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of Economics  
& Management  
Universidade de Lisboa



LISBOA

UNIVERSIDADE  
DE LISBOA

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# ARTIFICIAL INTELLIGENCE





# WHAT IS A.I.?

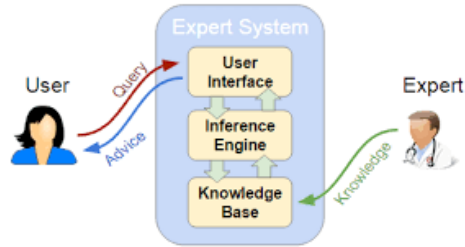


# WHAT IS A.I.?

Artificial  
Intelligence(AI)

- Artificial intelligence refers to the development of computer-based solutions that are able to perform tasks which mimic human intelligence.

Popularity



Explosive Growth

New Hopes

Inflated Hype

AI winter II



Birth

AI winter I



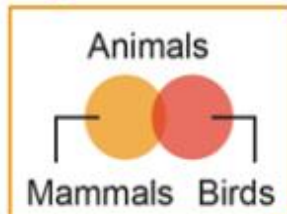
Lim, 2018

50 1956 1974 1980 1987 1993 Time





## Symbolists



Use symbols, rules, and logic to represent knowledge and draw logical inference

**Favored algorithm**

Rules and decision trees

## Bayesians

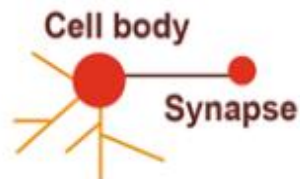


Assess the likelihood of occurrence for probabilistic inference

**Favored algorithm**

Naive Bayes or Markov

## Connectionists



Recognize and generalize patterns dynamically with matrices of probabilistic, weighted neurons

**Favored algorithm**

Neural networks

## Evolutionaries



Generate variations and then assess the fitness of each for a given purpose

**Favored algorithm**

Genetic programs

## Analogizers



Optimize a function in light of constraints ("going as high as you can while staying on the road")

