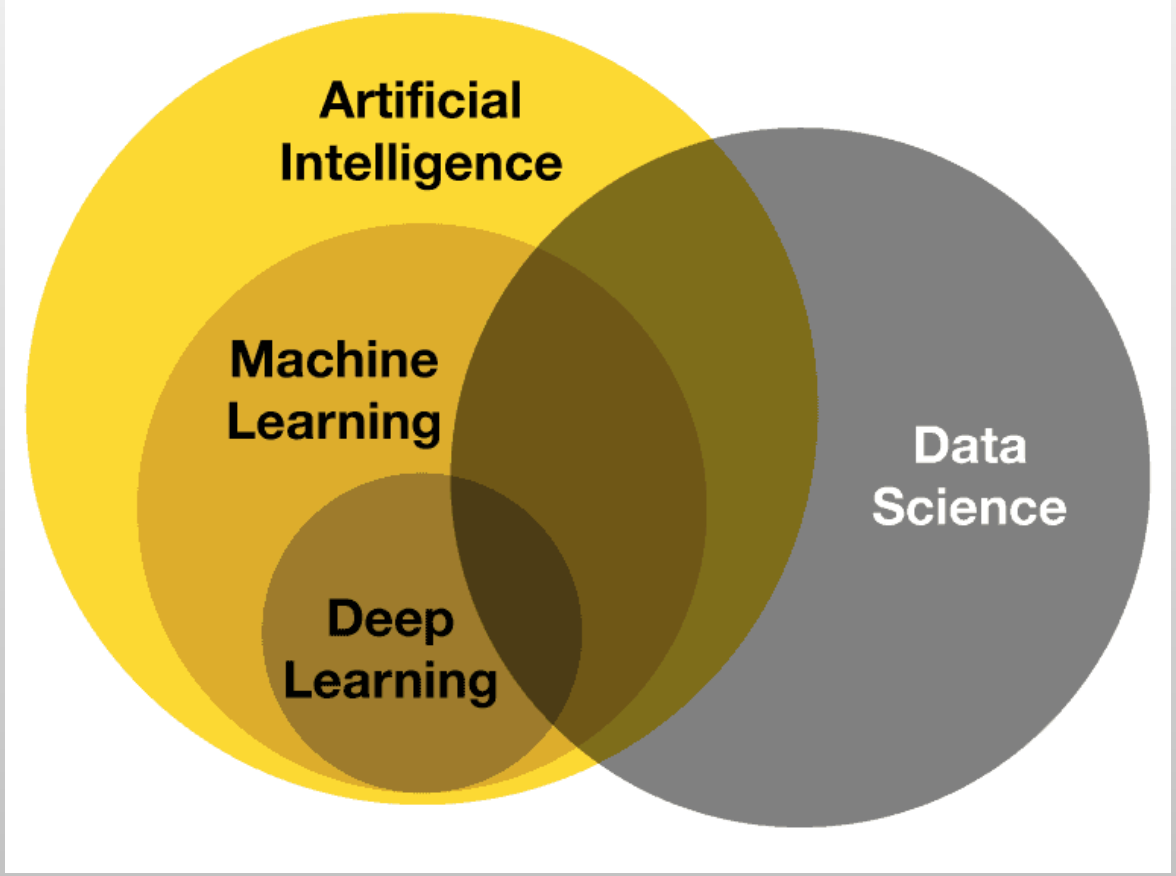
MPSSDEGB
कौशल से रोजगार, समृद्धि अपार

FOUNDATION FOR INNOVATION AND TECHNOLOGY TRANSFER
FITT
भारतीय प्रौद्योगिकी संस्थान दिल्ली
Indian Institute of Technology Delhi

Computer Vision

The content is added from different sources

Overview



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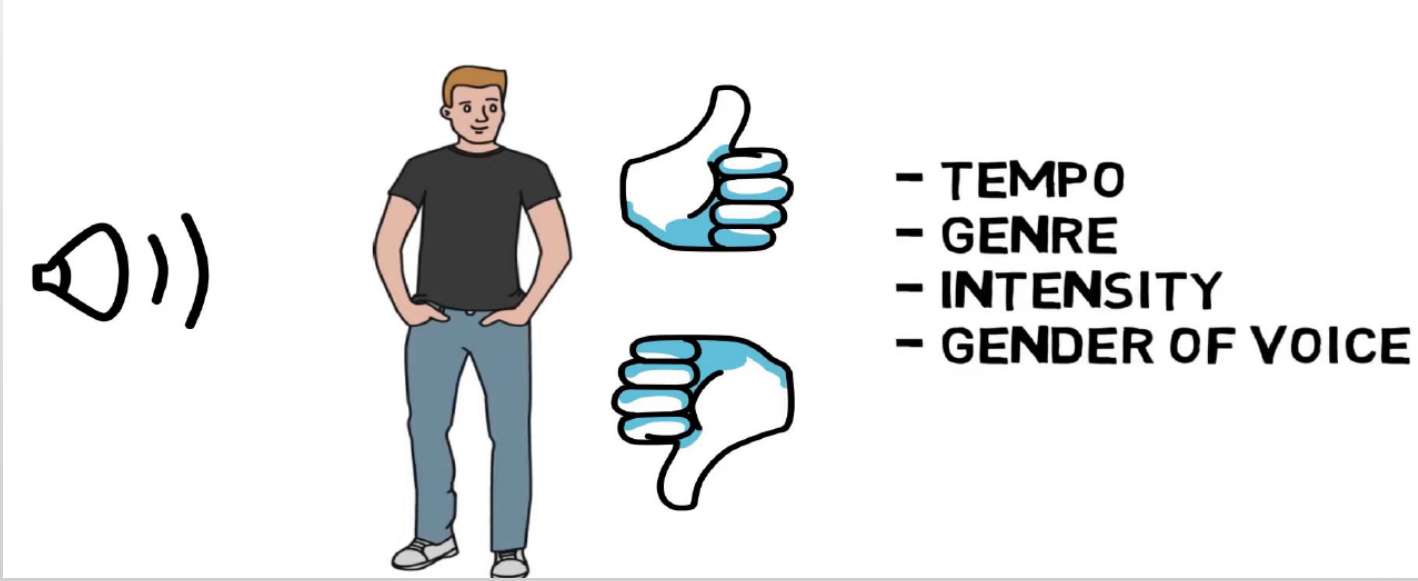
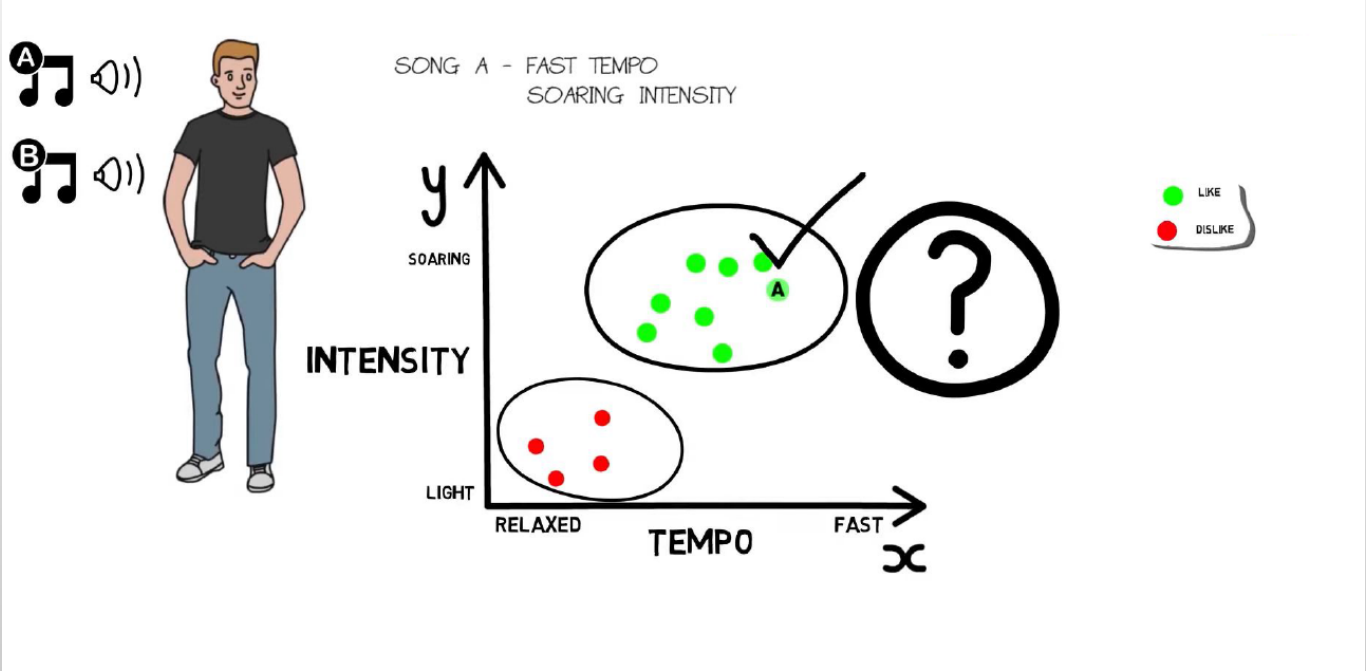
Acknowledging Machine Learning

