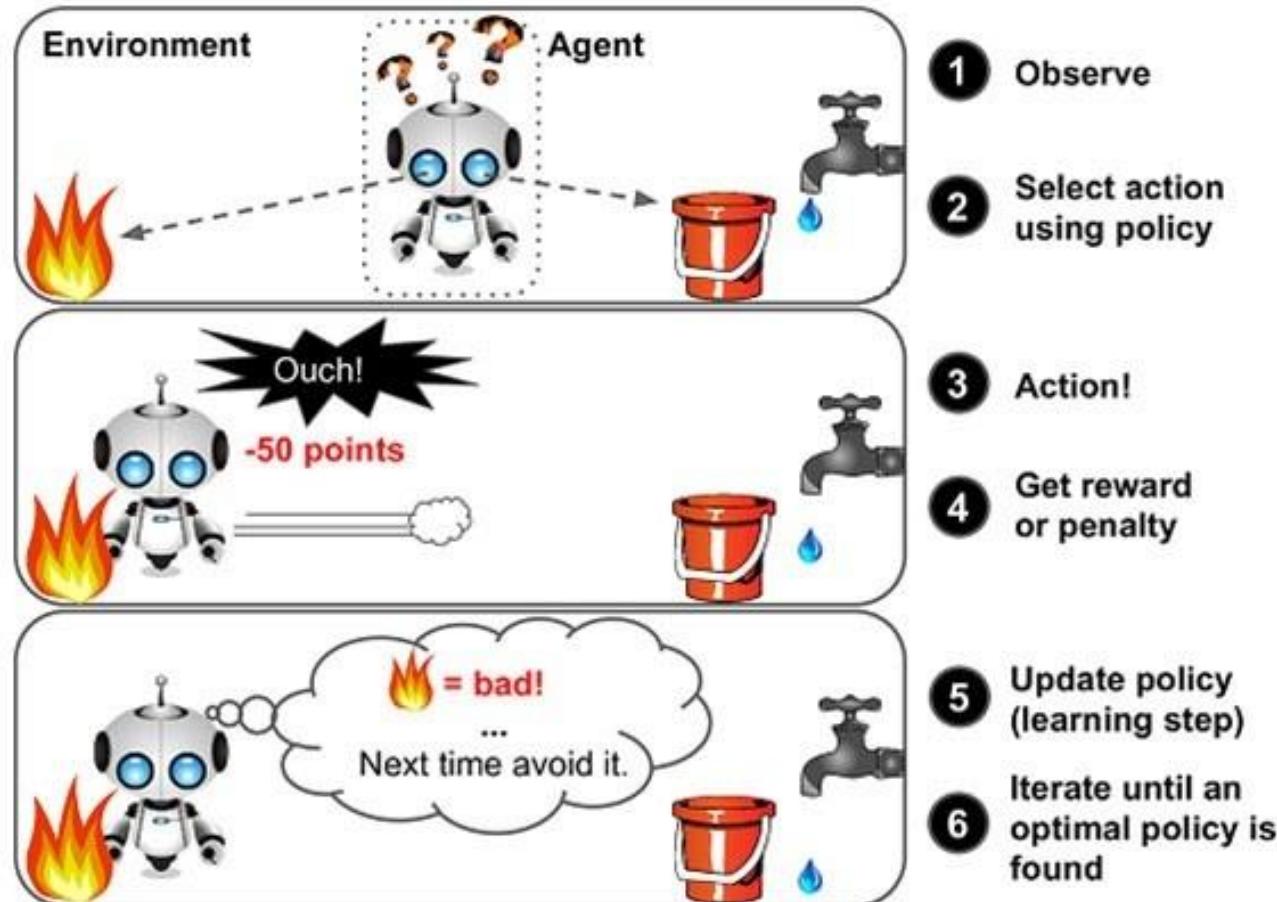
- ▶ This is exactly how Reinforcement Learning works.
 - an agent is put in an unknown environment
 - Agent must learn by observing and performing actions that result in rewards (maximal).



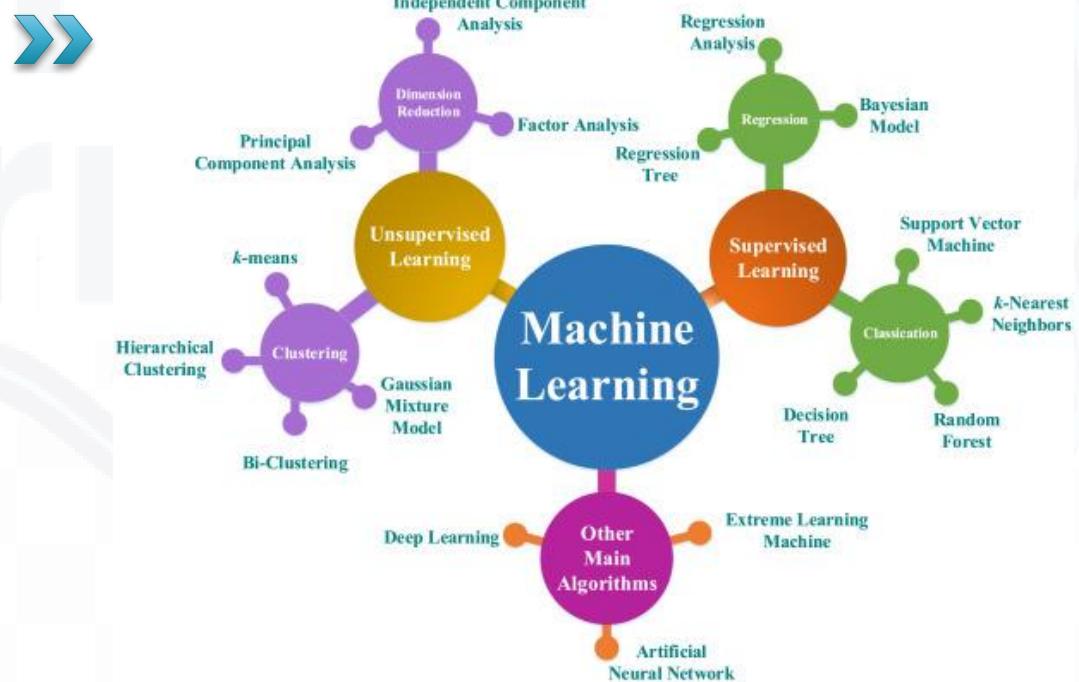
Trial and Error

Reinforcement Learning (cont.)

► An example of Reinforcement Learning:



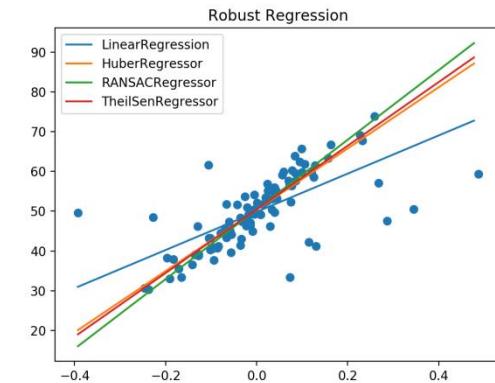
Machine Learning Algorithms



Machine Learning Algorithms

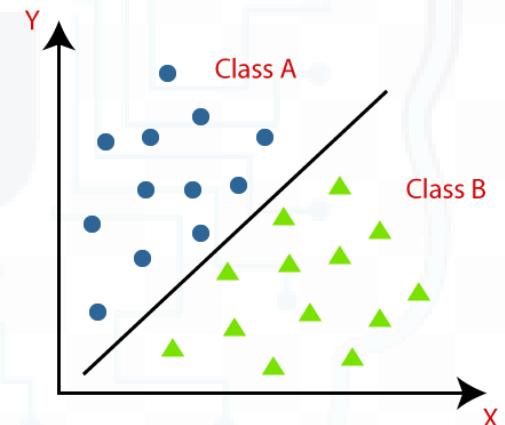
▶ Regression Algorithms

- Linear Regression
- Logistic Regression
- Stepwise Regression



▶ Classification Algorithms

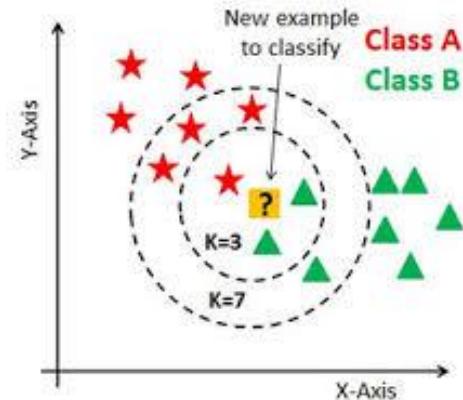
- Linear Classifier
- Support Vector Machine (SVM)
- Kernel SVM
- Sparse Representation-based classification (SRC)



Machine Learning Algorithms (cont.)