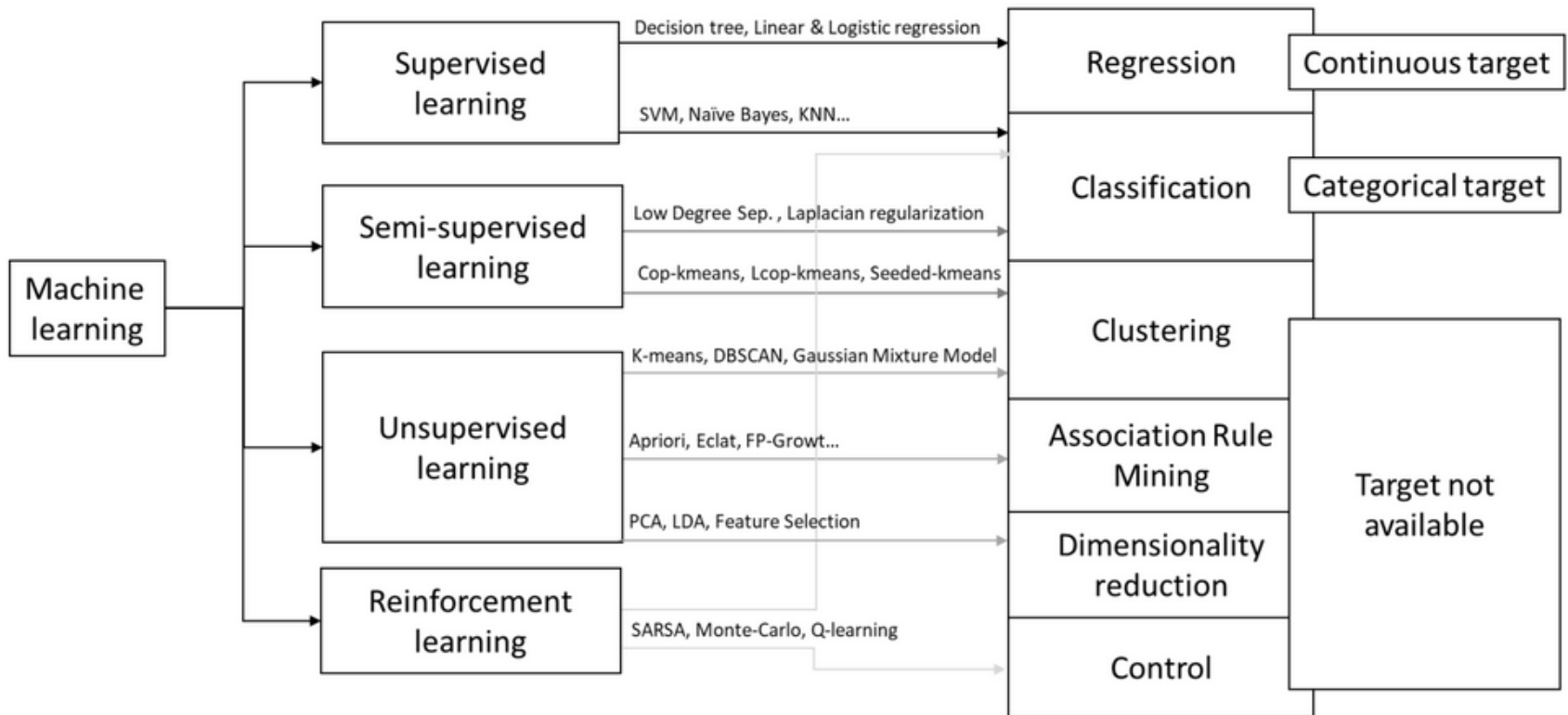
**Favored algorithm**

Support vectors

Source: Pedro Domingos, *The Master Algorithm*, 2015

# Machine Learning

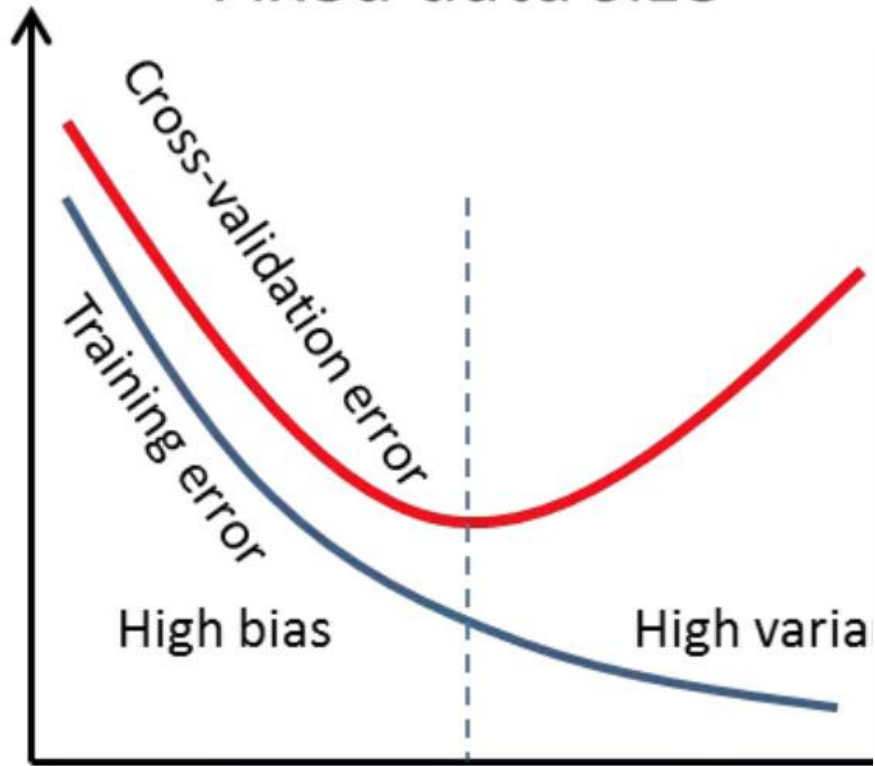
Tribe	Origins	Master Algorithm
Symbolists	Logic, philosophy	Inverse deduction
Connectionists	Neuroscience	Backpropagation
Evolutionaries	Evolutionary biology	Genetic programming
Bayesians	Statistics	Probabilistic inference
Analogizers	Psychology	Kernel machines





