

A stroll along Artificial Intelligence

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METIS Lecture Series

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PRESS RELEASE

8 October 2024

The Nobel Prize in Physics 2024

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Physics 2024 to

John J. Hopfield

Princeton University, NJ, USA

Geoffrey E. Hinton

University of Toronto, Canada

“for foundational discoveries and inventions that enable machine learning with artificial neural networks”

They trained artificial neural networks using physics

PRESS RELEASE

9 October 2024

The Nobel Prize in Chemistry 2024

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry 2024 with one half to

and the other half jointly to

David Baker

University of Washington, Seattle, WA, USA
Howard Hughes Medical Institute, USA.

Demis Hassabis

Google DeepMind, London, UK

John M. Jumper

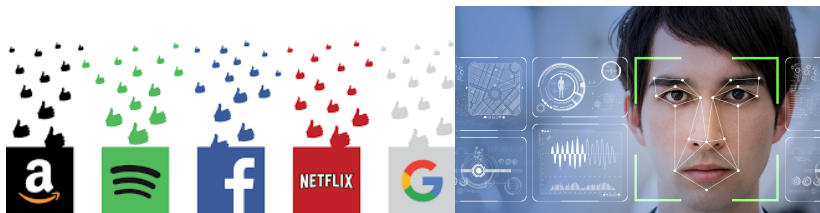
Google DeepMind, London, UK

“for computational protein design”

“for protein structure prediction”

They cracked the code for proteins' amazing structures

Artificial Intelligence in our society



Outline

- 1 A historical excursion
- 2 Overview and definition of concepts

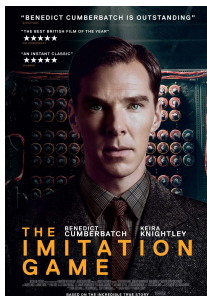
What is Artificial Intelligence ?

The ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings
(source :

<https://www.britannica.com/technology/artificial-intelligence>).

Origins : Alan Turing around the end of the 1940s. Famous book : **Computing Machinery and Intelligence** from 1950.

Author of the Touring test or Imitation Game



1956

Dartmouth Summer Research Project on AI : first time the term Artificial Intelligence was coined



<https://www.cantorsparadise.com/the-birthplace-of-ai-9ab7d4e5fb00>

1957



<https://www.lesechos.fr/idees-debats/dossiers/intelligence-artificielle-IA-Gafa-AlphaGo-Watson/1957-le-perceptron-premiere-machine-apprenante-130009>

1966

Development of ELIZA chatbot by Joseph Weizenbaum (1923-2008)

```

Welcome to

EEEEEE LL      IIII ZZZZZZ  AAAAA
EE      LL      II      ZZ  AA  AA
EEEEEE LL      II      ZZZ  AAAAAA
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:

```

Image source : wikipedia

1986

Significant methodological advance : backpropagation by Geoffrey Hinton (born 1947) and co-authors



Image source : wikipedia

1997

Upset in the chess world : Deep Blue beats the world champion Garry Kasparov



<https://www.britannica.com/topic/Deep-Blue>

2002

First autonomous vacuum cleaner iRobot Roomba



Image source : wikipedia

2010

Creation of DeepMind by Hassabis, Legg and Suleyman, the "Apollo-project of AI".

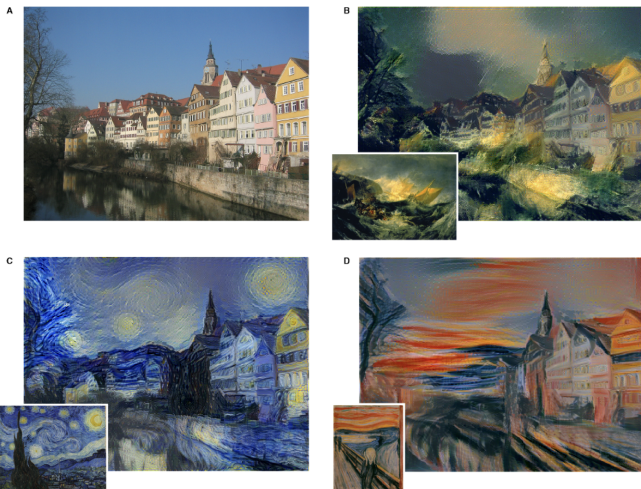
<https://deepmind.google>

2014

Amazon Alexa enters the picture



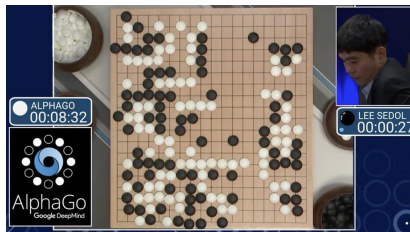
2015



Source : "A Neural Algorithm of Artistic Style" by Gatys, Ecker, Bethge

2016

Huge upset in the Go world : AlphaGo beats Lee Sedol.