- Google Search
- Voice and Facial Recognition
- Virtual Reality in the World of Gaming
- Online Shopping
- Commuting (Uber)


- TEMPO
- GENRE
- INTENSITY
- GENDER OF VOICE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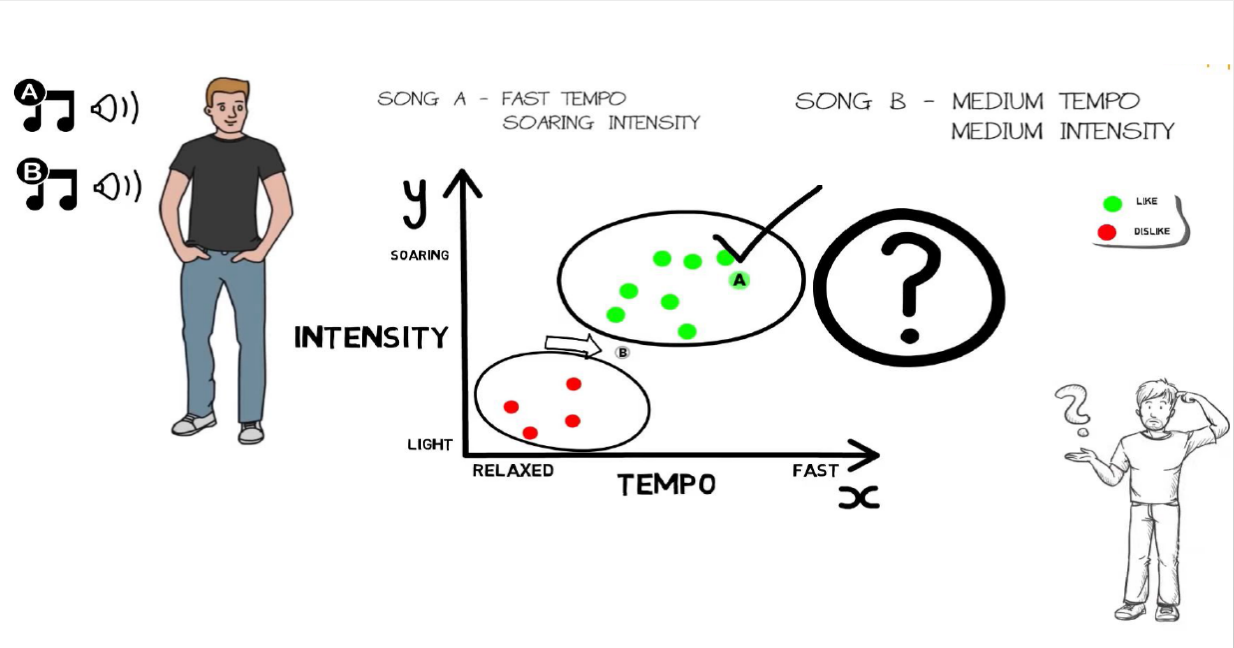
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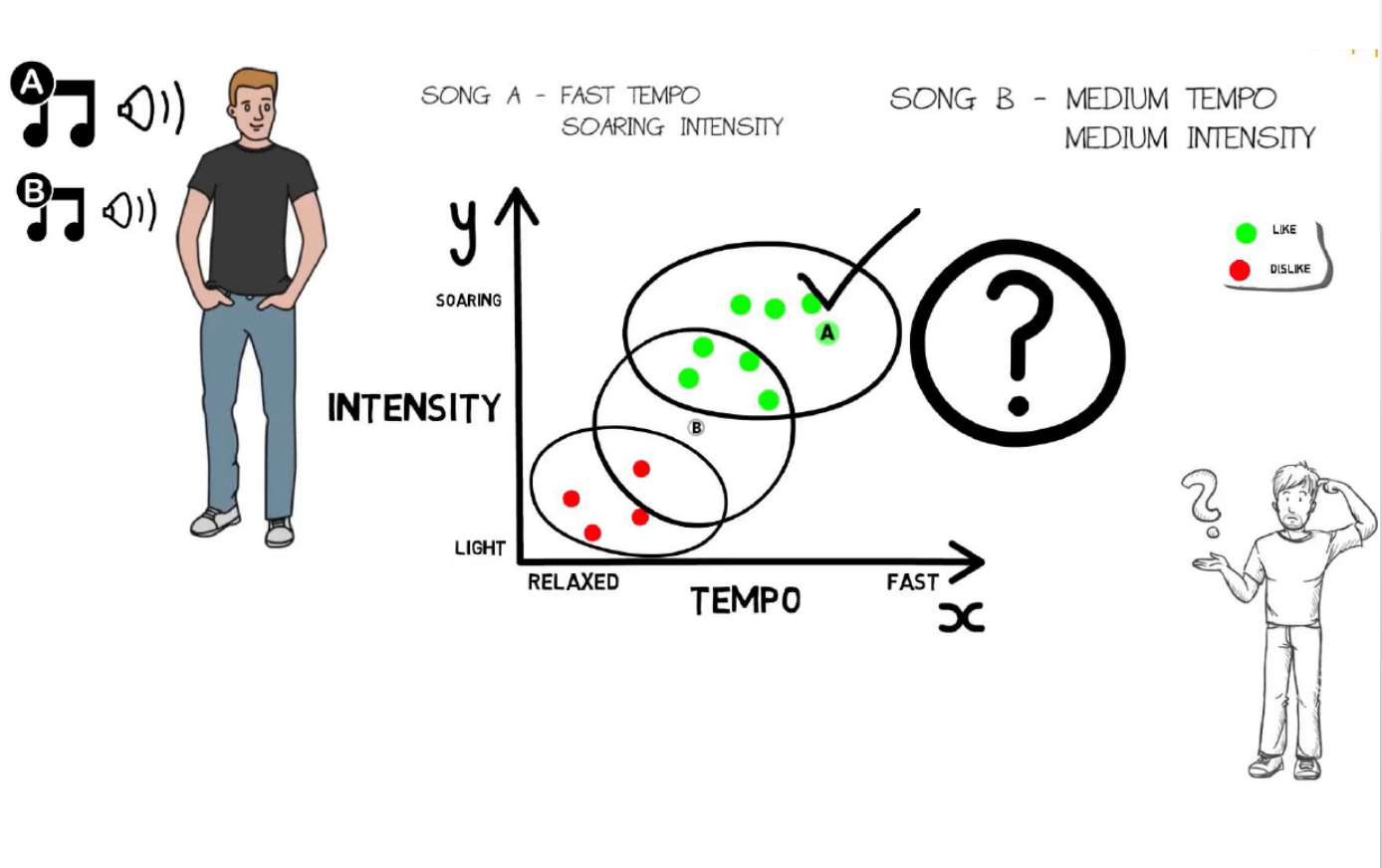
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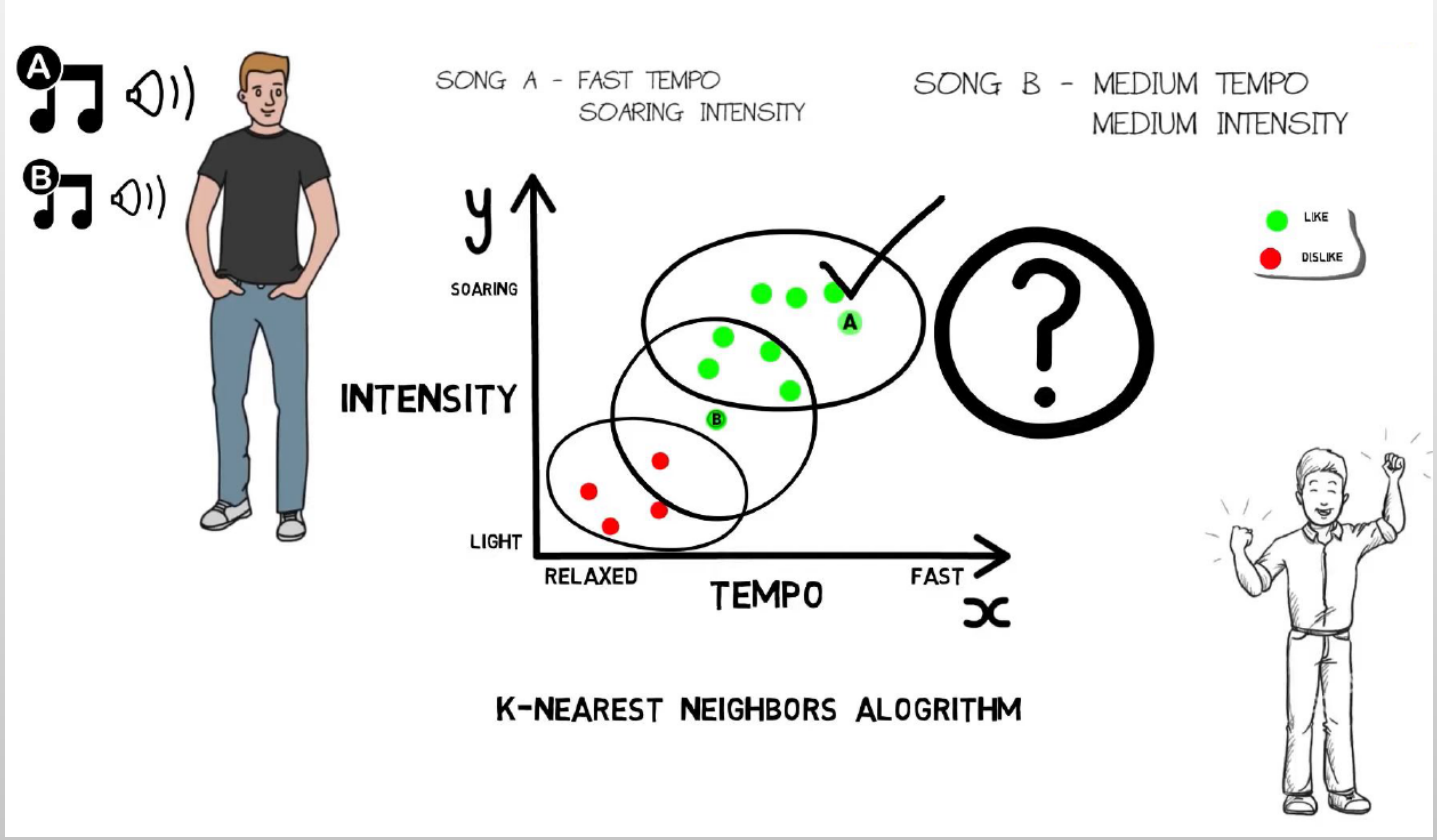