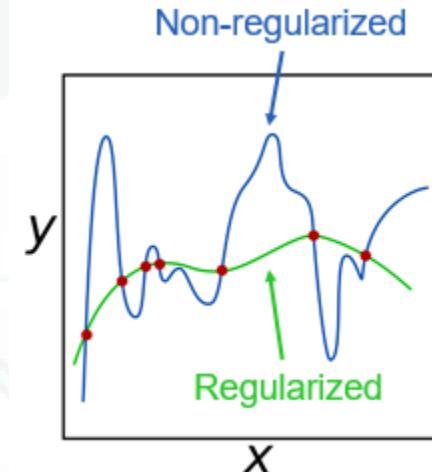
▶ Instance-based Algorithms

- k-Nearest Neighbor (kNN)
- Learning Vector Quantization (LVQ)



▶ Regularization Algorithms

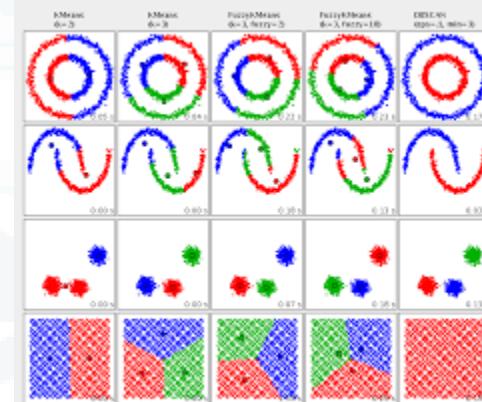
- Ridge Regression
- Least Absolute Shrinkage and Selection Operator (LASSO)
- Least-Angle Regression (LARS)
- Bayesian Algorithms
- Naive Bayes
- Gaussian Naive Bayes



Machine Learning Algorithms (cont.)

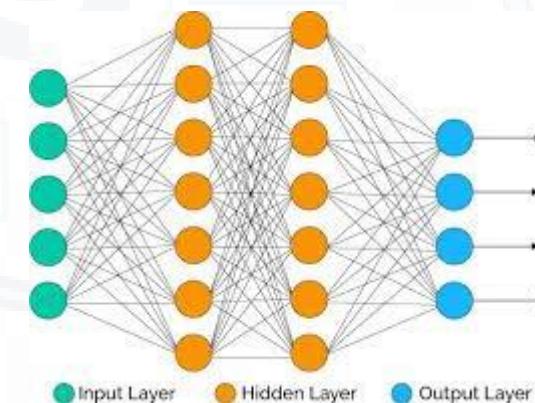
▶ Clustering Algorithms

- k-Means clustering
- k-Medians
- Expectation Maximization (EM)



▶ Artificial Neural Network Algorithms

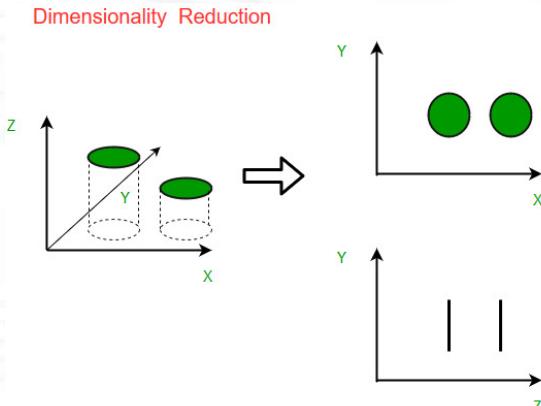
- Perceptron
- Softmax Regression
- Multilayer Perceptron
- Backpropagation



Machine Learning Algorithms (cont.)

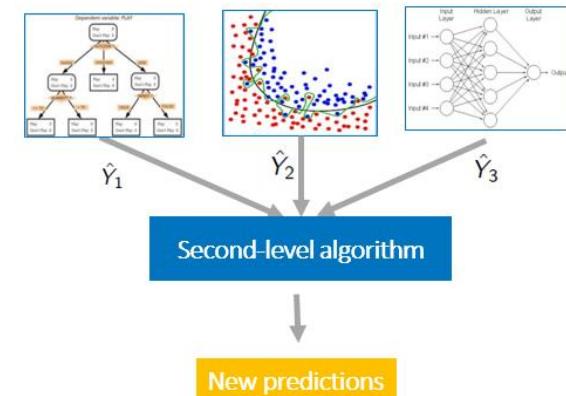
► Dimensionality Reduction Algorithms

- Principal Component Analysis (PCA)
- Linear Discriminant Analysis (LDA)



► Ensemble Algorithms

- Boosting
- AdaBoost
- Random Forest



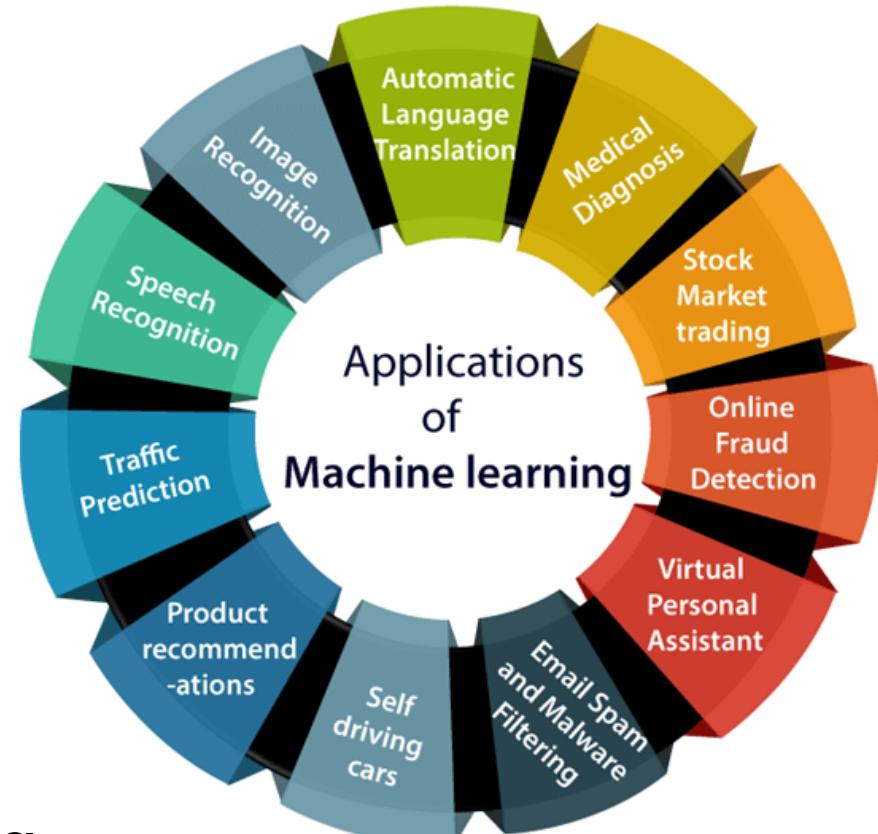
Applications

Micro
Learn



Applications of ML

- ▶ Association
- ▶ Supervised Learning
 - Classification
 - Regression
- ▶ Unsupervised Learning
- ▶ Reinforcement Learning



1. Leaning Associations



Picone

Learning Associations

- Given a set of records each of which contain some number of items from a given collection
 - $P(Y|X)$ probability that somebody who buys X also buys Y where X and Y are products/services.
 - Example: $P(\text{chips} | \text{beer}) = 0.7$



Learning Associations (cont.)

