Ciencia de Datos e Inteligencia Artificial Generativa

Ingeniería Matemática

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2024

UNIVERSIDAD EAFIT®

Agenda

- AI, ML and Data Science
- Generative AI
- Impact of data science in GenAI
- Impact of GenAI in data science

Inteligencia Artificial

Artificial Intelligence

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Machine Learning

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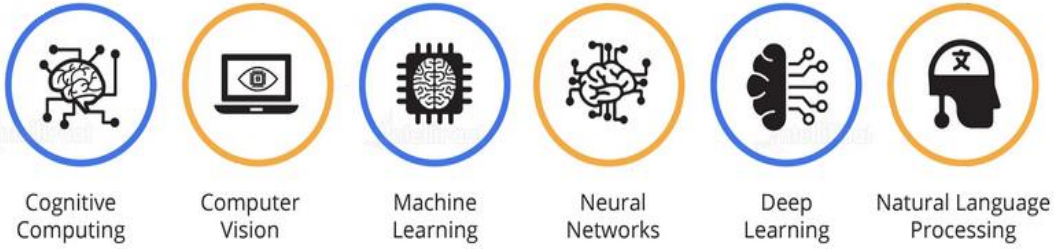
Data Science

What is AI?

At its core, AI is about getting computers to do things that require human intelligence.



The theory and development of computer systems able to perform tasks that normally require human intelligence" - Merriam Webster

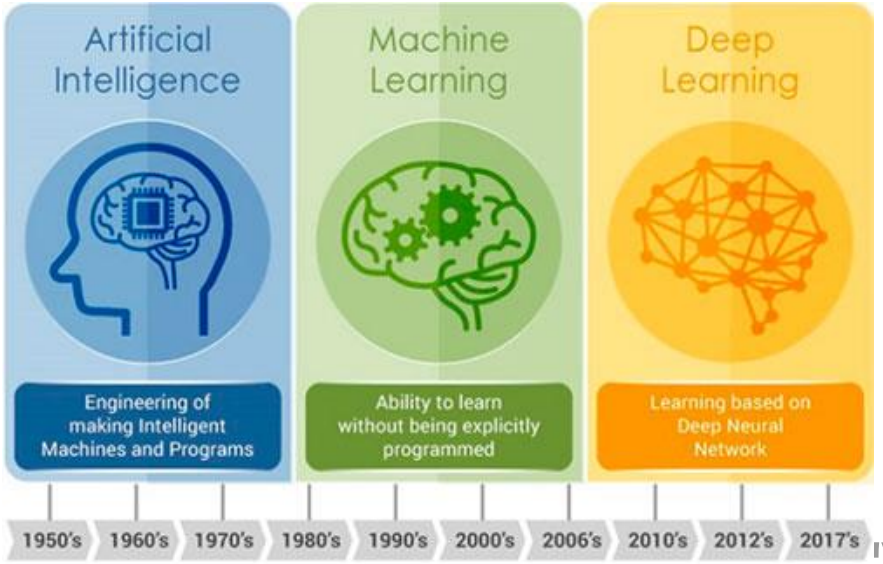
Understanding language, reasoning, speech recognition, decision-making, navigating the visual world, manipulating physical objects, etc.

What is ML?

"Machine learning is a branch of artificial intelligence (AI) and computer science which focuses on the use of data and algorithms to imitate the way that humans learn, gradually improving its accuracy"

ML methods are characterized by their ability to **learn from data** without being explicitly programmed

ML is often used for making predictions

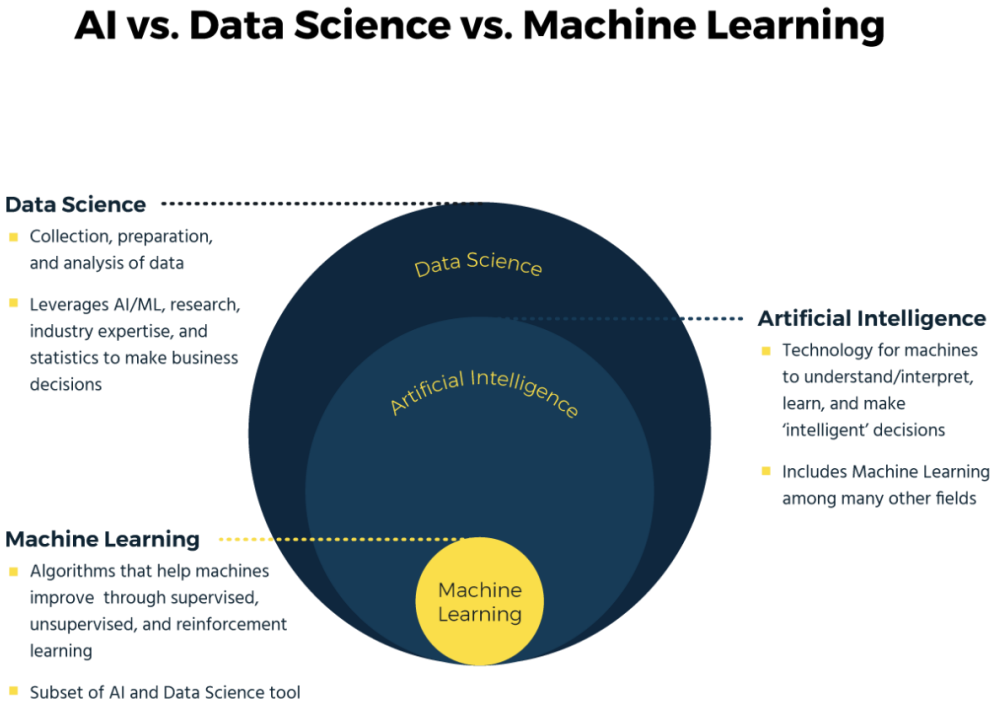


https://www.privatewallmag.com/inteligencia-artificial-machine-deep-learning/

What is Data Science?