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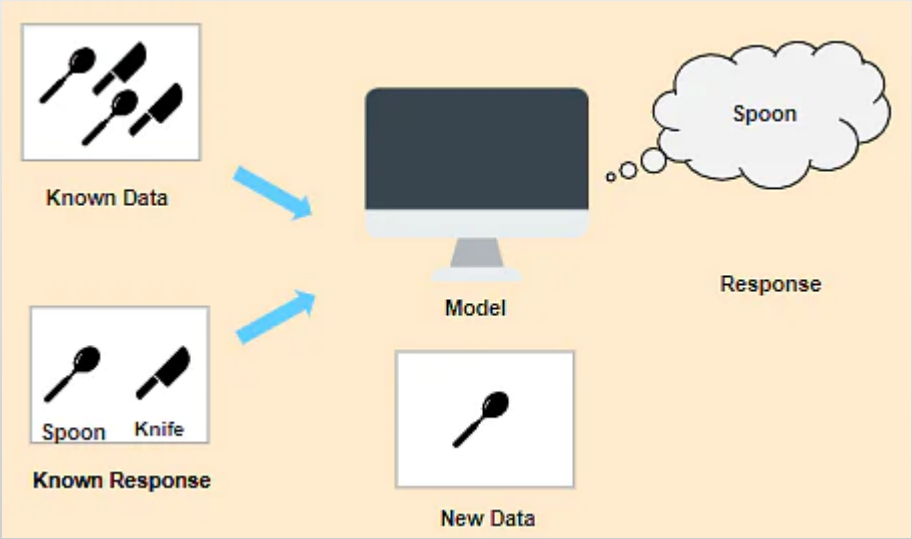
K-NEAREST NEIGHBORS ALOGRITHM

Types of Machine Learning

- Supervised machine learning: You supervise the machine while training it to work on its own. This requires labeled training data
- Unsupervised learning: There is training data, but it won't be labeled
- Reinforcement learning: The system learns on its own