- ▶ **Market-basket analysis**
 - Rules are used for sales promotion, shelf management, and inventory management
- ▶ **Telecommunication alarm diagnosis**
 - Rules are used to find combination of alarms that occur together frequently in the same time period
- ▶ **Medical Informatics**
 - Rules are used to find combination of patient symptoms and test results associated with certain diseases

Learning Associations (cont.)

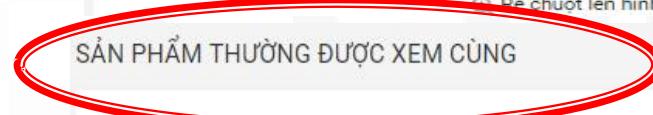
Trang chủ > Máy Ảnh - Máy Quay Phim > Máy ảnh DSLR > Máy Ảnh Canon 750D + Lens 18-55 IS STM (Lê Bảo Minh)



Rubberized touch points

Pé chuột lên hình để phóng to

SẢN PHẨM THƯỜNG ĐƯỢC XEM CÙNG



TikiNOW Máy Ảnh Canon 750D + Lens 18-55 Minh)

★★★★★ (Xem 248 đánh giá)

Đứng thứ 1 trong Top 10 Sacom giảm 1.500.000đ bán chạy tháng này

Thương hiệu: Canon SKU: 6001759234016

DEAL HOT Giá: 11.890.000 đ

TRẢ GÓP Chỉ 990.833 đ/tháng trong 12 tháng qua thẻ tín dụng (?)

Tiết kiệm: 32% (5.610.000 đ)

Giá thị trường: 17.500.000 đ

Khuyến mãi kết thúc sau 2 ngày 11 : 30 : 47

Đã bán 389

- Cảm biến: CMOS 24.2MP
- Bộ xử lý hình ảnh: DIGIC 6

tiki.vn



Canon M10 KIT 15-45mm (Lê Bảo Minh)
5.900.000 đ ~~10.500.000 đ~~ -44%

Máy Ảnh Sony Alpha A6000 + 16-50mm
11.790.000 đ ~~14.990.000 đ~~ -21%

Máy Ảnh Sony Alpha A6300 + Kit 16-50mm - Đen
19.490.000 đ ~~22.990.000 đ~~ -19%

Lens Canon 50mm f/1.8 STM (Lê Bảo Minh)
2.500.000 đ ~~2.990.000 đ~~ -16%

Máy Ảnh Sony Alpha A6000 (Body)
9.690.000 đ ~~12.400.000 đ~~ -22%

Learning Associations (cont.)

Xem Trước

nguyễn nhật ánh

"Để viết cuốn sách này không dành cho trẻ em,
tôi viết cho những ai từng là trẻ em."
- Cha tôi với một nỗi niềm

cảm
ƠN
người
lớn



NHÀ XUẤT BẢN TRẺ

Click để xem bìa sau



Sách nên mua kèm với sách này



Cảm Ơn Người Lớn (Bìa Cứng) (Kèm Quà Tặng - Số Lượng Có Hạn)

Tác giả: Nguyễn Nhật Ánh

Nhà xuất bản: Nxb Trẻ

Nhà phát hành: NXB Trẻ

Thích Chia sẻ 2 người thích nội dung này. Hãy là người đầu tiên trong số bạn bè của bạn.

★★★★★ (1 đánh giá . 1 bình luận)

Thông tin kèm theo

Miễn phí giao hàng toàn quốc cho Đơn hàng từ 250.000đ (Áp dụng từ 1/2/2015.
[Xem chi tiết >](#)

Phiên bản khác đang bán



Cảm Ơn Người Lớn (Bìa Mềm) (Kèm Quà Tặng ...

Nguyễn Nhật Ánh

★★★★★ 110.000 đ

88.000 đ

Tổng giá bán 122.000 đ

MUA NGAY

Thông tin thanh toán

Giá bìa 220.000 đ

Giá bán 154.000 đ

Tiết kiệm 66.000 đ (30%)

Chất lượng sách Loại A (2)