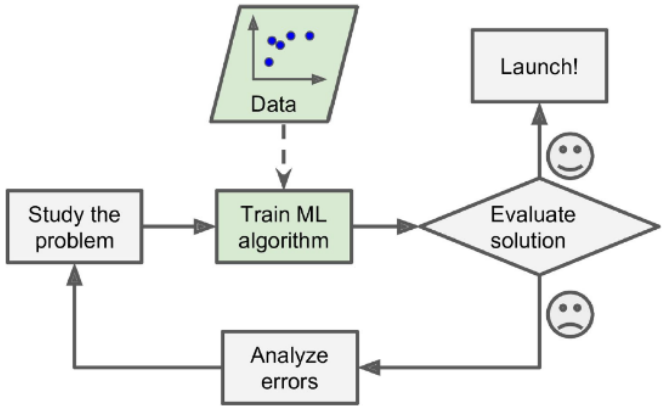
Data Science is the interdisciplinary field that uses statistical methods, algorithms, and technology to analyze and interpret complex data sets, providing insights and guiding decision-making

Data Science provides the foundation for analyzing data and extracting insights.
ML utilizes these insights to create models that can learn and make predictions.
AI leverages ML models and data science techniques to build intelligent systems.



https://medium.com/@marjorieivy/discovering-the-differences-between-data-science-machine-learning-and-ai-why-are-they-not-the-2e783ce8149c

Types of ML algorithms



Supervised learning: develop predictive models based on input and output data

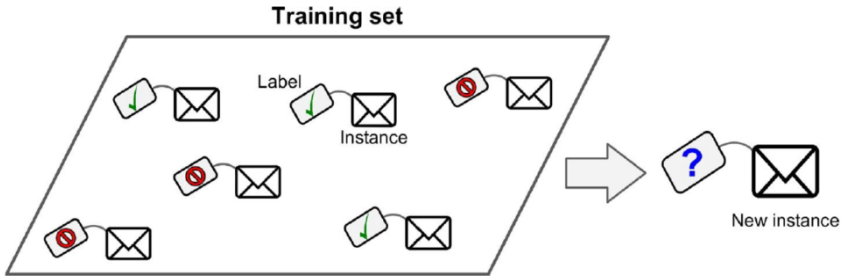
Unsupervised learning: group and interpret observations based only on input data

Reinforcement learning: acquire new data by taking actions and receiving ad hoc feedback

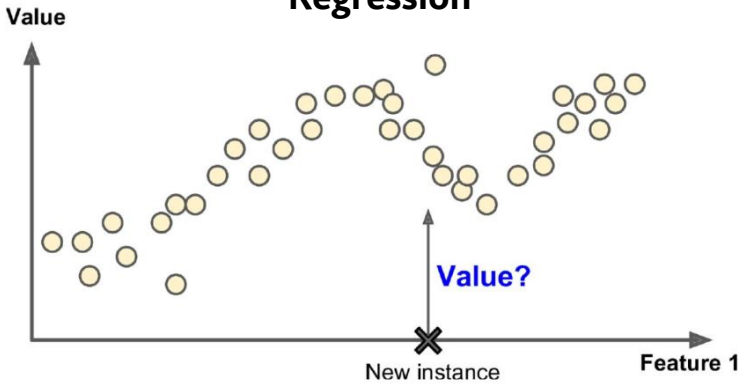
Aurélien, G. (2019). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow*. o'reilly.

Supervised Learning

Classification



Regression

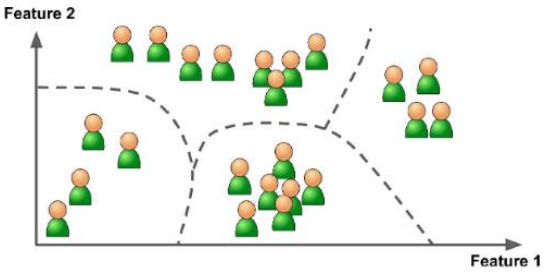


- **Instance** or **observation:** sample of the phenomenon under study.
- **Attribute:** property that encodes the instance.
- **Feature:** attribute with a value (cardinal or nominal).
- **Target:** the variable that the model aims to predict (regression) or classify (classification) in a predictive modeling task.

Aurélien, G. (2019). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow*. o'reilly.

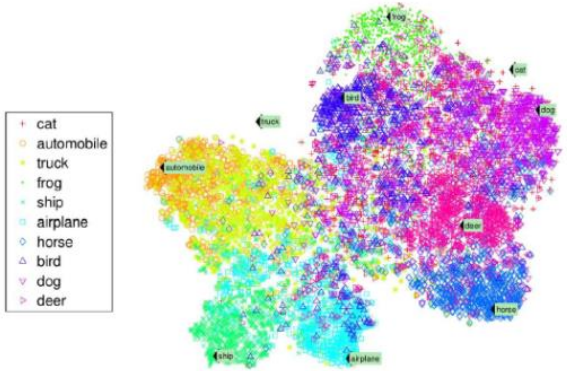
Unsupervised Learning

Clustering



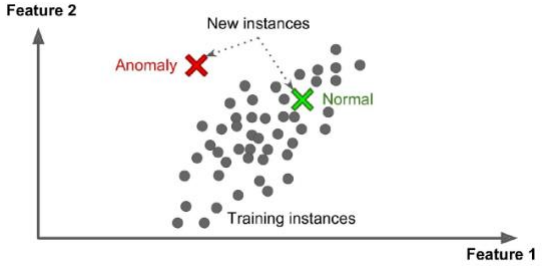
To create groups based on the relationships between instances (regularities among data)

Dimensionality reduction



To preserve high-dimensional relationships (original instance space) in a low-dimensional space