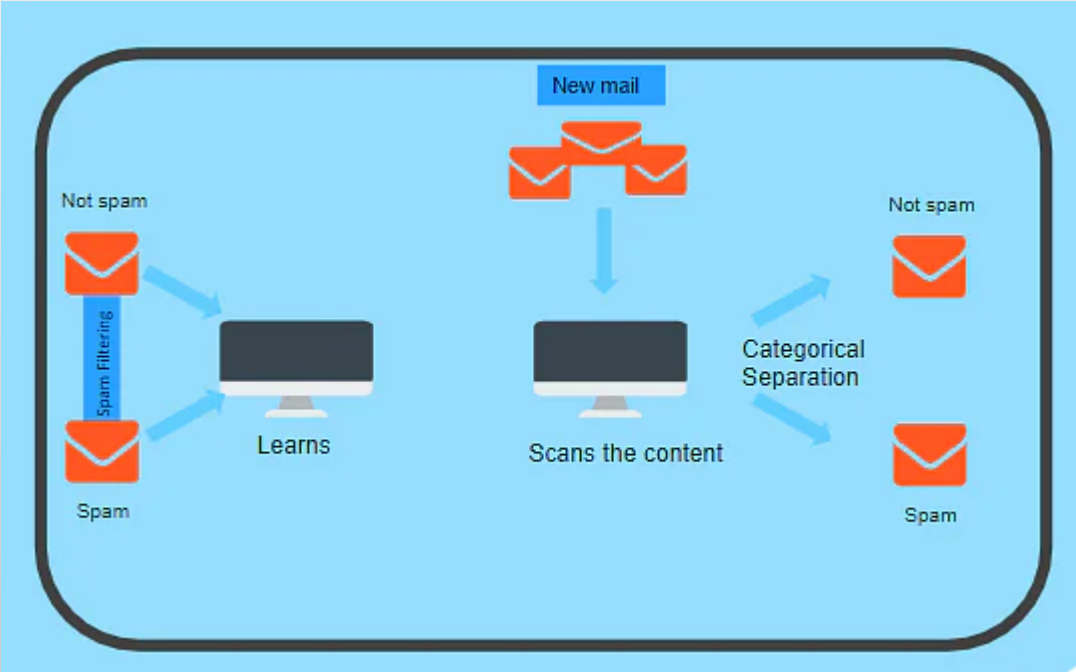
Supervised Learning?



Supervised learning can be further divided into two types:

1. Classification
2. Regression

Supervised Learning (Classification)?



Logistic Regression

Logistic regression is a supervised machine learning algorithm mainly used for binary classification where we use a logistic function, also known as a sigmoid function that takes input as independent variables and produces a probability value between 0 and 1. For example, we have two classes Class 0 and Class 1 if the value of the logistic function for an input is greater than 0.5 (threshold value) then it belongs to Class 1 it belongs to Class 0. It's referred to as regression because it is the extension of linear regression but is mainly used for classification problems. The difference between linear regression and logistic regression is that linear regression output is the continuous value that can be anything while logistic regression predicts the probability that an instance belongs to a given class or not.

In Logistic regression, instead of fitting a regression line, we fit an "S" shaped logistic function, which predicts two maximum values (0 or 1).

The curve from the logistic function indicates the likelihood of something such as whether the cells are cancerous or not, a mouse is obese or not based on its weight, etc.

https://www.geeksforgeeks.org/understanding-logistic-regression/

- Logistic Regression is a significant machine learning algorithm because it has the ability to provide probabilities and classify new data using continuous and discrete datasets.

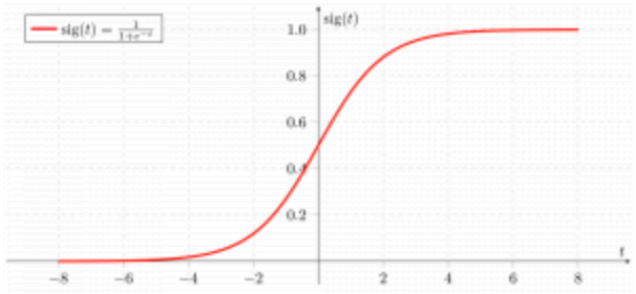
- In logistic regression, we use the concept of the threshold value, which defines the probability of either 0 or 1. Such as values above the threshold value tends to 1, and a value below the threshold values tends to 0.

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1m} \\ x_{21} & \cdots & x_{2m} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{nm} \end{bmatrix}$$

$$z = (\sum_{i=1}^{n} w_i x_i) + b$$

$$z = w \cdot X + b$$

$$\sigma(z) = \frac{1}{1-e^{-z}}$$



Sigmoid function

https://www.geeksforgeeks.org/understanding-logistic-regression/

Likelihood function for Logistic Regression

The predicted probabilities will p(X;b,w) = p(x) for y=1 and for y = 0 predicted probabilities will 1-p(X;b,w) = 1-p(x)

$$L(b, w) = \prod_{i=1} np(x_i)^{y_i}(1 - p(x_i))^{1-y_i}$$

Taking natural logs on both sides

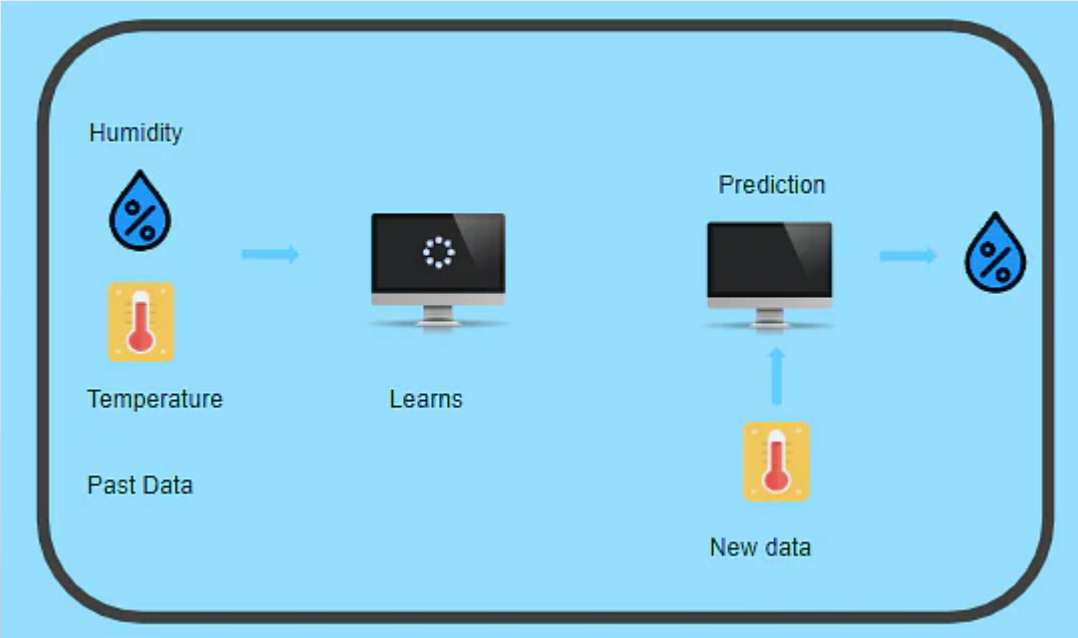
$$\begin{aligned} l(b, w) = \log(L(b, w)) &= \sum_{i=1}^{n} y_i \log p(x_i) \ + \ (1 - y_i) \log(1 - p(x_i)) \\ &= \sum_{i=1}^{n} y_i \log p(x_i) + \log(1 - p(x_i)) - y_i \log(1 - p(x_i)) \\ &= \sum_{i=1}^{n} \log(1 - p(x_i)) + \sum_{i=1}^{n} y_i \log \frac{p(x_i)}{1 - p(x_i} \\ &= \sum_{i=1}^{n} - \log 1 - e^{-(w \cdot x_i + b)} + \sum_{i=1}^{n} y_i (w \cdot x_i + b) \\ &= \sum_{i=1}^{n} - \log 1 + e^{w \cdot x_i + b} + \sum_{i=1}^{n} y_i (w \cdot x_i + b) \end{aligned}$$