SẮP HẾT HÀNG



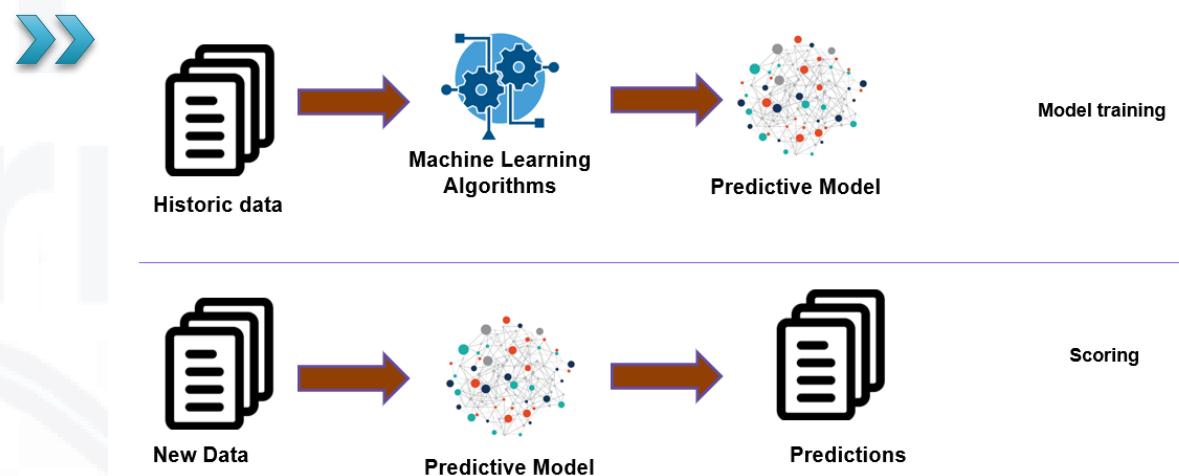
MUA NGAY

THÍCH

ĐÃ ĐỌC

vinabook.com

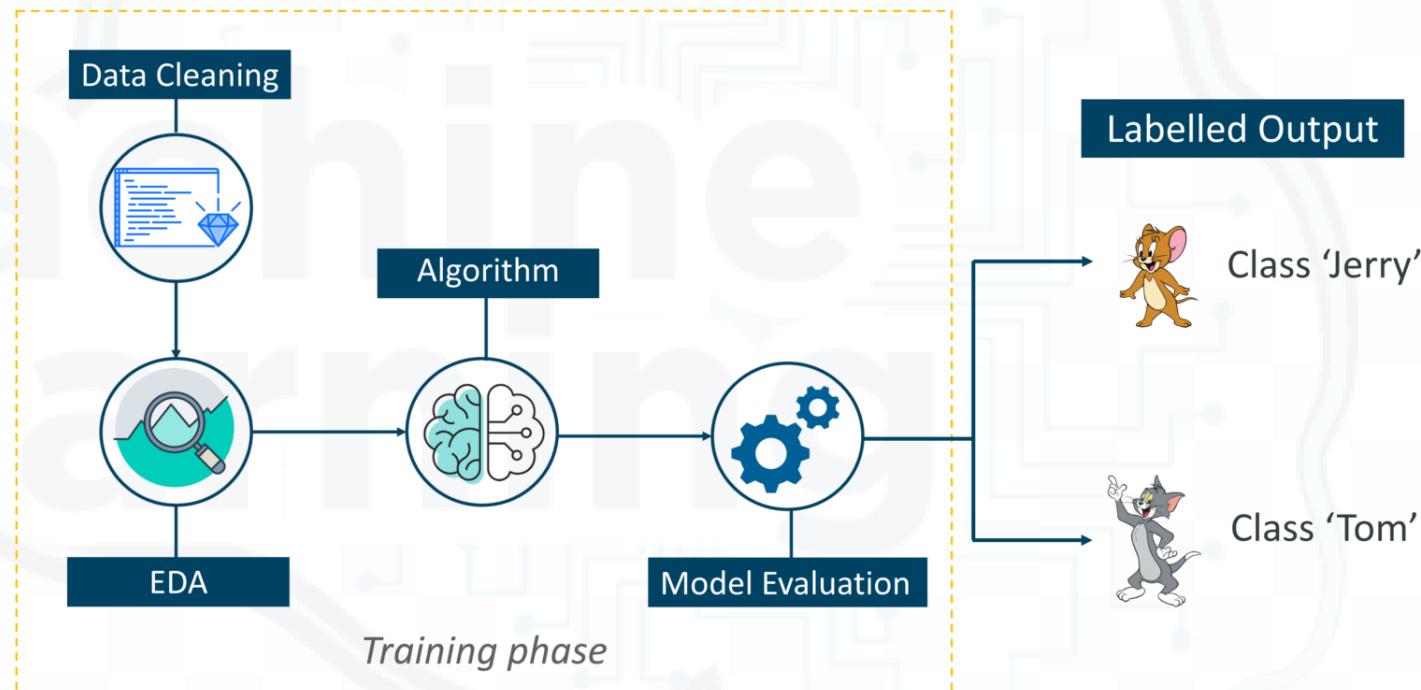
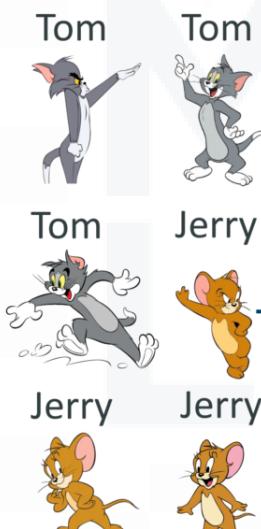
2. Supervised Learning



Classification

▶ How does classification work?

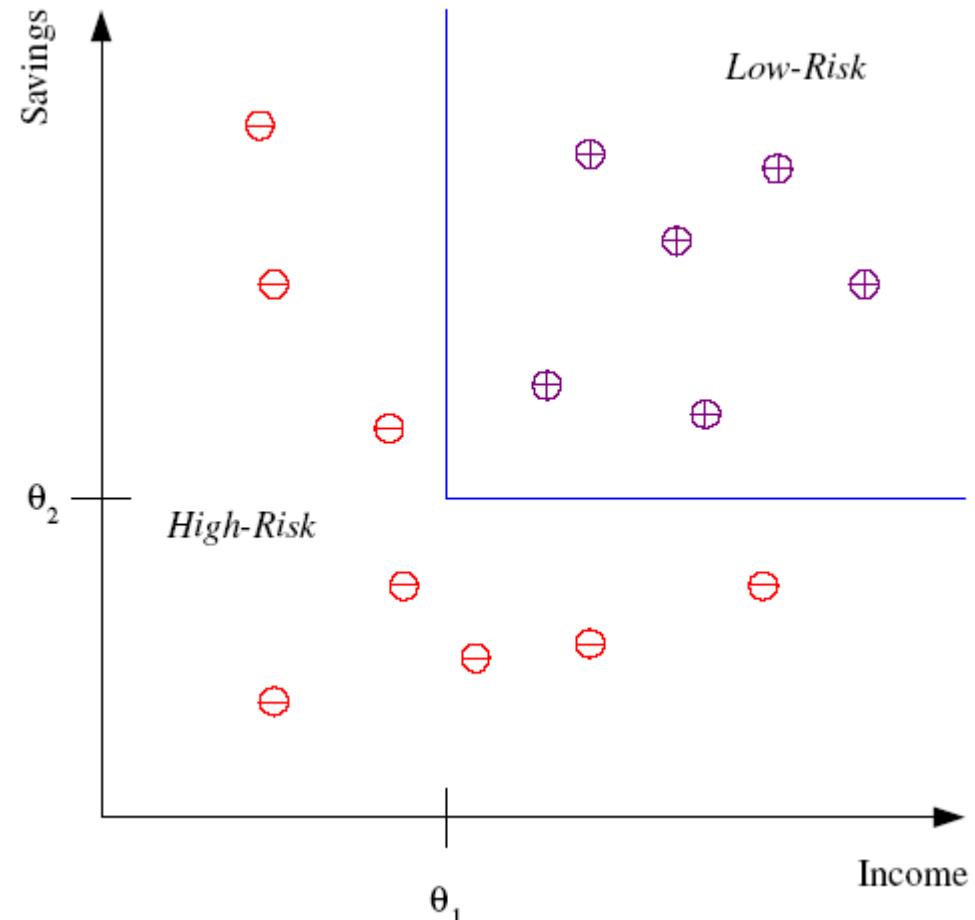
Labelled Data



EDA: Exploratory Data Analysis

Classification (cont.)

- ▶ Example: Credit scoring
- ▶ Differentiating between **low-risk** and **high-risk** customers from their *income* and *savings*



Discriminant: IF $income > \theta_1$ AND $savings > \theta_2$
THEN **low-risk** ELSE **high-risk**

Classification (cont.)

- ▶ Aka Pattern recognition
- ▶ **Face recognition:** Pose, lighting, occlusion (glasses, beard), make-up, hair style
- ▶ **Character recognition:** Different handwriting styles.
- ▶ **Speech recognition:** Temporal dependency.
- ▶ **Medical diagnosis:** From symptoms to illnesses
- ▶ **Biometrics:** Recognition/authentication using physical and/or behavioral characteristics: Face, iris, signature, etc
- ▶ ...