# Machine Learning

Fixed data size



Model Complexity

- **Train-Validate-Test**
- **Step 1: Making the model examine data.**
- **Step 2: Making the model learn from its mistakes.**
- **Step 3: Making a conclusion on how well the model performs**

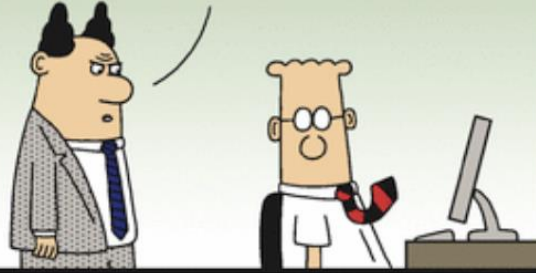
	<b>Prediction:</b> <i>Predicting Y from X</i>	<b>Inference:</b> <i>Understand relationship between X and Y</i>
<b>Goal</b>	Develop a "best" model (considering all predictors) to predict Y with high accuracy, low error.	Estimate an association between an outcome variable and a predictor variable (while adjusting for confounders).
<b>Answers the question</b>	How can I accurately predict new data points?	What do the relationships between the variables mean?
<b>Example</b>	What mortality levels does the model predict given a certain income and education level?	Which has the biggest impact on mortality: income or education?

SOMEONE SENT ME ANOTHER ANONYMOUS EMAIL WITH A LINK TO AN ARTICLE ABOUT THE WORLD'S WORST BOSSES.



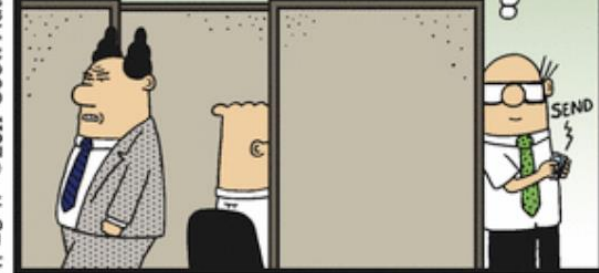
Dilbert.com DilbertCartoonist@gmail.com

I GET ONE OF THOSE EMAILS EVERY TIME I LEAVE YOUR CUBICLE. DID YOU THINK I WOULDN'T NOTICE THE CORRELATION?



© 2011 Scott Adams, Inc./Dist. by Universal Uclick

CORRELATION DOES NOT IMPLY CAUSATION.



# Inference

- Given a dataset, the purpose is to infer how the output is generated as a function of the data.
- Use the model to learn about the data generation process.
- Understand the way the independent variables  $X$  affect the target variable  $Y$ .
- Ex: find out what the effect of passenger gender, class and age, has on surviving the Titanic Disaster
- Model interpretability is a necessity for inference



# Prediction

- Use the model to predict the outcomes for new data points.
- When performing predictions over data, the purpose is estimating  $f$  in  $y=f(x)$
- The purpose is not understanding the exact form of the estimated function, as far as it can perform predictions quite accurately.
- To be able to predict what the responses are going to be to future input variables.
- Ex: predict prices of oil

# Machine Learning

- **Supervised Learning:**
  - Classification
  - Regression
- **Unsupervised Learning**
  - Clustering
  - Dimensional Reduction