Gradient of the log-likelihood function

To find the maximum likelihood estimates, we differentiate w.r.t w,

$$\begin{aligned}\frac{\partial J(l(b,w)}{\partial w_j} &= -\sum_{i=n}^{n} \frac{1}{1+e^{w\cdot x_i+b}} e^{w\cdot x_i+b} x_{ij} + \sum_{i=1}^{n} y_i x_{ij} \\ &= -\sum_{i=n}^{n} p(x_i;b,w) x_{ij} + \sum_{i=1}^{n} y_i x_{ij} \\ &= \sum_{i=n}^{n} (y_i - p(x_i;b,w)) x_{ij}\end{aligned}$$

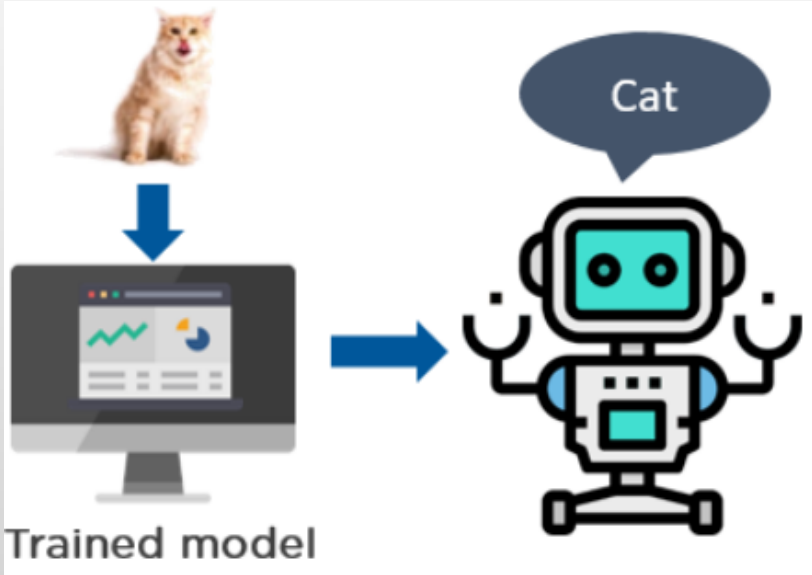
Supervised Learning (Regression)?



Supervised Learning (Regression)?

Algorithms

- Linear Regression
- Logistic Regression
- Support Vector Machine
- K Nearest Neighbor
- Decision Tree
- Random Forest
- Naive Bayes



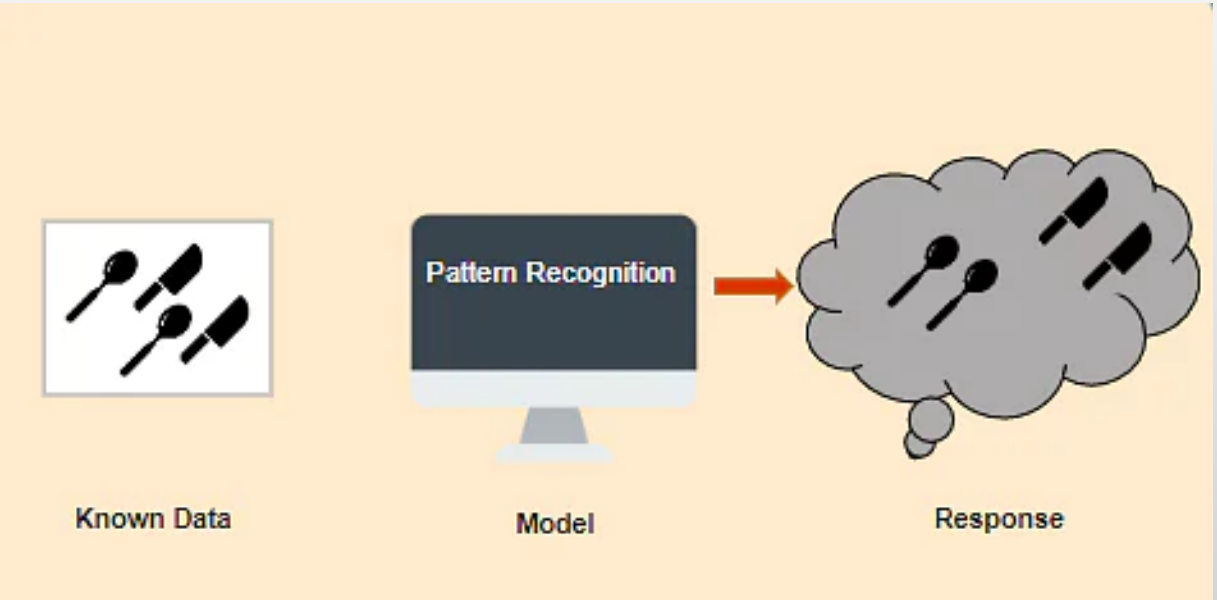
Applications of Supervised Learning

- **Risk Assessment**
  Supervised learning is used to assess the risk in financial services or insurance domains in order to minimize the risk portfolio of the companies.
- **Image Classification**
  Image classification is one of the key use cases of demonstrating supervised machine learning. For example, Facebook can recognize your friend in a picture from an album of tagged photos.
- **Fraud Detection**
  To identify whether the transactions made by the user are authentic or not.
- **Visual Recognition**
  The ability of a machine learning model to identify objects, places, people, actions, and images.

Unsupervised Learning?

Unsupervised learning can be further grouped into types:

1. Clustering
2. Association



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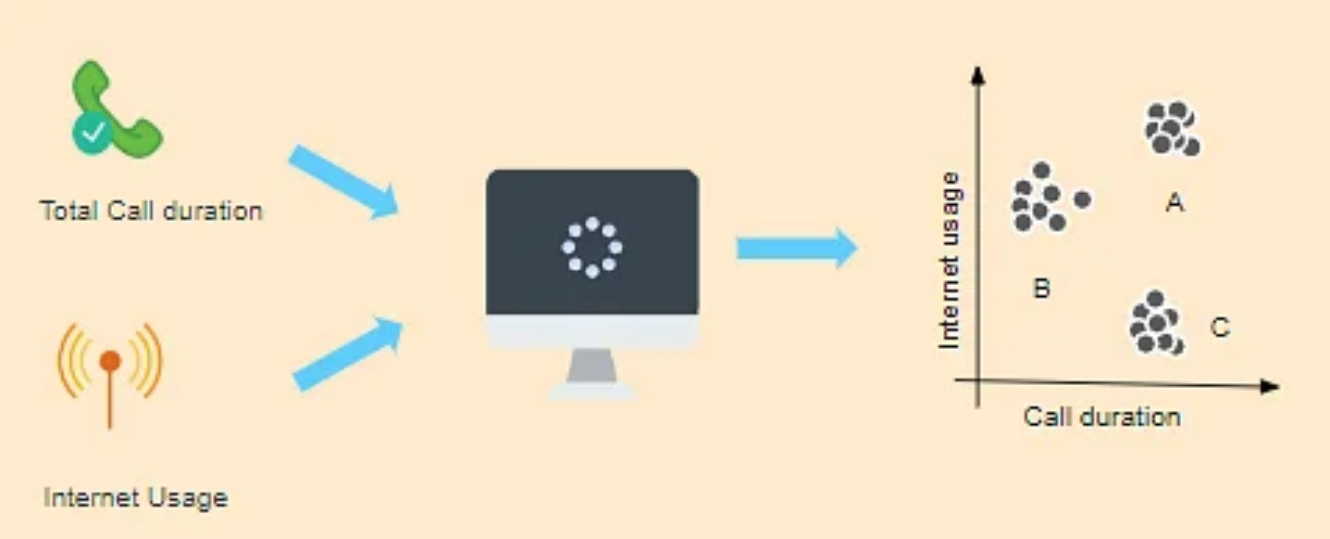
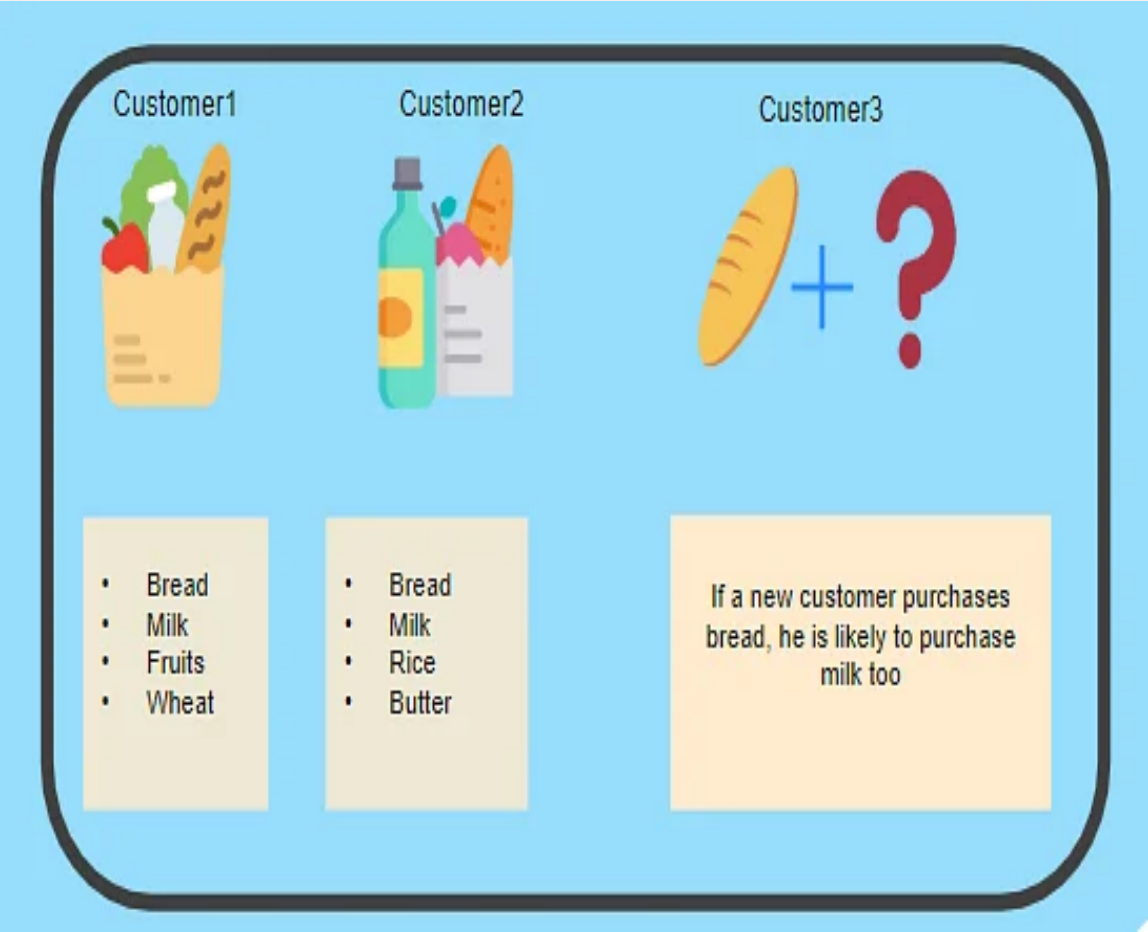
Unsupervised Learning (Clustering)?



Unsupervised Learning (Association)?



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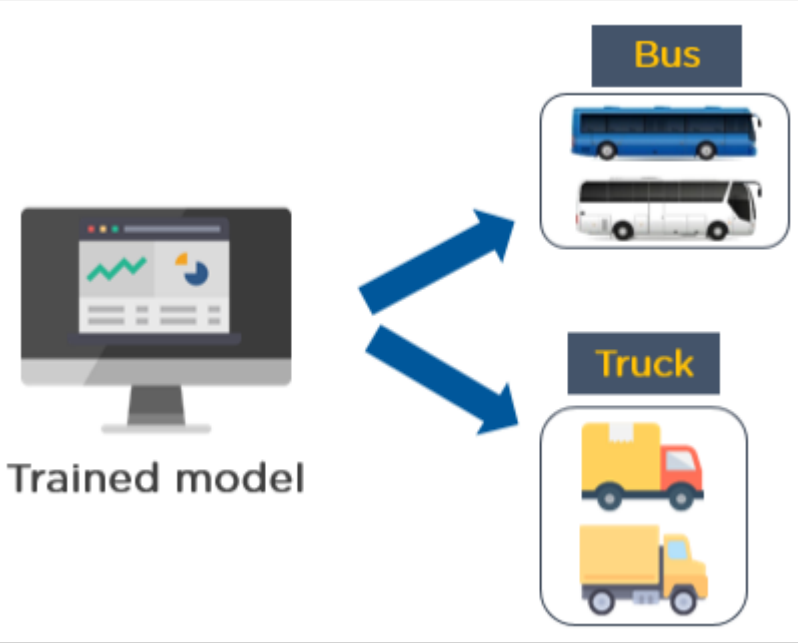
Unsupervised Learning?