Face Recognition

Training examples of a person

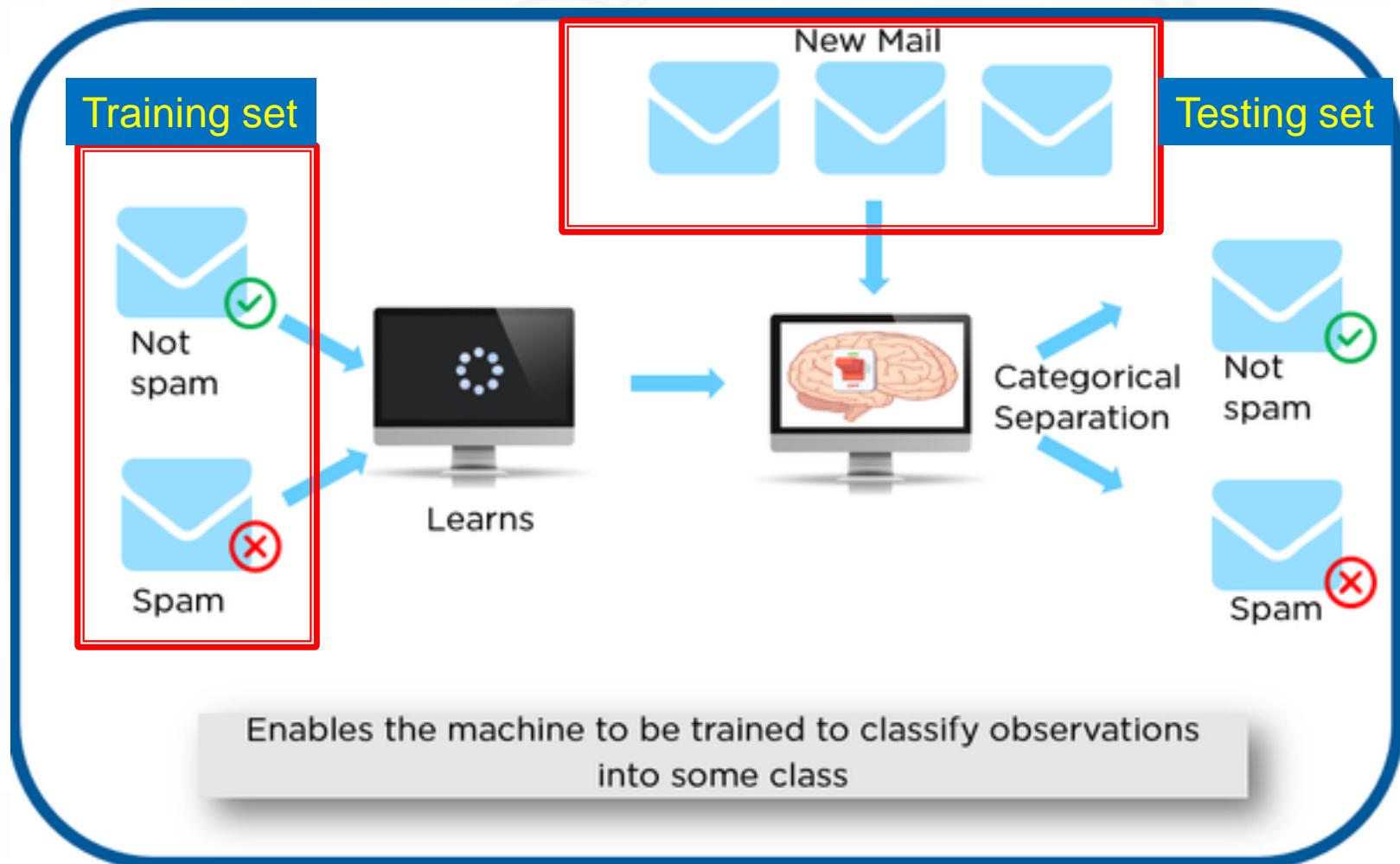


Test images



ORL dataset,
AT&T Laboratories, Cambridge UK

Spam mail detection



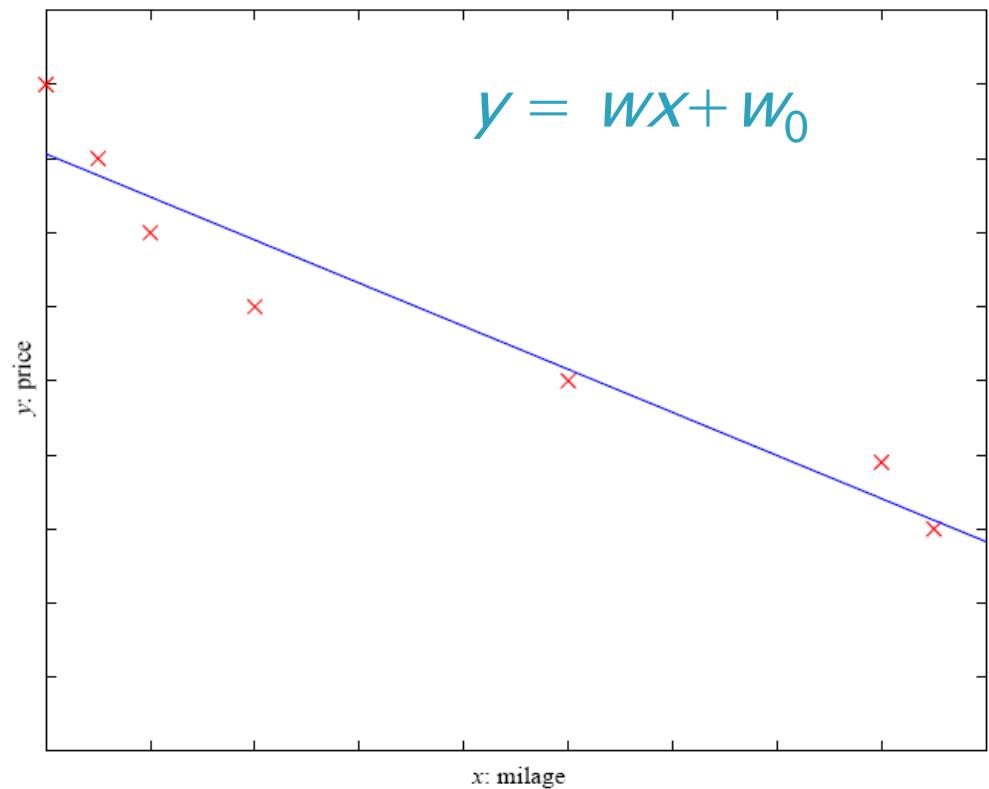
Regression

► Example: Price of a used car

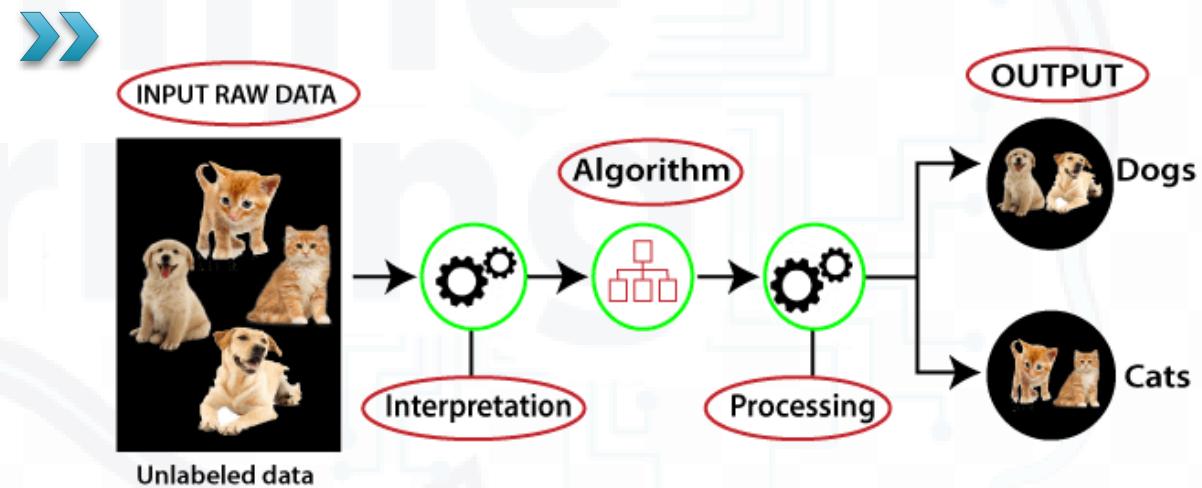
- x : car attributes
- y : price

$$y = g(x | \theta)$$

$g()$ model,
 θ parameters

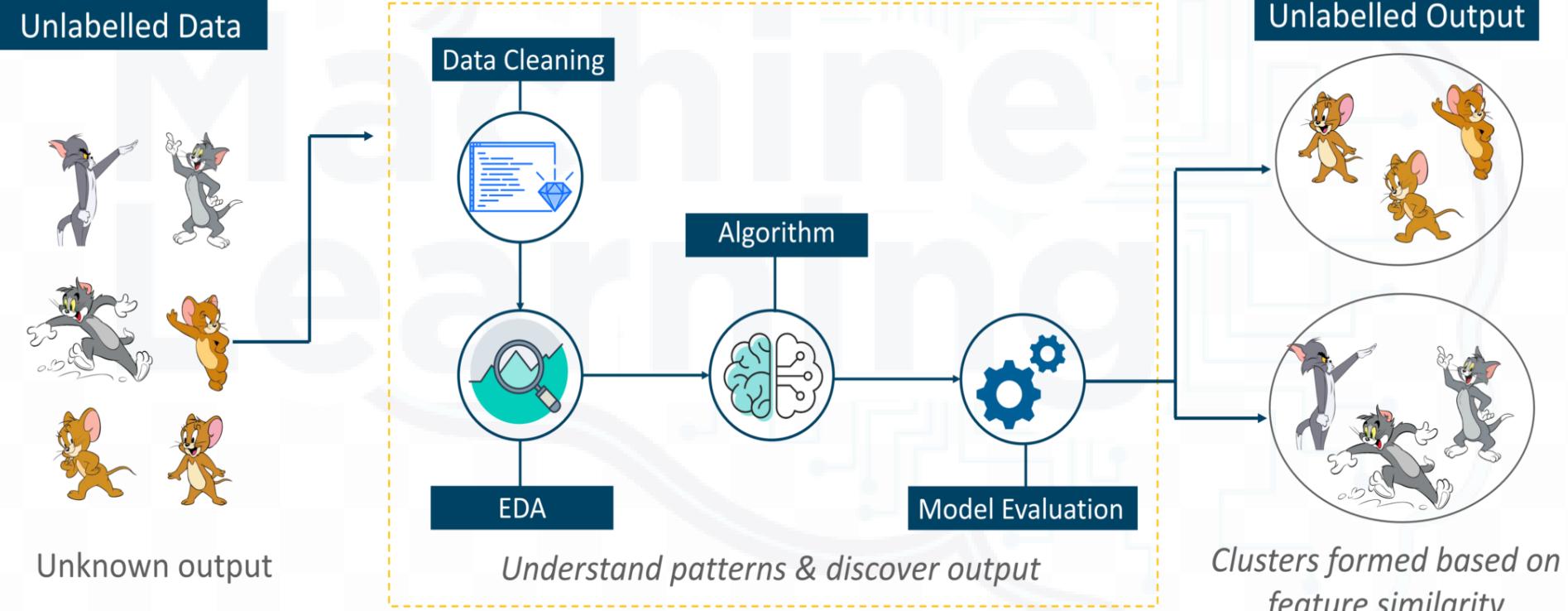


3. Unsupervised Learning



Clustering

▶ How does clustering work?

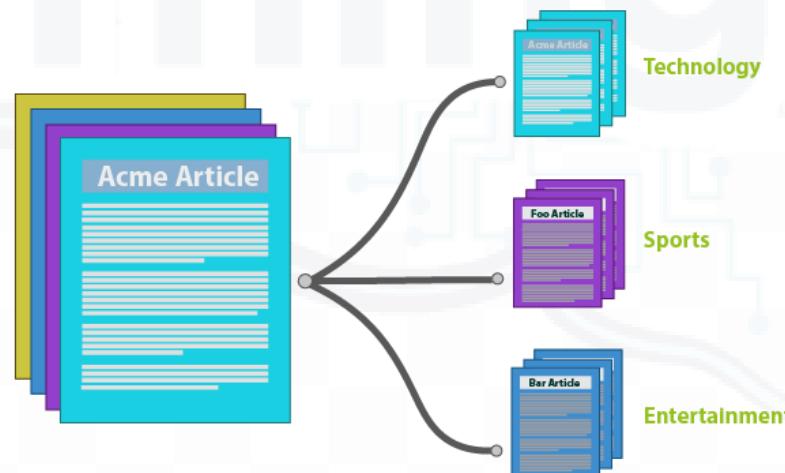


EDA: Exploratory Data Analysis

Clustering: Application

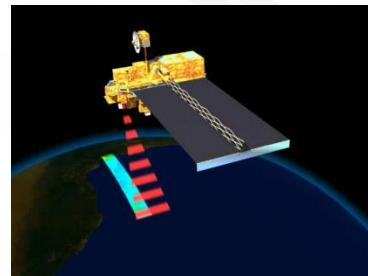