UDERA

Caffe



PYT

otData

H<sub>2</sub>O.ai



OMINO

Tamr



remio

mlflow

Spark



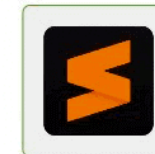
PyCharm



Visual Studio Code



Sublime Text



Vim



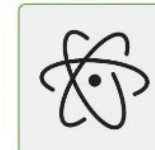
GNU



Spyder



Atom



Jupyter



Eclipse

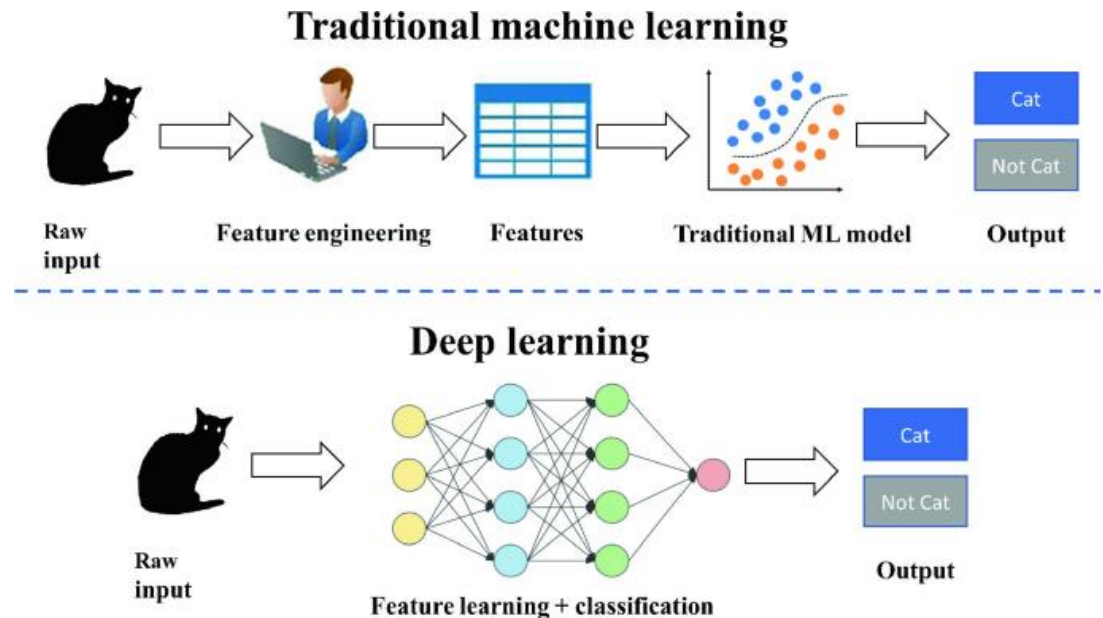


IntelliJ IDEA



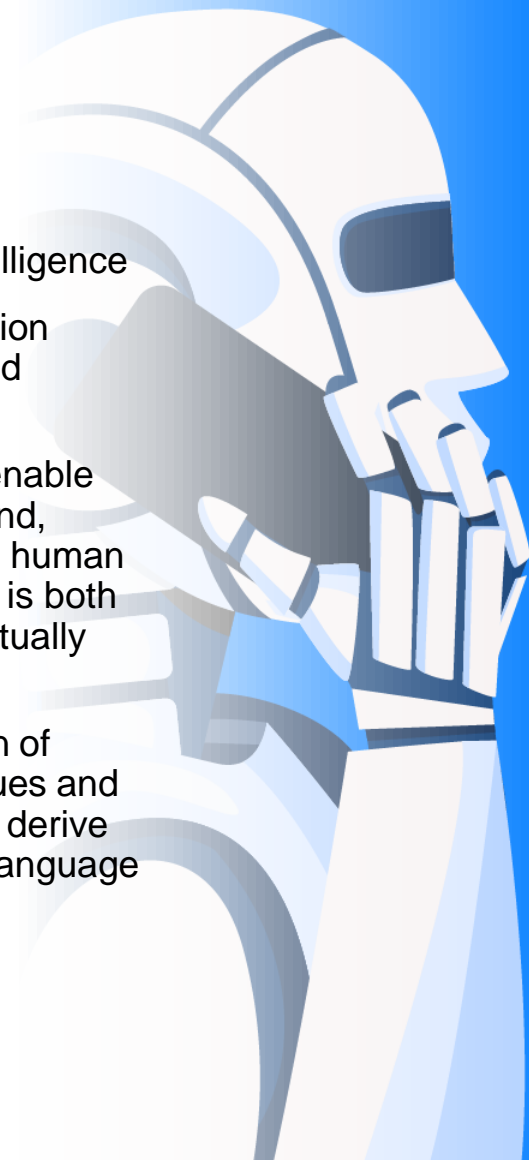
# Deep learning

- is a subfield of machine learning
- focuses on the development and application of artificial neural networks, particularly deep neural networks.
  - composed of layers of interconnected nodes (artificial neurons) that can learn and make decisions.