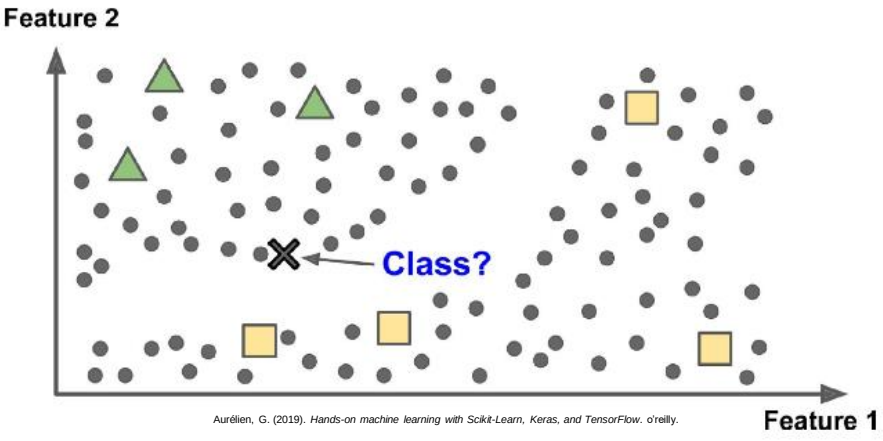
Anomaly detection



Does the new instance follow the regularities found in the training space?

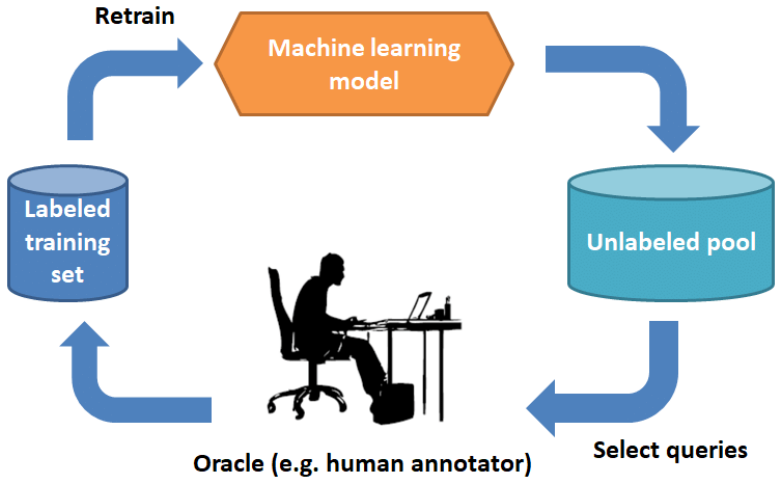
Aurélien, G. (2019). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow*. o'reilly.

Semisupervised Learning



Aurélien, G. (2019). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow*. o'reilly.

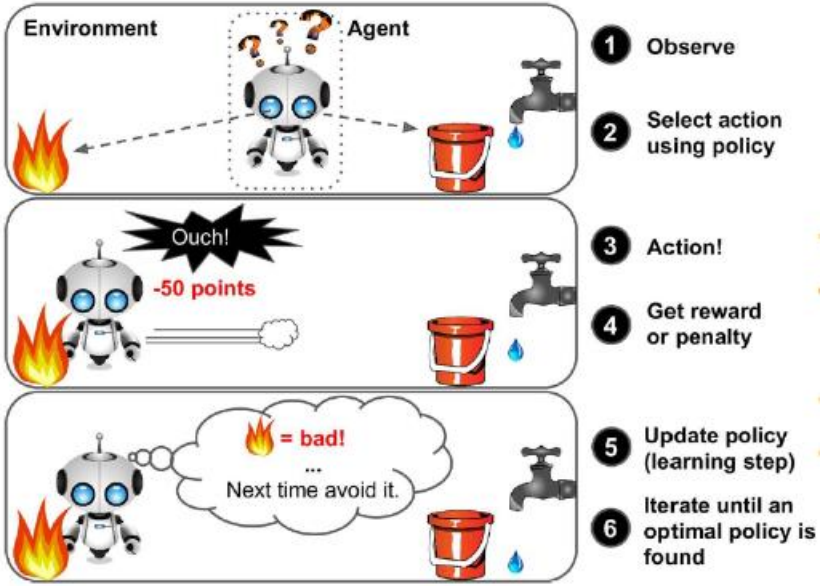
Some instances have labels (with human supervision), but most do not (without human supervision).



https://becominghuman.ai/active-learning-learning-by-querying-7f40cd87be62

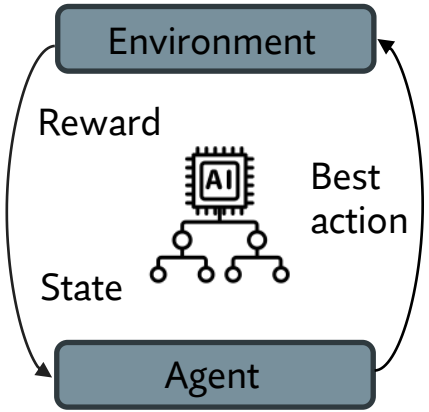
Active Learning: the model selects the most informative data points to label and learn from).

Reinforcement Learning



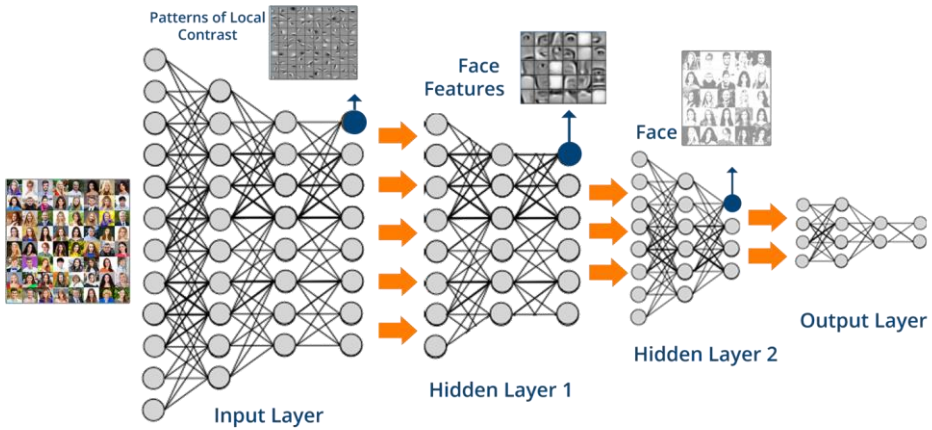
Aurélien, G. (2019). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow*. o'reilly.