▶ Document Clustering:

- **Goal:** To find groups of documents that are similar to each other based on the important terms appearing in them.
- **Approach:** To identify frequently occurring terms in each document. Form a similarity measure based on the frequencies of different terms. Use it to cluster.



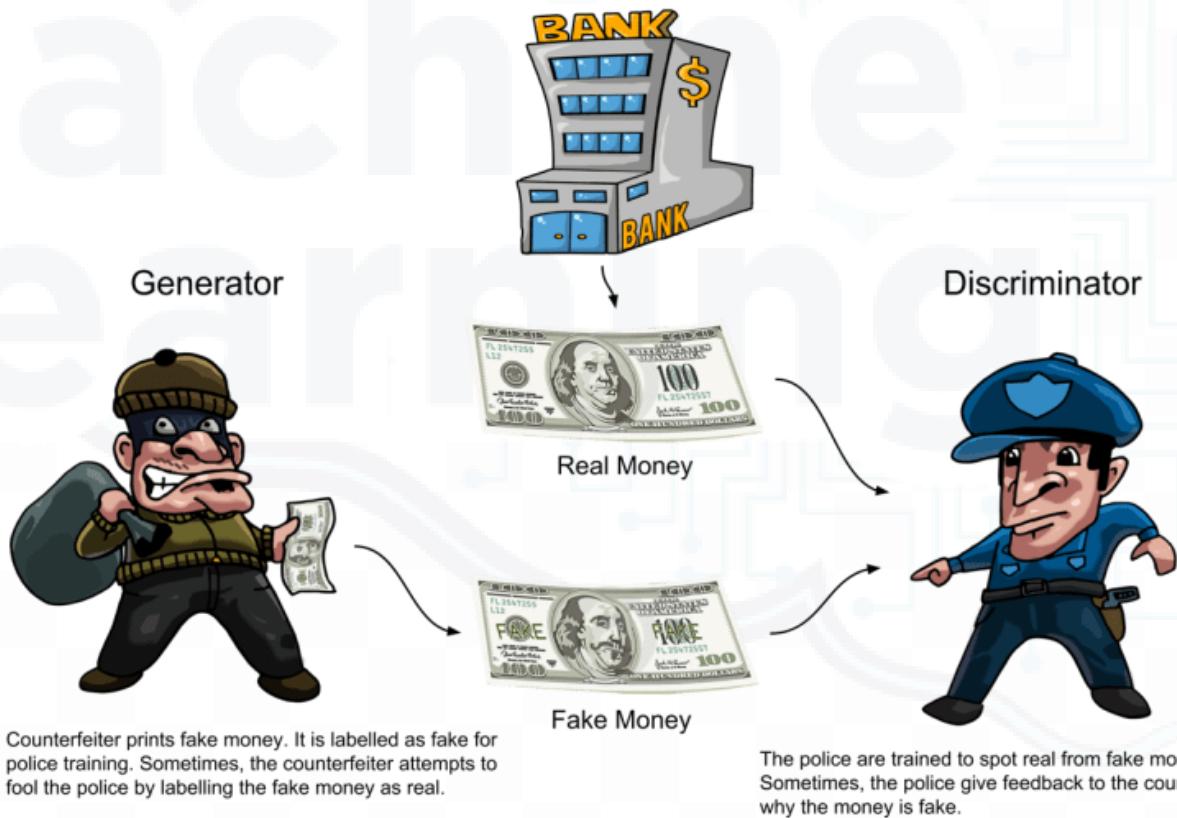
Deviation/Anomaly/Change Detection

- ▶ Detect significant deviations from normal behavior
- ▶ **Applications:**
 - Credit Card Fraud Detection
 - Network Intrusion Detection
 - Identify anomalous behavior from sensor networks for monitoring and surveillance.
 - Detecting changes in the global forest cover.

