

MOD500 Decision Analysis with Artificial Intelligence Support

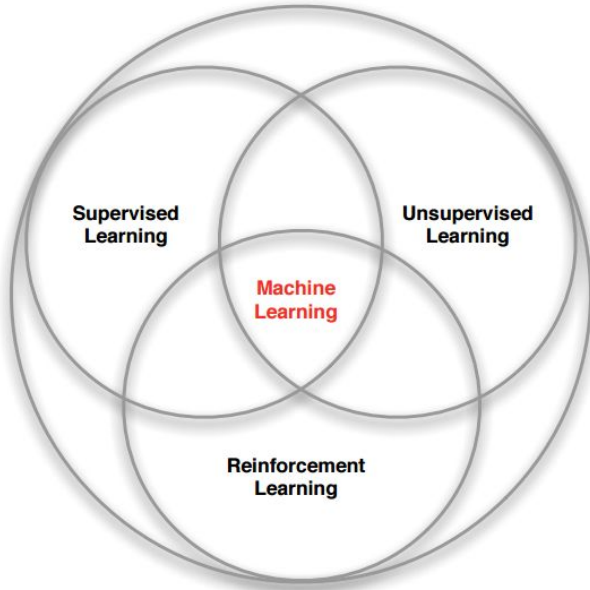
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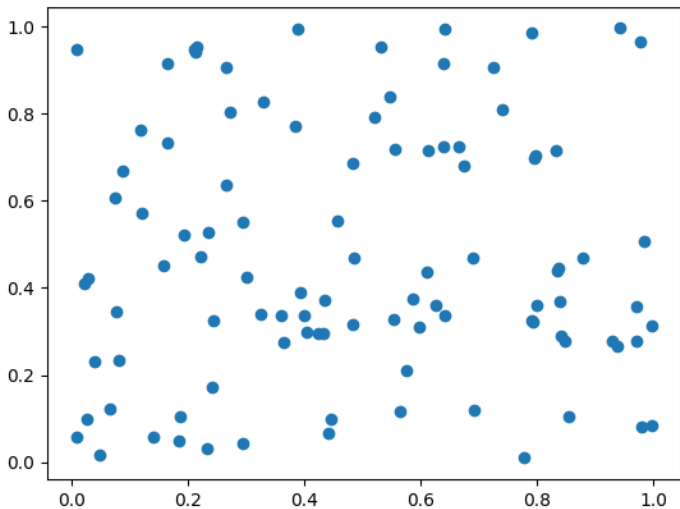
Sep 27, 2024