- The term "deep" refers to the use of multiple layers in the neural network.



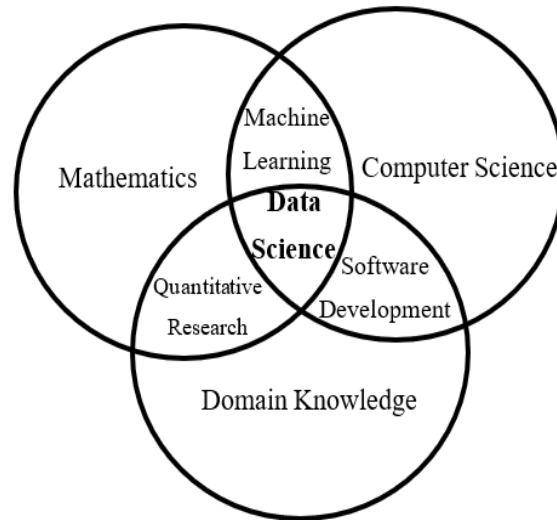
# Natural Language Processing (NLP)

- subfield of artificial intelligence
- focuses on the interaction between computers and human language.
- The goal of NLP is to enable computers to understand, interpret, and generate human language in a way that is both meaningful and contextually relevant.
- involves the application of computational techniques and models to analyze and derive meaning from natural language data.



# Data Science

- includes techniques developed in some traditional fields like artificial intelligence, statistics or machine learning.