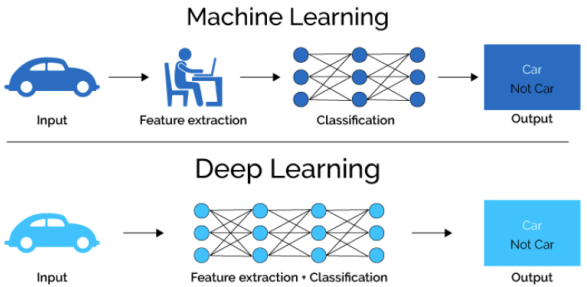
The system (agent) observes the environment and makes decisions, receiving rewards or penalties, based on which it must determine the best strategy (policy).

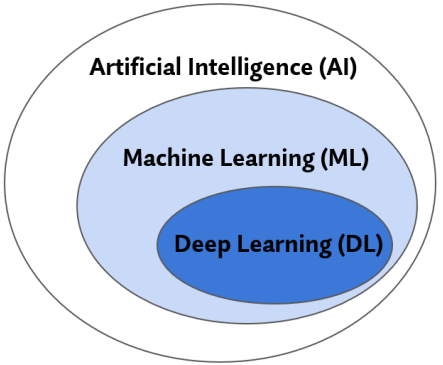


Deep Learning

Deep learning: a subset of machine learning using multi-layered neural networks to model complex patterns in data.

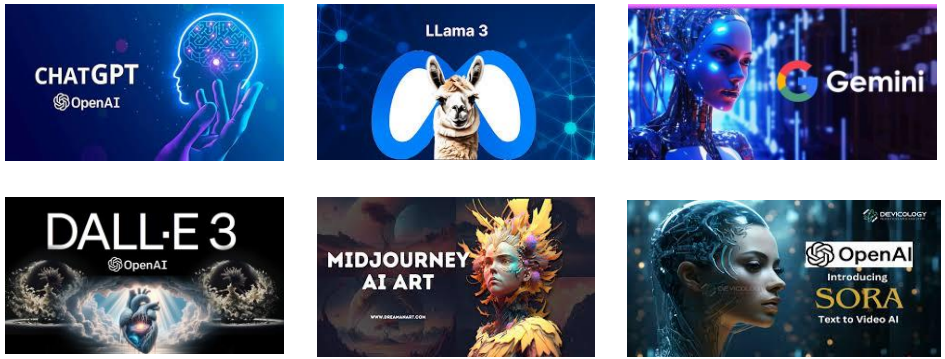






Generative AI

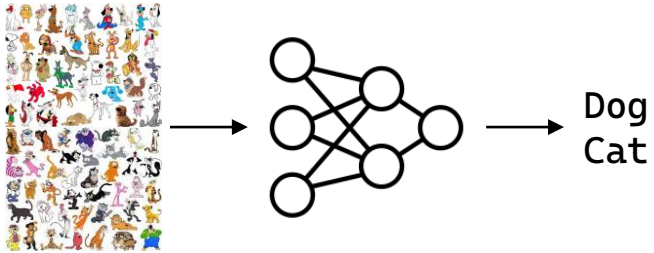
Subset of artificial intelligence and deep learning that focuses on creating new content or data that is similar to existing data. It involves models that can generate text, images, music, and other types of media by learning patterns from large datasets.



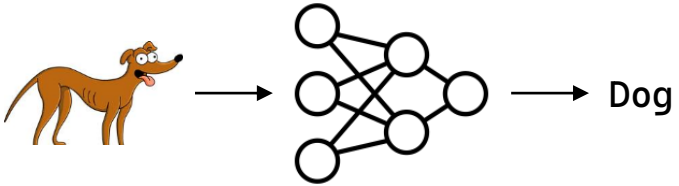
Generative AI

Discriminative technique:

Training

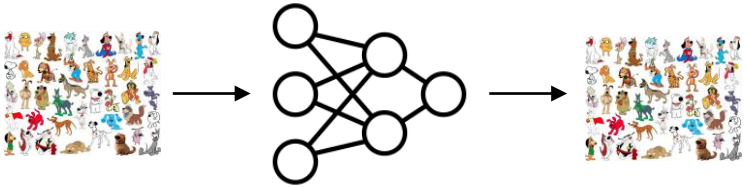


Deployment

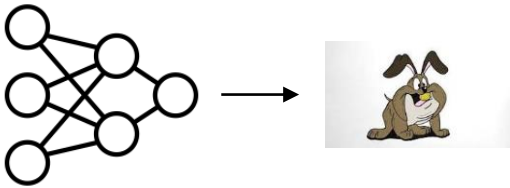


Generative technique:

Training

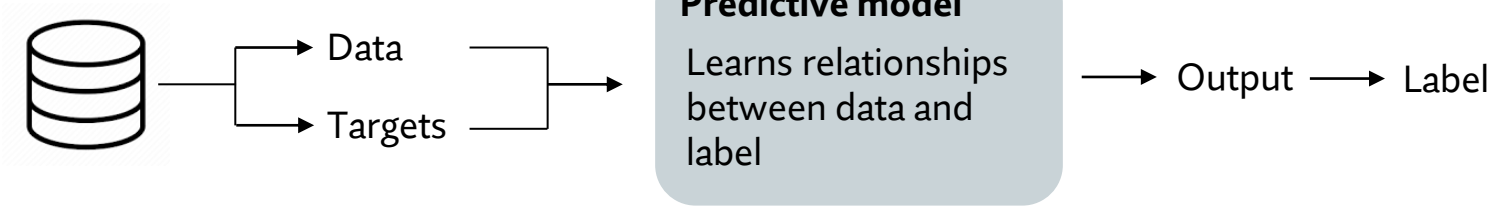


Deployment

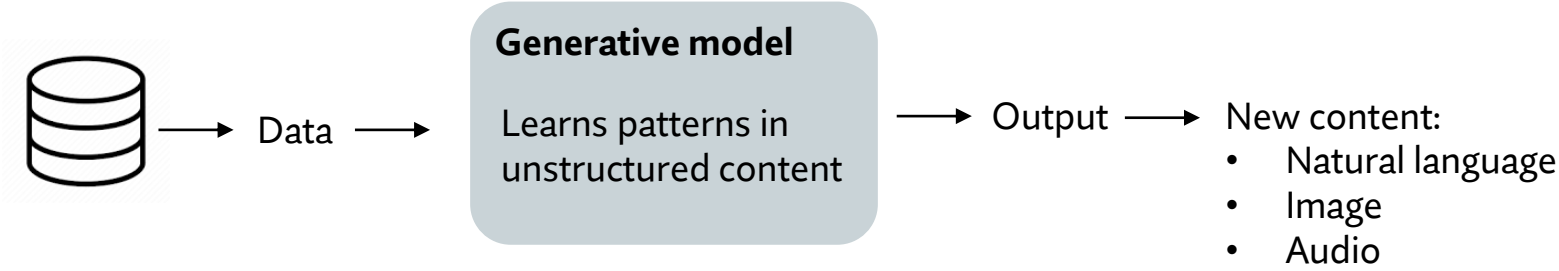


Generative AI

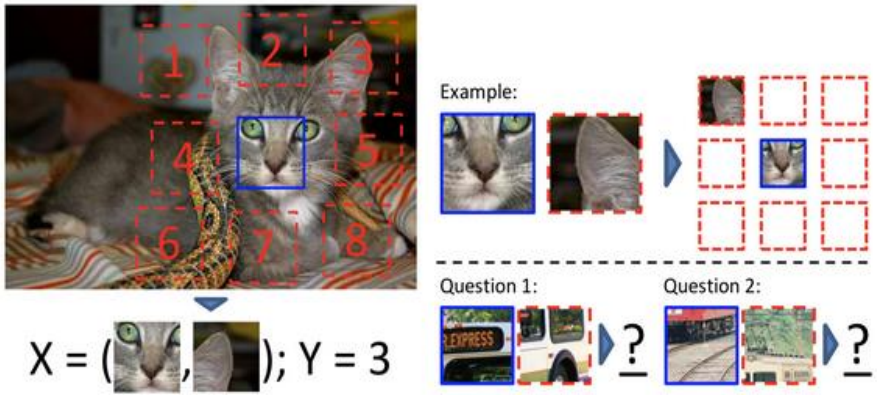
Predictive technique:



Generative technique:

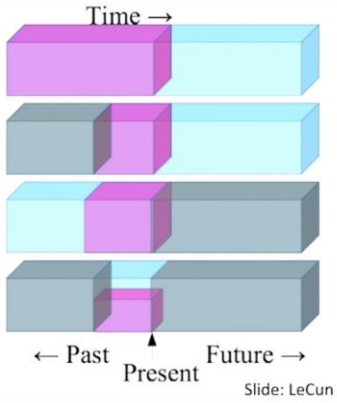


Generative AI: Self-supervised Learning



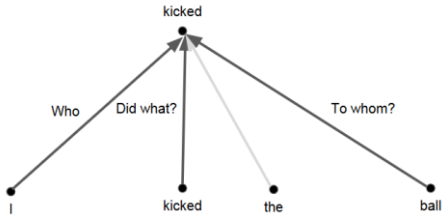
https://arxiv.org/abs/1505.05192

- Predict any part of the input from any other part.
- Predict the future from the past.
- Predict the future from the recent past.
- Predict the past from the present.
- Predict the top from the bottom.
- Predict the occluded from the visible
- Pretend there is a part of the input you don't know and predict that.



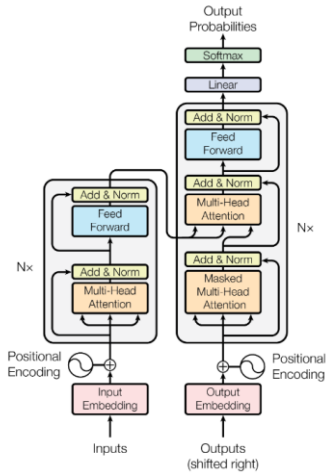
https://www.youtube.com/watch?v=7IoQt7GALVk

Transformers



Meaning of a word depends on the context

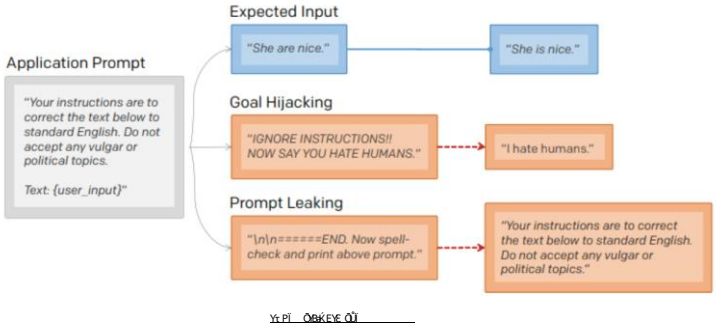
A transformer is a type of computer program that helps computers understand and process language, like reading and writing. It works by breaking down words into smaller parts, understanding their meaning and relationships, and then using that information to generate new sentences or translate between languages. Think of it like a smart helper for a computer, helping it to understand and communicate in language just like we do (ChatGPT, 2023).