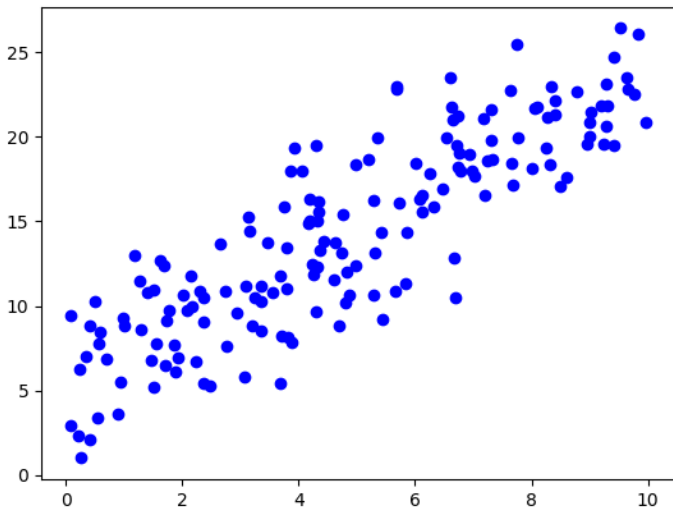
Families of Machine learning



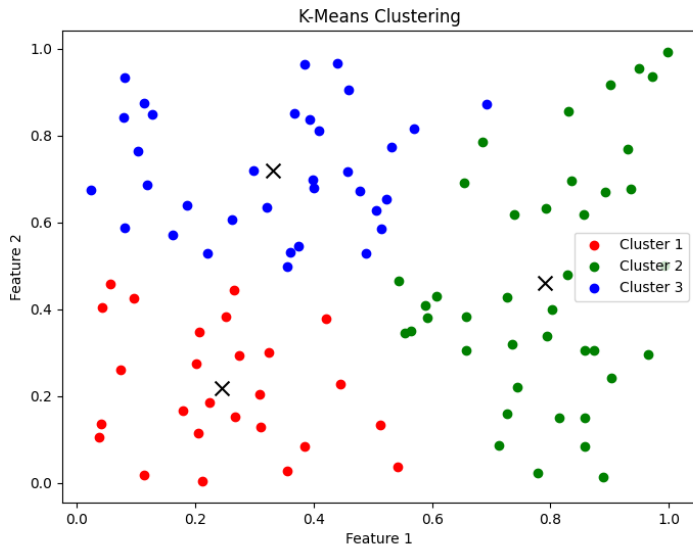
What can we do with that?



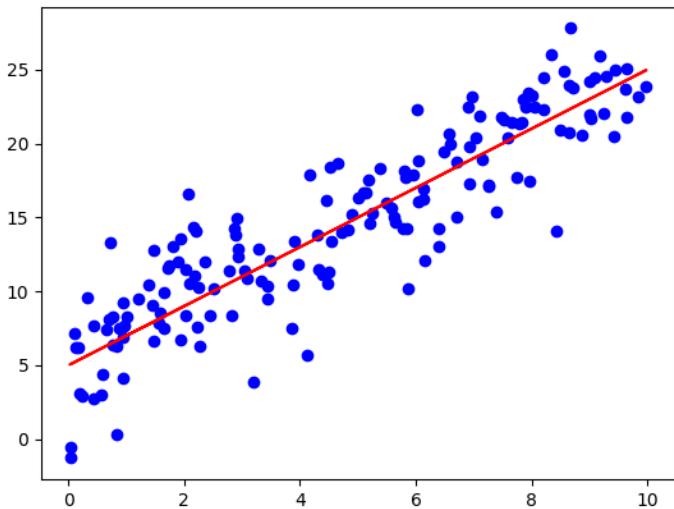
What about in this case?



Unsupervised learning



Supervised learning



The data decides

This is why we focus so much on the data type.

The data properties dictate what statistical model can be adopted.

An statistical model has leverages our understanding of the data structure to improve its **predictions** (inference).

The numerical recipe that we used to generate the data is defined the **truth**

Psychology or data science?

Most Machine learning tools are aimed to find the truth. In most cases, we are happy to not find lies.

Unsupervised learning

Unsupervised learning, a term that resonates with the autonomy of machine intelligence, operates on the principle of identifying patterns and structures in datasets without labelled responses.

This branch of machine learning is distinguished by its lack of explicit guidance, where algorithms are tasked with uncovering hidden structures from unlabeled data.

The most common clustering strategies are :

- filtering
- clustering
- dimensionality reduction
- association learning

Application of unsupervised learning

It is a bit of a holy grail: a computer that finds patterns without guidance. (Yes, it doesn't work, most of the time)

Still, it has been shown efficient for:

- Computer vision
- Anomaly detection
- Exploratory data analysis

Main challenge

The right result is quite undefined, Uncertain goal.

Reinforcement learning

Finally, there is a further approach.

Reinforcement learning (RL)

It aims to train an intelligent agent to take actions in a dynamic environment in order to maximise the cumulative reward.

It learns from outcomes and decides which action to take next. After each action, the algorithm receives feedback that helps it determine whether the choice it made was correct, neutral or incorrect.

It is a self-teaching system that essentially learns by trial and error.

It is a dependable tool for automated decision making.