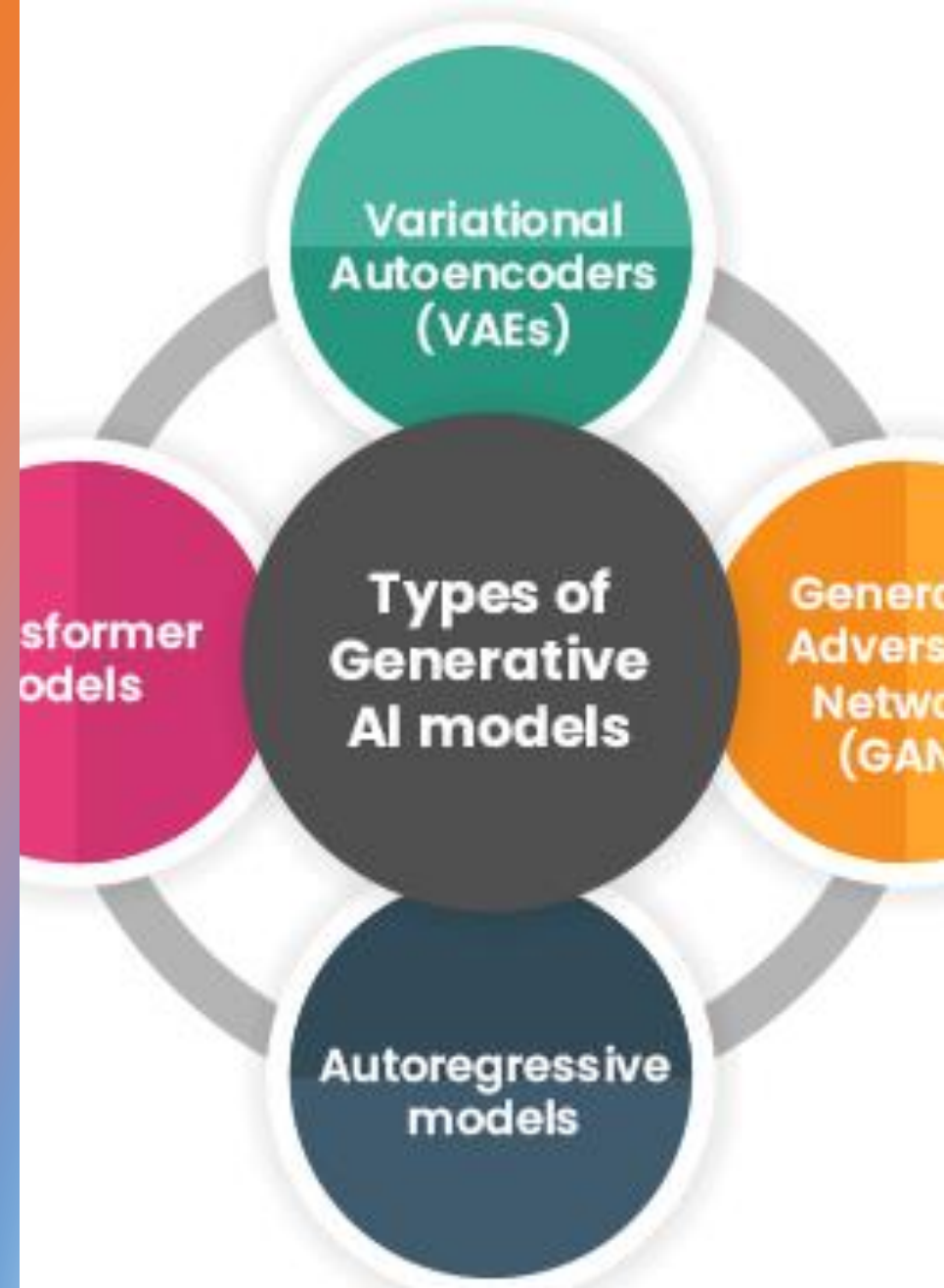
Aparicio et al. (2019).





# Generative AI

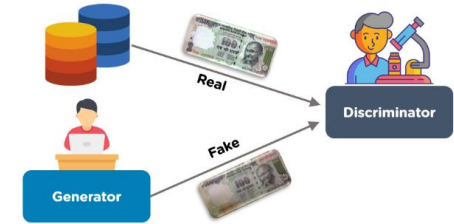
- class of AI algorithms and models that are designed to generate new, original content.
- Gen AI learn the underlying patterns and structures in the data and can generate novel outputs.
- *Instead of being trained on specific examples and then making predictions or classifications*
- These models are particularly good at creating content that resembles or is similar to the data they were trained on.



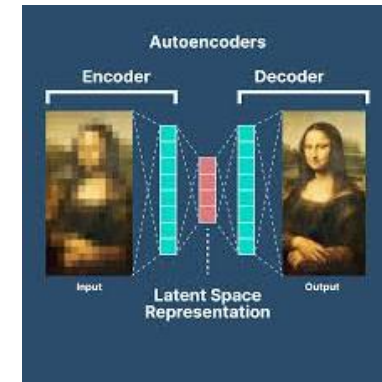
## Types of generative AI models

- Generative Adversarial Networks (GANs)
- Variational Autoencoders (VAEs)
- Autoregressive Models
- Recurrent Neural Networks (RNNs)
- Transformer-based Models
- Reinforcement Learning for Generative Tasks
- Generative AI for Data Privacy, Security and Governance.

# Types of generative AI models



- Generative Adversarial Networks (GANs):
  - a generator and a discriminator are trained simultaneously through adversarial training.
- Variational Autoencoders (VAEs):
  - learn a probabilistic mapping from the observed data to a latent space.
  - Good to generate new samples from the learned latent space.
- Autoregressive Models:
  - the probability distribution of the next value in a sequence depends on the previous values.