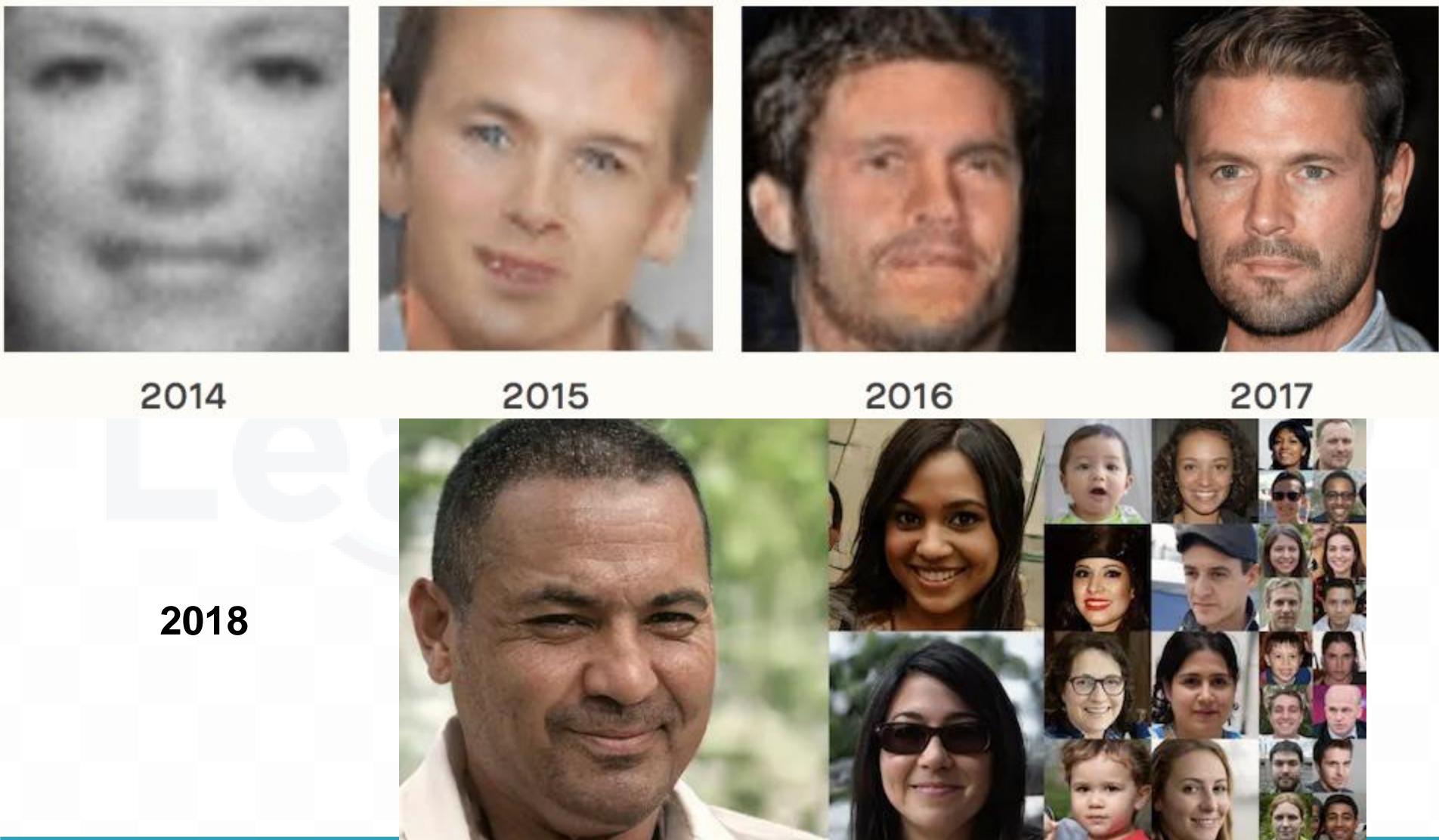


GAN: Generative Adversarial Networks

- ▶ GAN: learn to model the input distribution by training two competing (and cooperating) networks called **generator** and **discriminator**



GAN (cont.)



GAN (cont.)

- ▶ Generate Anime characters

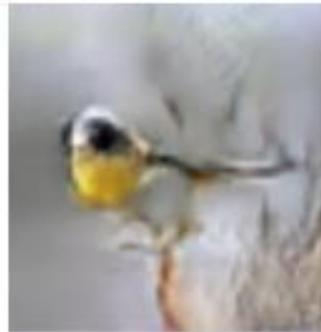


GAN (cont.)

▶ Text to image

(a) Stage-I
images

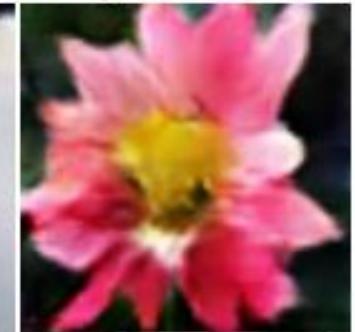
This bird has a yellow belly and tarsus, grey back, wings, and brown throat, nape with a black face



This bird is white with some black on its head and wings, and has a long orange beak



This flower has overlapping pink pointed petals surrounding a ring of short yellow filaments



(b) Stage-II
images



GAN (cont.)

► Music generation



(a) MidiNet model 1



(b) MidiNet model 2



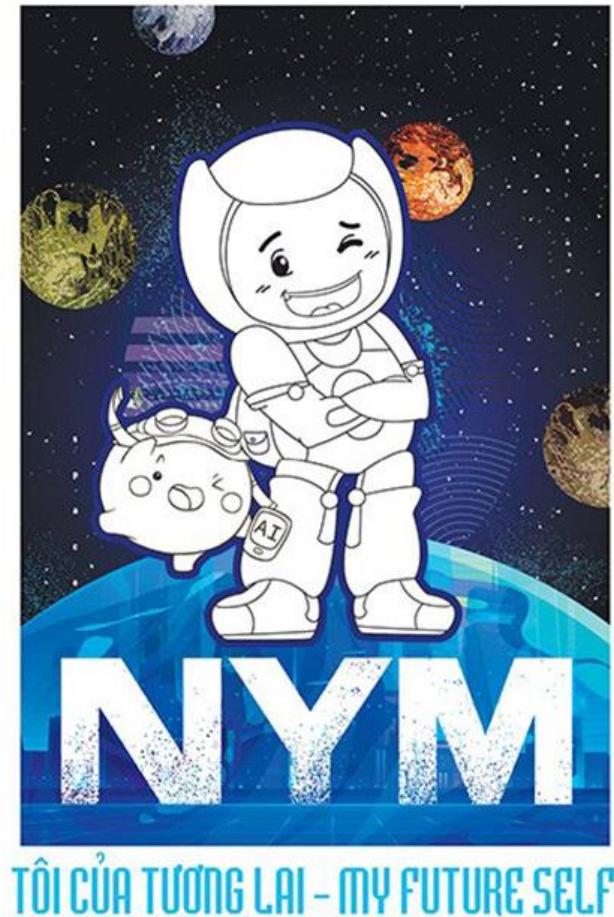
(c) MidiNet model 3

Figure 3. Example result of the melodies (of 8 bars) generated by different implementations of MidiNet.