<https://www.bbc.com/news/technology-35785875>

January 2017

Letter | [Published: 25 January 2017](#)

Dermatologist-level classification of skin cancer with deep neural networks

[Andre Esteva](#) , [Brett Kuperl](#) , [Roberto A. Novoa](#) , [Justin Ko](#), [Susan M. Swetter](#), [Helen M. Blau](#) & [Sebastian Thrun](#) 

[Nature](#) **542**, 115–118 (2017) | [Cite this article](#)

220k Accesses | **7044** Citations | **2898** Altmetric | [Metrics](#)



A [Corrigendum](#) to this article was published on 29 June 2017

2018

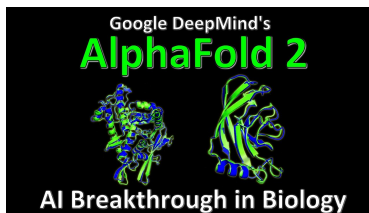


"A Style-Based Generator Architecture for Generative Adversarial Networks" by Karras, Laine and Aila.

2018

AlphaFold crushes the competitors at CASP13 (Critical Assessment of Structure Prediction).

In 2020, AlphaFold2 does even much better $\Rightarrow$ "astounding, transformational" game-changer



https://www.youtube.com/watch?v=B9PL__gVxLI

2021

DALLE

A machine learning algorithm for medical doctors to help athletes



2022

The floor is yours... ChatGPT

What is the project METIS at the University of Luxembourg?

At the [University of Luxembourg](#), **Project METIS** is a **recent EU-funded research and education initiative** **focused on modernising medical education**.



What METIS stands for

METIS = "Future-Proofing Medical Education through Emerging Technologies for Enhanced Social Resilience." UNI...



Main idea

The project aims to **update how medicine is taught** so that future doctors are better prepared for a rapidly changing, digital healthcare world.



What the project does

METIS brings together universities across Europe (including Luxembourg, Germany, Italy, Norway, and Greece) to:

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Structured overview

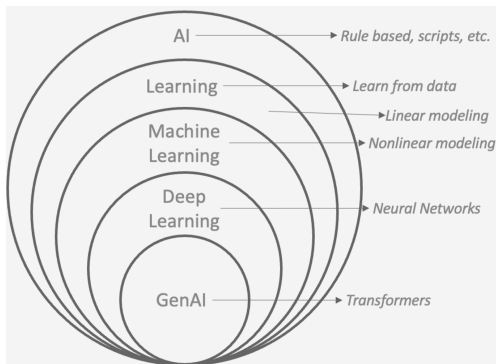


Image credits : Goodfellow, I., Bengio, Y., & Courville, A. (2016).

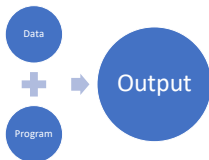
Deep learning. MIT press

Felice, F., Ley, C. et al. "Statistically Enhanced Learning : a feature engineering framework to boost (any) learning algorithms." Scientific Reports (2025).

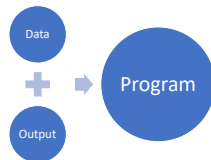
What is Machine Learning ?

Definition provided by Arthur Samuel in 1959 : **Field of study that gives computers the ability to learn without being explicitly programmed**

Traditional Programming



Machine Learning



Supervised Machine Learning

Based on determining factors, we seek to predict a certain quantity called the response !

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In mathematical terms : for each set of predictors $(x_1, x_2, \dots, x_p)_i$, there is an associated response $y_i, i = 1, \dots, n$.

Supervised Machine Learning

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The machine learns from *training data* the relationship between determining factors and the response.

Note : the response can be quantitative (regression) and qualitative (classification).