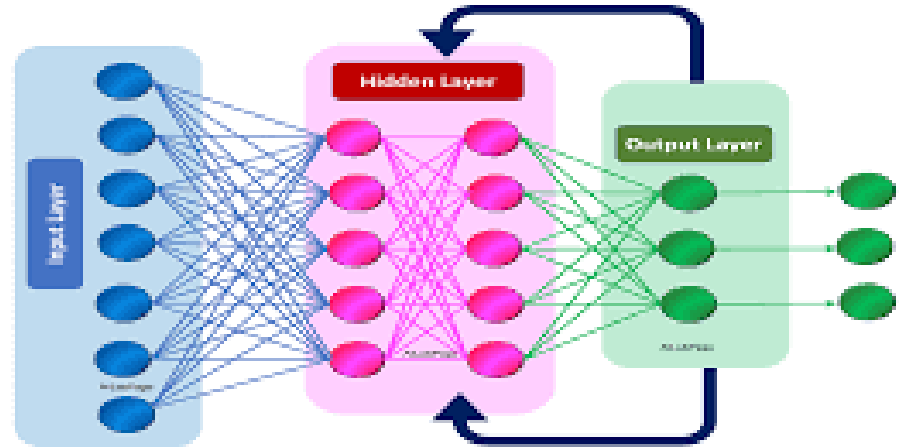


$$y_t = c + \sum_{i=1}^p a_{t-i} y_{t-i} + e_t$$

# Recurrent Neural Networks

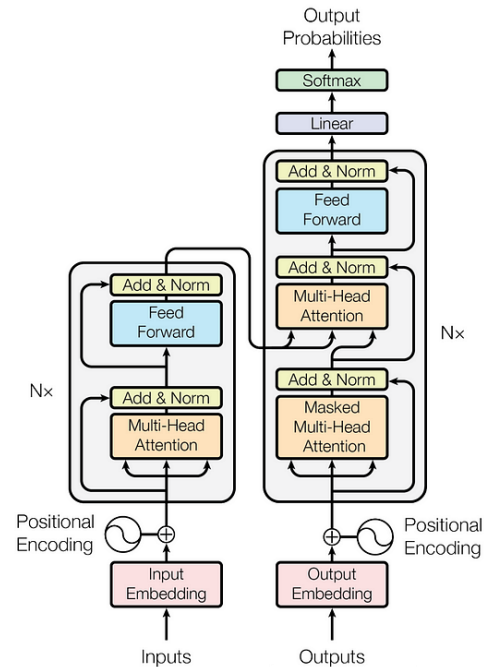
## Types of generative AI models

- Recurrent Neural Networks (RNNs):
  - RNNs are commonly used for sequence tasks, including some generative tasks, they are not exclusively generative models.
  - Variants like LSTM and GRU are popular choices.
- Transformer-based Models:
  - Transformers, especially large language models.
- Reinforcement Learning for Generative Tasks:
  - can be used in conjunction with generative models, and this combination is powerful in scenarios where the generative model needs to produce sequences or structures guided by a reward signal.



**BERT**

Encoder



**GPT**

Decoder

# GPT

- Generative Pre-trained Transformer
- Is a type of autoregressive language model that utilizes a transformer architecture.
- Is pre-trained on a large corpus of text data and can then be fine-tuned for specific tasks.



**ChatGPT**

# Google Bard

Bard is a conversational AI chatbot powered by a combination of generative AI techniques, including:

- **Transformer-based models:**
  - Google's Pathways Language Model (PaLM) is used to generate text that is fluent, coherent, and grammatically correct.
- **Autoregressive models**
  - to predict the next word in a sequence, which helps to ensure that its responses are natural and engaging.
- **Reinforcement learning:**
  - it is rewarded for generating responses that are informative, comprehensive, and relevant to the user's query.

Bard

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