Algorithms

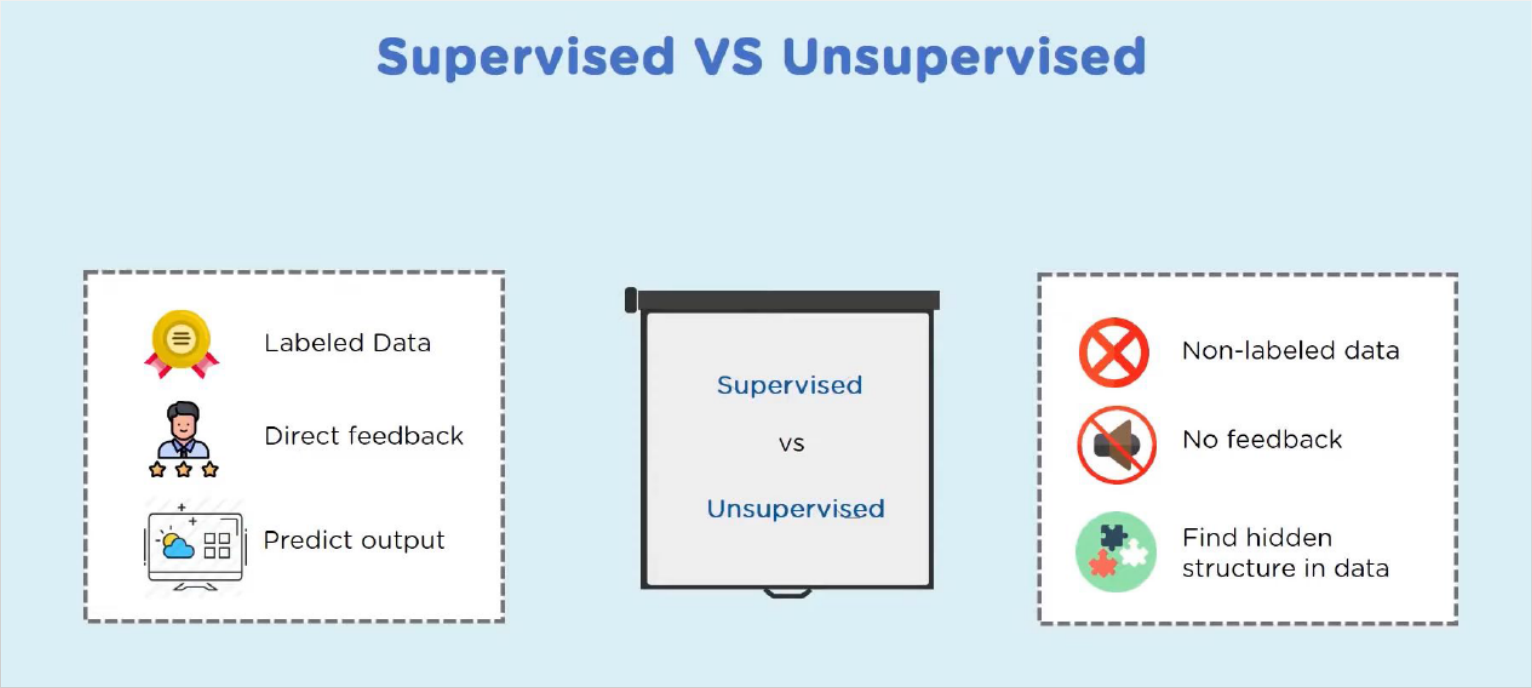
- K Means Clustering
- Hierarchical Clustering
- DBSCAN
- Principal Component Analysis



Applications of Unsupervised Learning?

- **Market Basket Analysis**
  It is a machine learning model based on the algorithm that if you buy a certain group of items, you are less or more likely to buy another group of items.
- **Semantic Clustering**
  Semantically similar words share a similar context. People post their queries on websites in their own ways. Semantic clustering groups all these responses with the same meaning in a cluster to ensure that the customer finds the information they want quickly and easily. It plays an important role in information retrieval, good browsing experience, and comprehension.
- **Delivery Store Optimization**
  Machine learning models are used to predict the demand and keep up with supply. They are also used to open stores where the demand is higher and optimizing roots for more efficient deliveries according to past data and behavior.
- **Identifying Accident Prone Areas**
  Unsupervised machine learning models can be used to identify accident-prone areas and introduce safety measures based on the intensity of those accidents.

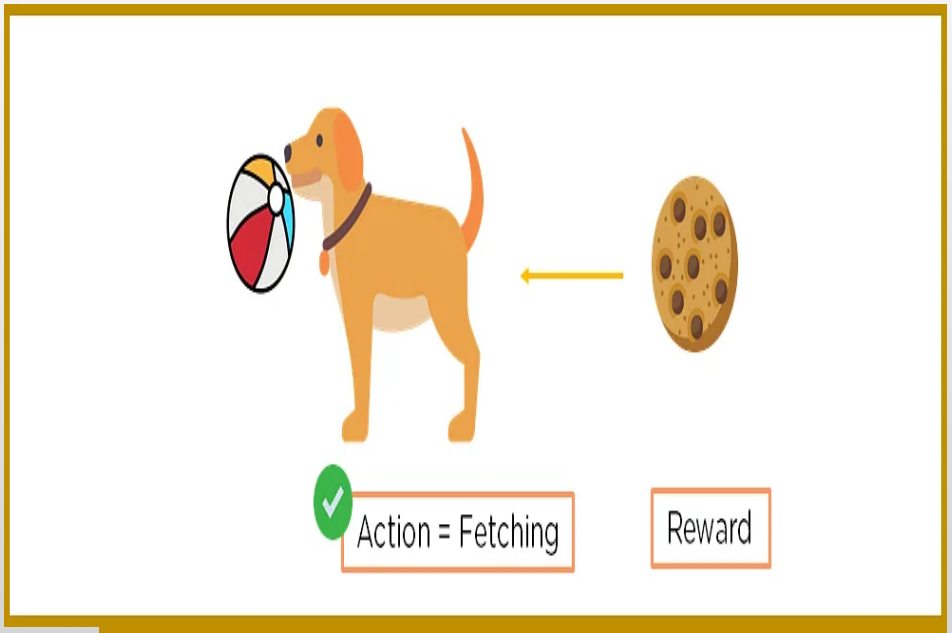
Supervised	Unsupervised
In supervised learning algorithms, the output for the given input is known.	In unsupervised learning algorithms, the output for the given input is unknown.
The algorithms learn from labeled set of data. This data helps in evaluating the accuracy on training data.	The algorithm is provided with unlabeled data where it tries to find patterns and associations in between the data items.
It is a Predictive Modeling technique which predicts the future outcomes accurately.	It is a Descriptive Modeling technique which explains the real relationship between the elements and history of the elements.
It includes classification and regression algorithms.	It includes clustering and association rules learning algorithms.
Some algorithms of supervised learning are Linear Regression, Naïve Bayes, and Neural Networks.	Some algorithms for unsupervised learning are k- means clustering, Apriori, etc.
This type of learning is relatively complex as it requires labelled data.	It is less complex as there is no need to understand and label data.
It is more accurate than unsupervised learning as input data and corresponding output is well known, and the machine only needs to give predictions.	It has less accuracy as the input data is unlabeled. Thus the machine has to first understand and label the data and then give predictions.
It is an online process of data analysis and does	This is a real time analysis of data.


Supervised VS Unsupervised
Labeled Data
Direct feedback
Predict output
Supervised
vs
Unsupervised
Non-labeled data
No feedback
Find hidden structure in data

Reinforcement Learning?

Reinforcement learning is a sub-branch of Machine Learning that trains a model to return an optimum solution for a problem by taking a sequence of decisions by itself.

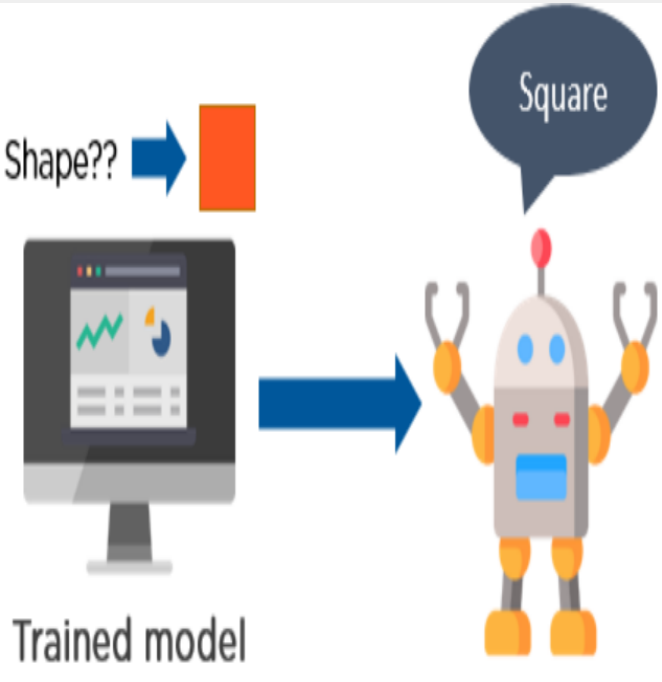
Reinforcement Learning?