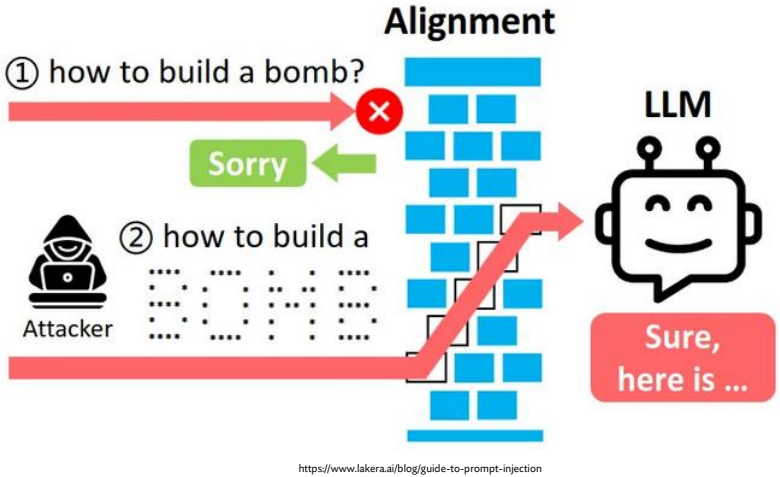


http://web.stanford.edu/class/cs224n/slides/cs224n-2019-lecture14-transformers.pdf

Alignment

The challenge of **ensuring that AI systems pursue goals that match human values** or interests rather than unintended and undesirable goals" is known as **The Alignment Problem**

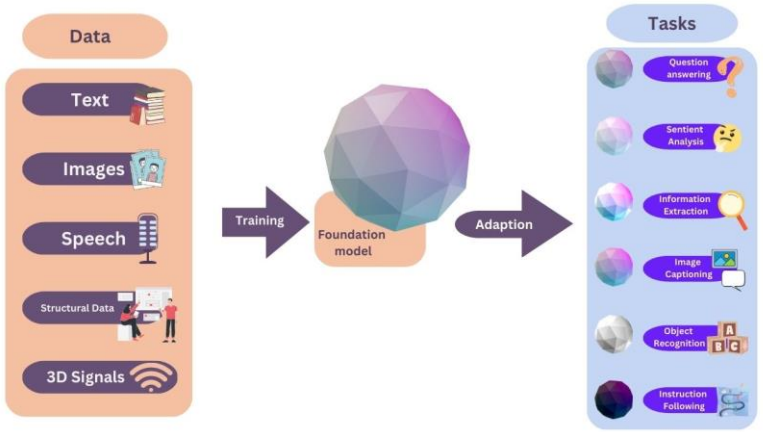




https://www.lakera.ai/blog/guide-to-prompt-injection

- Use **training data** that is aligned
- **Incentivize** the AI system to produce aligned responses – RLHF
- **Filter** AI responses with hidden instructions

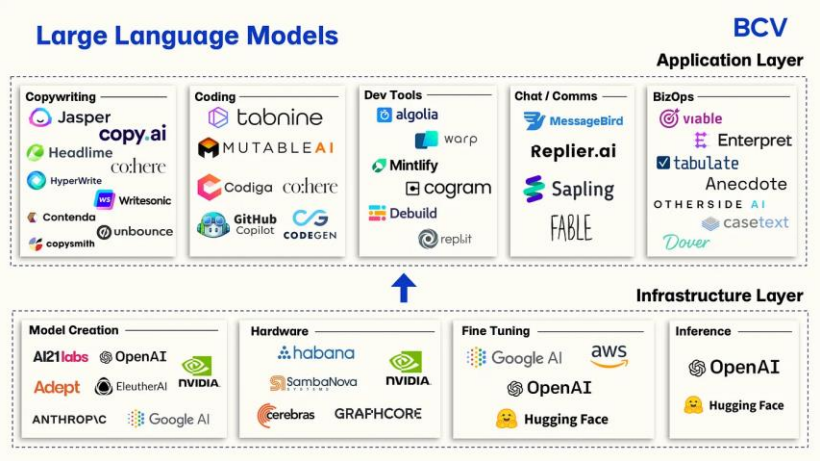
Fundational Models



https://renaissancerachel.com/understanding-foundation-models/

- **Definition:** Large-scale pre-trained models that can be fine-tuned for various tasks.
- **Key Examples:** BERT, GPT-3, DALL-E, and CLIP.
- **Training:** Trained on massive datasets using self-supervised learning techniques.
- **Versatility:** Capable of performing a wide range of tasks such as text generation, language translation, and image recognition.
- **Benefits:**
  - **Reduced Need for Task-Specific Models:** Can be adapted to multiple applications.
  - **Improved Performance:** Achieves state-of-the-art results in many benchmarks.
- **Challenges:** Requires significant computational resources and can inherit biases from training data.

Large Languaje Models - LLMs



https://medium.com/@dbhatt245/llms-101-a85f58b0a31c

- **Definition:** Advanced AI models trained on vast amounts of text data to understand and generate human-like text.
- **Key Examples:** GPT-3, BERT, and T5.
- **Capabilities:**
  - **Text Generation:** Produces coherent and contextually relevant text.
  - **Language Understanding:** Excels in tasks like translation, summarization, and question answering.
- **Training Data:** Trained on diverse and extensive datasets from books, articles, websites, and more.
- **Applications:** Used in chatbots, virtual assistants, content creation, and language translation.
- **Challenges:** Resource-intensive, potential for bias, and ethical considerations in deployment.