Classification Problem

Our recipe :

- 1 Define the goal : predict whether a person will have diabetes or not

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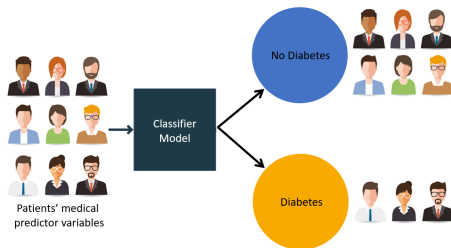


Image credits : <https://jnyh.medium.com/building-a-machine-learning-classifier-model-for-diabetes-4fca624daed0>

Image Processing

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- 1 Define the goal : image classification, e.g., cat or not, tumor or not

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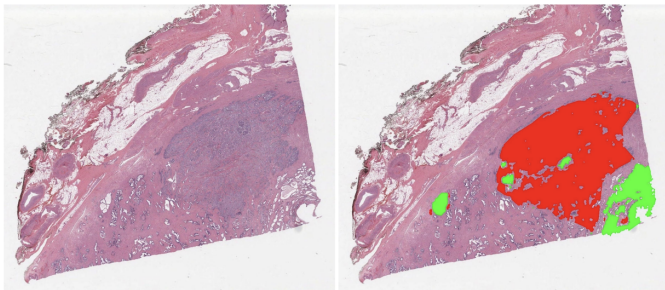
The exercise is challenging ! This is part of what we call **Deep Learning**.

Example 1



source: Yu, Fisher, et al. "BDD100K: A Diverse Driving Video Database with Scalable Annotation Tooling." arXiv:1805.04687 (2018)

Example 2



source: R Sivalingam, G Somasundaram, X Li, JC Henriksen, A Banerjee, V Morellas, N Papanikolopoulos, AM Truskinovsky. "Diagnosing Adenocarcinoma of the Prostate by Computer Vision Methods". *Modern Pathology* 2012; 25 (Supplement 2): 394A.

Popular Supervised ML models

- Linear/Logistic regression
- LASSO, Ridge Regression
- Decision Trees and Random Forests
- Boosting algorithms like XGBoost, CatBoost, AdaBoost
- Support Vector Machines
- Neural Networks

Unsupervised Machine Learning

Here, only determining factors (observations) are given, no response !

We ask the AI to "find a certain order" in the data

A typical example is **clustering**.

What is a natural grouping among these objects?



Clustering is subjective



Simpson's Family



School Employees



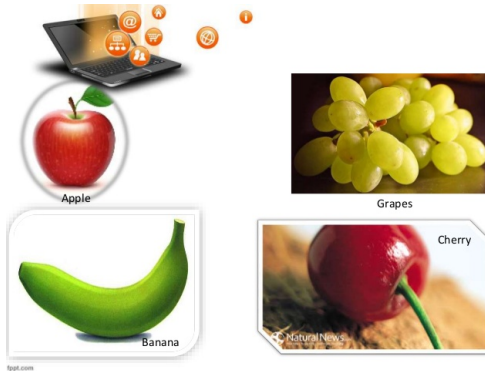
Females



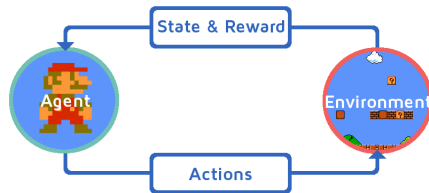
Males

Can you see concrete examples where this is used in everyday life ?

Difference Between Supervised and Unsupervised Machine Learning



Reinforcement Learning



An agent is supposed to find sequentially the optimal path to maximize reward in a given situation, with many hurdles in between.

The computer continues learning from its own experience and failures, and improves incredibly.

Famous examples : chess, Go, protein structure prediction, ...

Moral of this story

Learning by failing is a natural way to learn and grow.



Generative AI

- Text
- Image
- Audio - for text-to-speech and text-to-music
- Code
- Video

Concerns surrounding AI development

- Will jobs be lost and people replaced by AI technology ?
- How does education have to adapt to especially Generative AI possibilities ?
- Plagiarism, cheating, hacking and hard-to-detect fakes
- AI can create offensive content, discrimination, toxic content, weapons
- What about artists ?
- Totally made up text/images might be taken for ground truth (never forget : content is created based on probabilities)
- Huge use of energy resources, both for data storage and running of AI

Ethical aspects (also about (data) privacy) need to be discussed !

Responsible AI

Goal from the OECD : “AI that is innovative and trustworthy and respects human rights and democratic values”

The following aspects need to be ensured :

- Fairness and robustness (reliability)
- Data privacy
- Human control as much as possible
- AI must be explainable

Responsible AI



wolf



wolf



wolf



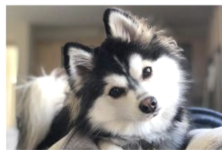
wolf



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