AI for Writing

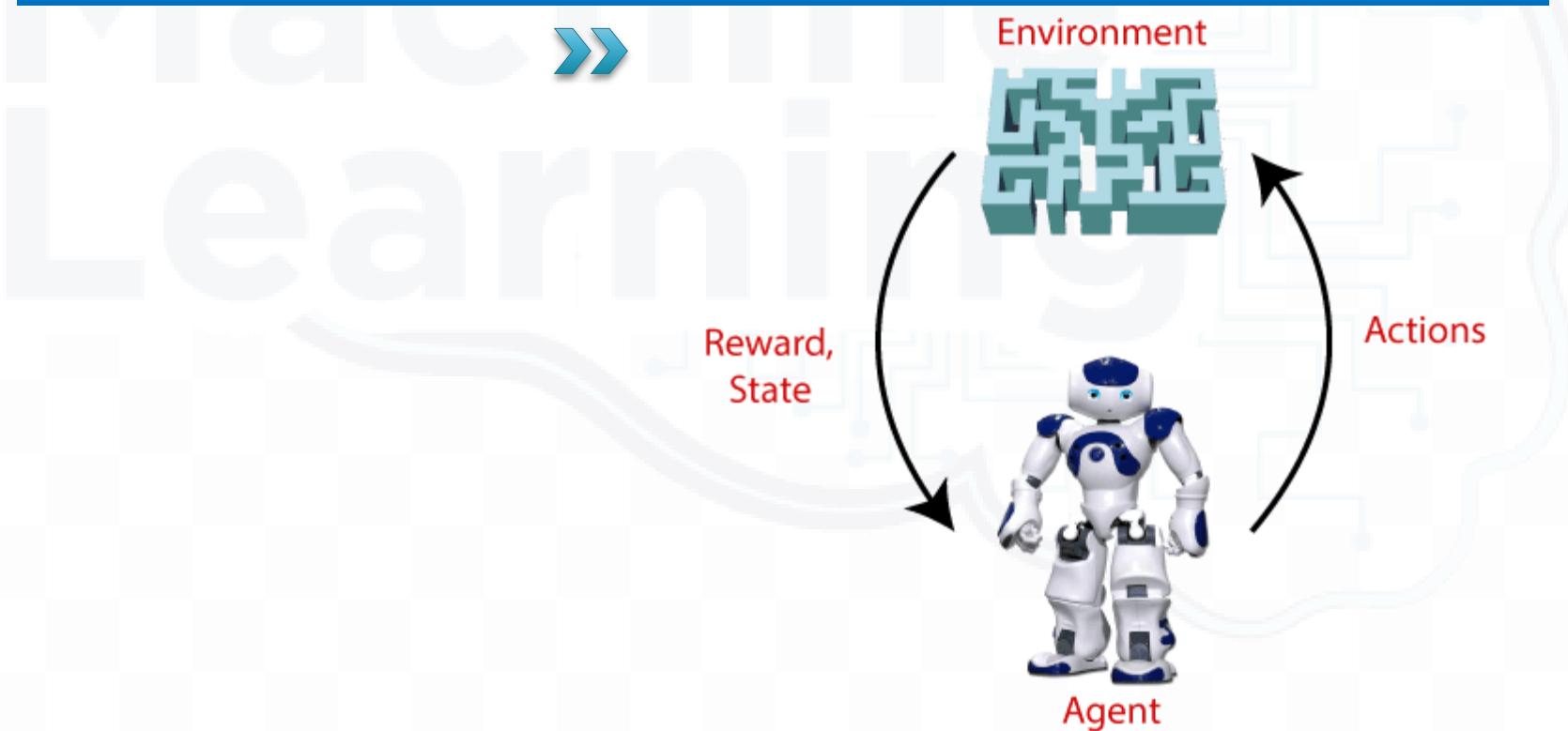
- ▶ **Nym**: AI do Nguyễn Phi Vân xây dựng trong hơn ba năm, được nạp dữ liệu về ngôn ngữ, kiến thức đời sống.
 - AI đã nói chuyện trực tiếp, một – một với 11 triệu người trẻ Việt trên facebook để thu thập thông tin.
 - **Nym – Tôi của tương lai** – quyển sách con người và AI hợp tác viết.

Một cuốn sách của **NGUYỄN PHI VÂN**



SAIGONBOOKS NHÀ XUẤT BẢN
VĂN HÓA - VĂN NGHỆ

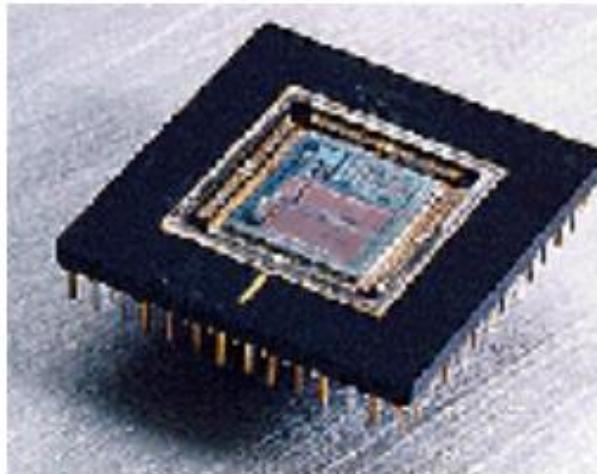
4. Reinforcement Learning



Game Playing – Chess

- ▶ 1997, Deep Blue (IBM) has defeated Garry Kasparov

won 3 games,
lost 2,
tied 1



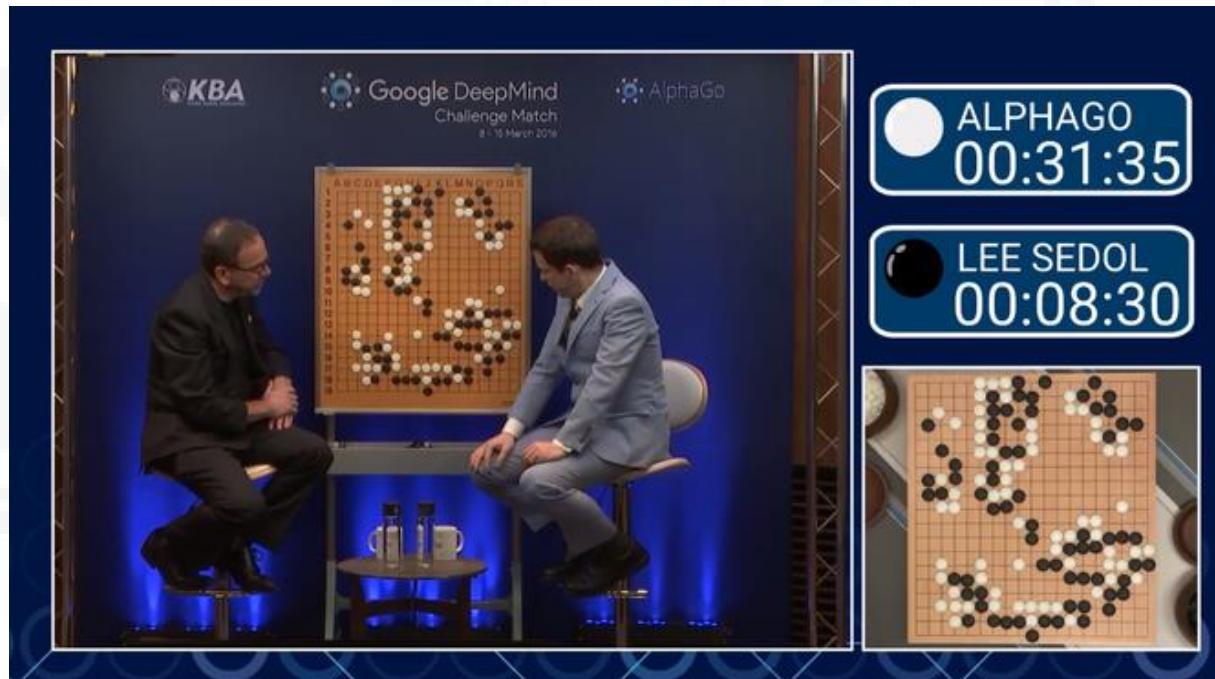
Deep Blue chip



Game Playing – Go

- ▶ 2016, **AlphaGo** (Deepmind, Google) has defeated Lee Sedol.

won 4 games,
lost 1



Robotic Vehicles

- ▶ 2006, a driverless robotic car – STANLEY won in DARPA Grand Challenge (desert)



- ▶ 2007, a driverless robotic car – CMU's BOSS won in Urban Challenge





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