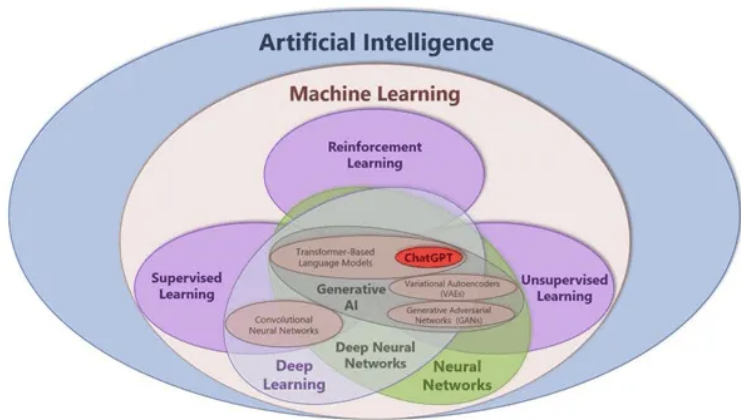
Generative AI

A generative AI model is a type of artificial intelligence that is designed to generate new content, based on the data it has been trained on.

It started in 1932, with the **mechanical brain** by Georges Artsrouni that was supposed to translate automatically between languages,

Here [a nice recaps of Generative AI](#) and its [storyline](#)

Generative AI



Structure of generative AI

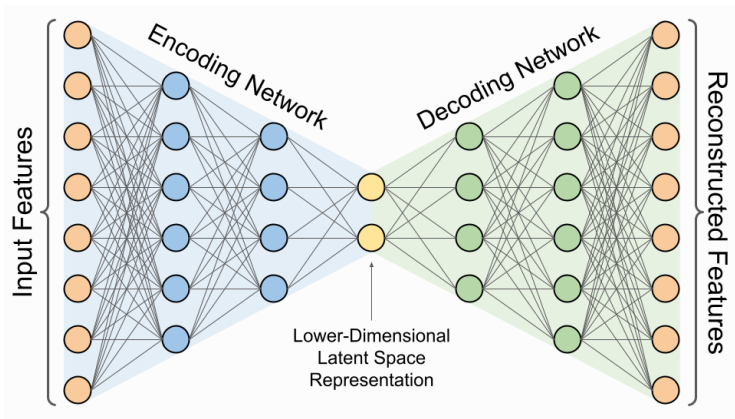


Image: <https://www.rapidops.com>

Key characteristics of generative AI models include:

- 1 Learning from Data: They are trained on large datasets, enabling them to learn patterns, styles, or features inherent in the data.
- 2 Generating New Content: Generative models can create new data instances. For example, a model trained on a dataset of paintings can generate new images in the style of those paintings.

Trained generative models are thus able to input information at a low resolution/dimension and give output with a much greater dimensionality.

Here a list of possible applications:

- Images/video: Image generation, Super-resolution, Deep fakes.
- Music: noise filter, voice and music generation, voice deep fake.
- Text(LLM): chatGPT, bard, Gemini, etc.
- Chemistry: DeepMind (Alphafold).
- Coding (co-pilot)
- Speech
- Attacks and Hacking (Security testing)
- Generating training sets
- And many more

This is scary:

- ① Virtual best friends
- ② Medical images to show diseases consequences
- ③ Synthetic data for digital twins
- ④ Preemptive suggestions (e.g. driving)
- ⑤ Matrix

Problems (currently)

New possibilities do not come with side effects.

- ❶ Lack of transparency: how the output is generated, and why?
- ❷ Accuracy: a lot of hallucinations
- ❸ Bias: human biases are kept, supported and eventually increased
- ❹ Intellectual properties (IP): who owns what is produced?
- ❺ Cybersecurity and frauds: mass cyber attacks can be created
- ❻ Sustainability: massive quantity of electricity is used
- ❼ Responsibility (who to blame?): Will AI get citizenship everywhere?

Where generative AI is ?