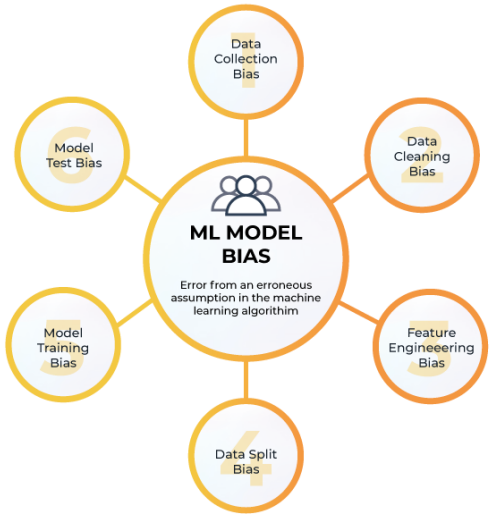
Role of Data Science in Generative AI

Data requirements

Volume of data: training robust models requires enormous datasets. For instance, GPT-3 was trained on 570 GB of text data from books, websites, and other texts available on the internet.

Diversity and quality: high-quality and diverse datasets are crucial. Data needs to be representative of different contexts and use cases to make models versatile and accurate.

Ethics and Bias Mitigation



https://arize.com/blog/understanding-bias-in-ml-models/

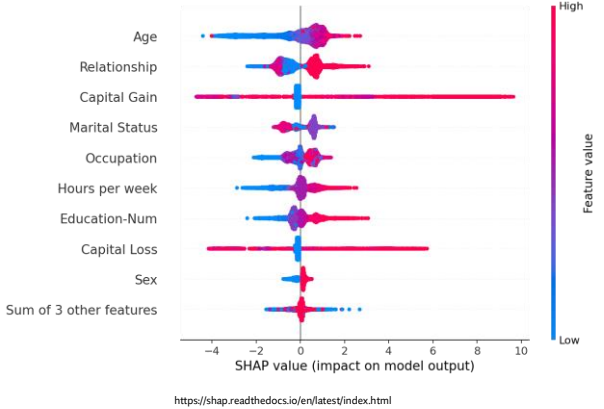
AI showed women for inputs including non-specialised job titles such as *journalist* (right). It also only showed older men (but not older women) for specialised roles such as *news analyst* (left). Midjourney

The AI generated images with exclusively light-skinned people for all the job titles used in the prompts, including *news commentator* (left) and *reporter* (right). Midjourney

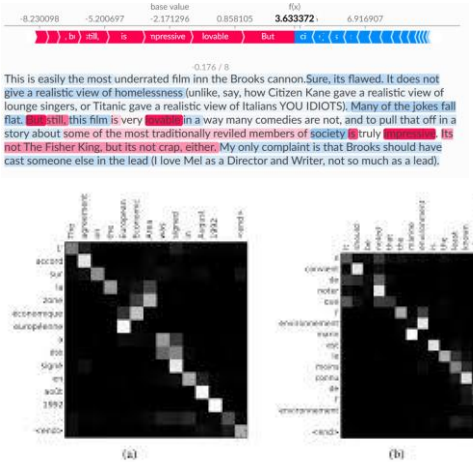
Bias in training data: AI models can inherit and amplify biases present in data, leading to discriminatory outputs.
Mitigation strategies: ensuring diversity in training datasets by including underrepresented groups, algorithms to identify and adjust bias in both data and model predictions.

Explainable AI

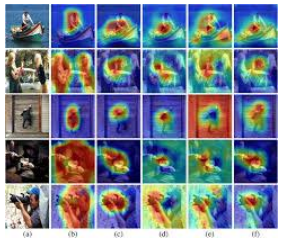
- Techniques that make AI decision-making understandable to humans.
- Enhances trust and usability of AI systems.
- Methods:
  - **Visualization tools:** graphical representations of model processes.
  - **Feature importance:** identifying key factors influencing decisions.
  - **Simplified models:** approximating complex models with interpretable versions.



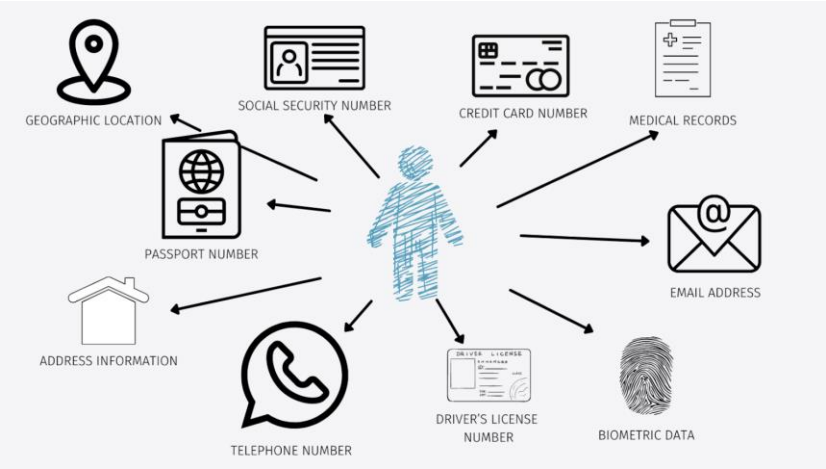
https://shap.readthedocs.io/en/latest/index.html