Reinforcement Learning?

Algorithms

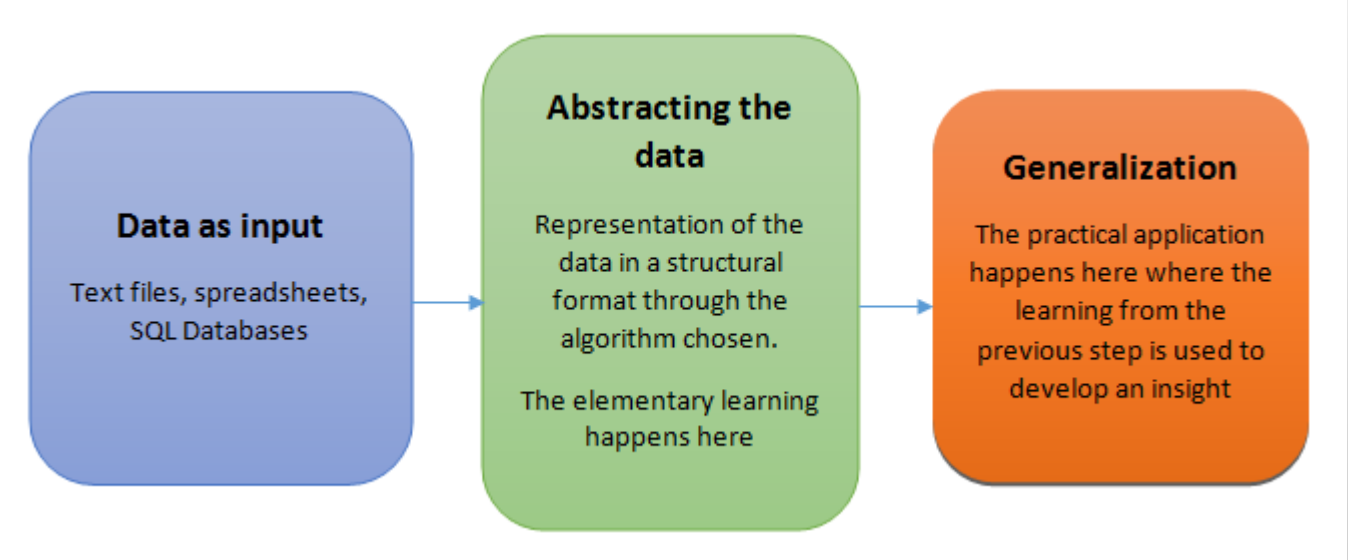
- Q-learning
- Sarsa
- Monte Carlo
- Deep Q network



List of machine learning algorithm

- Linear regression
- Logistic regression
- Decision tree
- SVM algorithm
- Naive Bayes algorithm
- KNN algorithm
- K-means
- Random forest algorithm
- Dimensionality reduction algorithms
- Gradient boosting algorithm and AdaBoosting algorithm

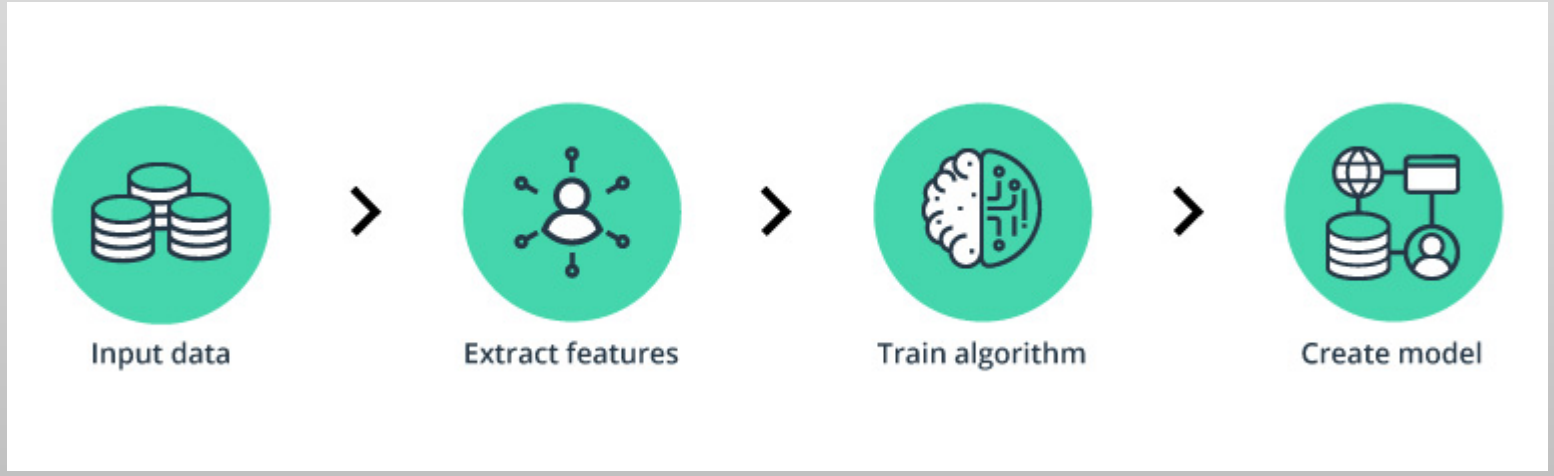
What we teach to machines?



Steps used in machine learning?

There are 5 basic steps used to perform a machine learning task:

1. Collecting data
2. Preparing the data
3. Training a model
4. Evaluating the model
5. Improving the performance



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Basic terminology in machine learning?

Concept	Definition	Example
Capacity	The ability of a model to capture complex patterns in data. Higher capacity models can learn intricate relationships but might be prone to overfitting.	A deep neural network with multiple layers has higher capacity than a linear regression model.
Overfitting	Occurs when a model learns the training data too well, capturing noise and not generalizing to new data.	A decision tree with too many branches may overfit the training data, performing poorly on unseen data.
Generalization	The model's ability to make accurate predictions on new, unseen data, reflecting its ability to apply learned patterns effectively.	A well-trained image classifier correctly identifies objects in new images it hasn't seen during training.

Basic terminology in machine learning?

Concept	Definition	Example
Confusion Matrix	A table summarizing the performance of a classification model, showing true positive, true negative, false positive, and false negative predictions.	In a binary classification problem, a confusion matrix shows the counts of correctly and incorrectly classified instances.
Precision	Measures the accuracy of positive predictions made by a model, emphasizing the correctness of positive predictions.	In a medical diagnosis, precision measures the ratio of correctly diagnosed positive cases to all positive cases.
Recall	Measures a model's ability to capture all relevant instances of a positive class, emphasizing the ratio of true positives to all actual positives.	In a search engine, recall measures the ratio of relevant search results retrieved to all relevant results.

Basic terminology in machine learning?

Concept	Definition	Example
ROC Curve	A graphical representation showing a classification model's performance across various thresholds by plotting true positive rate against false positive rate.	A medical test's ROC curve illustrates its ability to correctly identify true positive cases and avoid false positives.
Classification	A supervised learning task where the goal is to assign predefined labels or categories to input data.	Classifying emails as spam or not spam based on their content.
Regression	A supervised learning task where the goal is to predict continuous values instead of categories.	Predicting house prices based on features like area, location, and number of rooms.

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