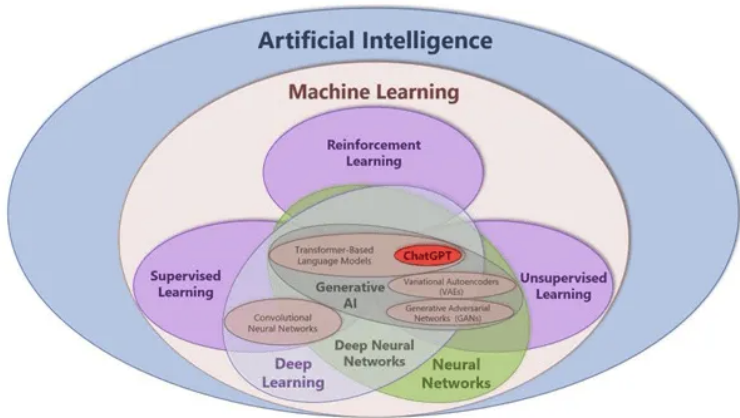


Image: <https://iot-analytics.com>

Structure of generative AI

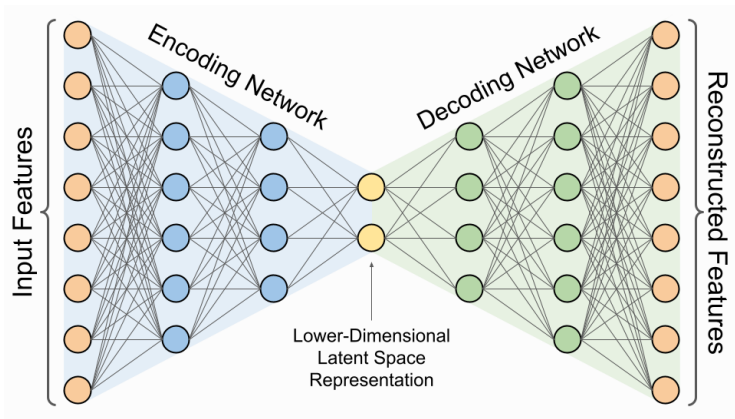


Image: <https://www.rapidops.com>

A new field?

Generative AI is actually a new evolution.

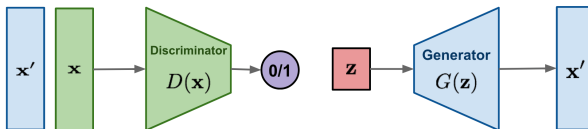
It is based on Neural Network, and in comprises a set of advanced tools (numerical recepites):

- 1 Generative Adversarial Networks
- 2 Generative Pre-trained Transformers
- 3 Variational Autoencoders
- 4 Conditional Variational Autoencoders
- 5 Autoencoders

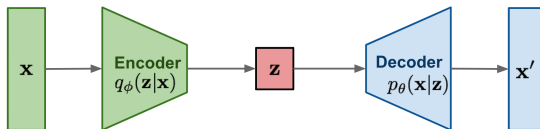
Types of generative AI

It is quite an advanced technique

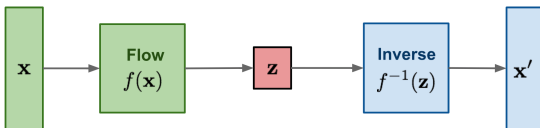
GAN: minimax the classification error loss.



VAE: maximize ELBO.



Flow-based generative models: minimize the negative log-likelihood



Source: [Lilian Weng](#)

How to play with a machine ?

- If then statements
- Look forward and evaluate
- Look for all possibilities
- Look ahead

Minimax aims to maximize the minimum gain (or best of worst case scenario)

No math no fun

$$v_i = \max \min v_i(a_i, a_{-i})$$

v_i : value of function of player i

a_i : action taken by player i

a_{-i} : action taken by not i player(s)

i : index of the player

Alpha-beta approach (minimax extension)