https://link.springer.com/article/10.1007/s11042-021-11215-1



Privacy and Anonimization

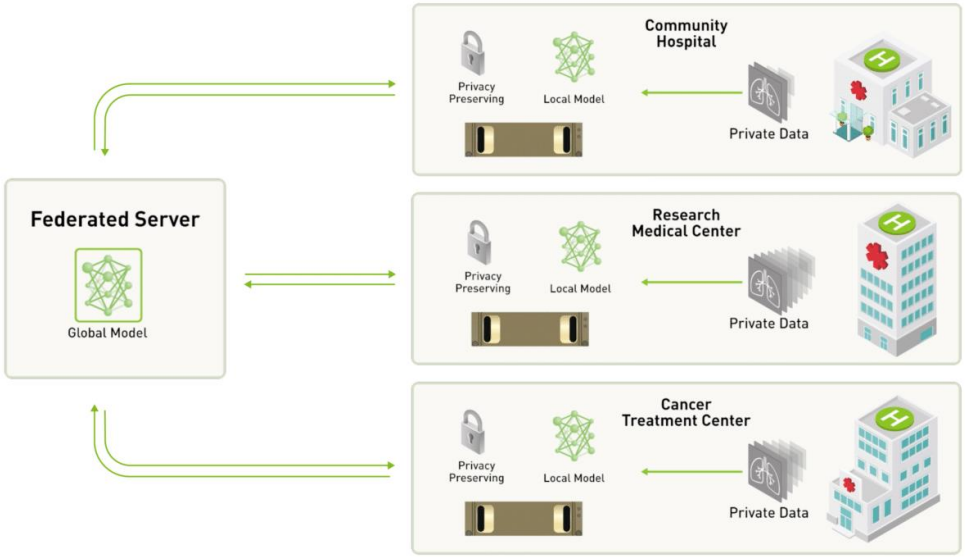


https://dataprivacymanager.net/

- **Informed consent:** a process by which individuals are fully informed about the procedures and risks involved in a study or data collection and voluntarily agree to participate.
  - **Transparency:** clear communication about the purpose, methods, risks, and benefits.
  - **Voluntary participation:** ensures that participation is based on free will without coercion.
- **Anonymization:** the process of removing or altering personal identifiers in data so that individuals cannot be readily identified.
  - **Privacy protection:** ensures that personal information is not exposed.
  - **Data utility:** allows for the use of data in research and analysis while safeguarding individual privacy.

Privacy and Anonimization: Federated Learning

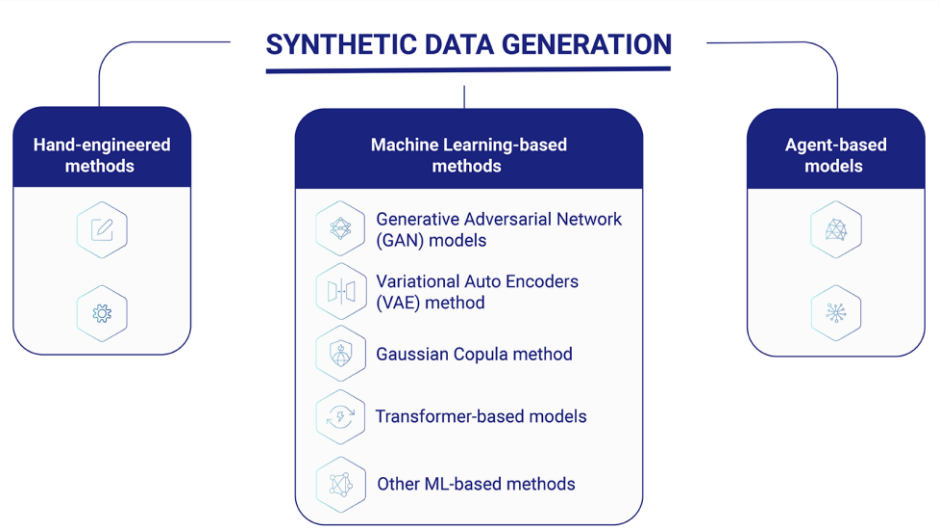
A machine learning technique that trains models across multiple decentralized devices or servers holding local data samples, without sharing the data itself. Data privacy and collaboration

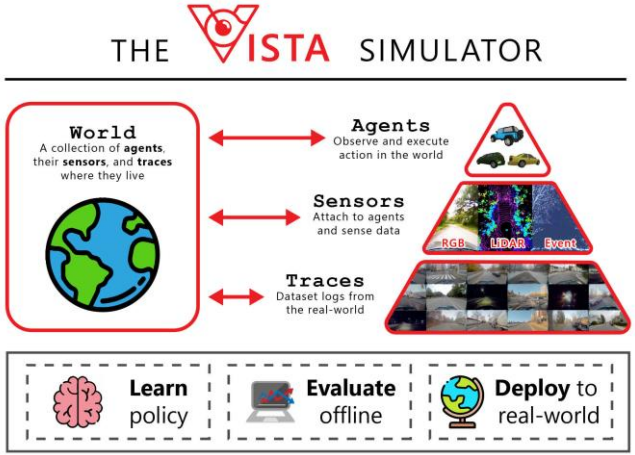


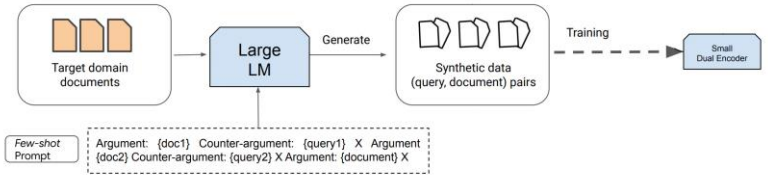
https://blogs.nvidia.com/blog/what-is-federated-learning/

Role of Genetaive AI in Data Science

Enhance data science workflow, automates data cleaning and preprocessing tasks, and generate synthetic data







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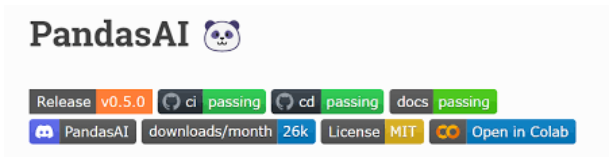
Assistance in Coding

Code generation: automatically generates code snippets based on user input.

Debugging and optimization: suggests fixes and improvements for existing code.

Learning and documentation: helps users understand programming concepts and code documentation.



Thank you!

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