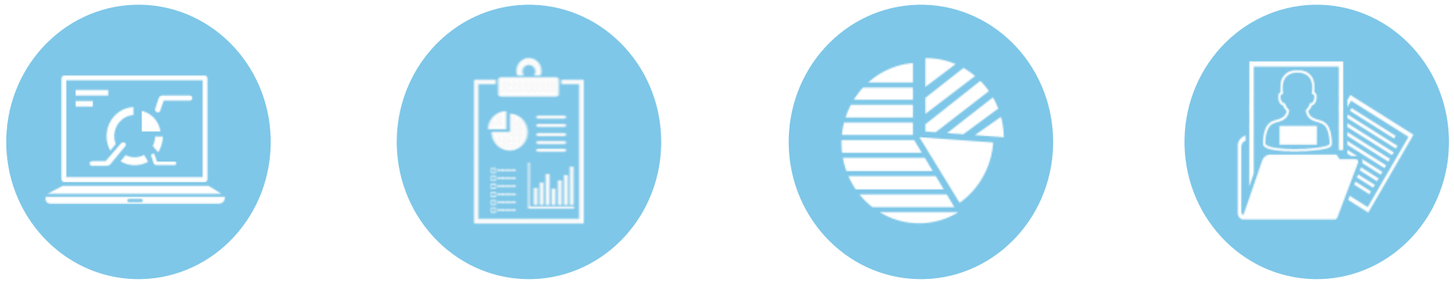
Machine Learning

Lesson 2—Techniques of Machine Learning



Learning Objectives

- Discuss supervised learning with examples
- Explain unsupervised learning with examples
- Describe semi-supervised learning and reinforcement learning
- Define some important models and techniques in Machine Learning

Techniques of Machine Learning

Topic 1—Supervised Learning

Supervised Learning: Case Study

Ever wondered how Amazon makes recommendations?

https://www.kdnuggets.com/2015/10/big-data-recommendation-systems-change-lives.html

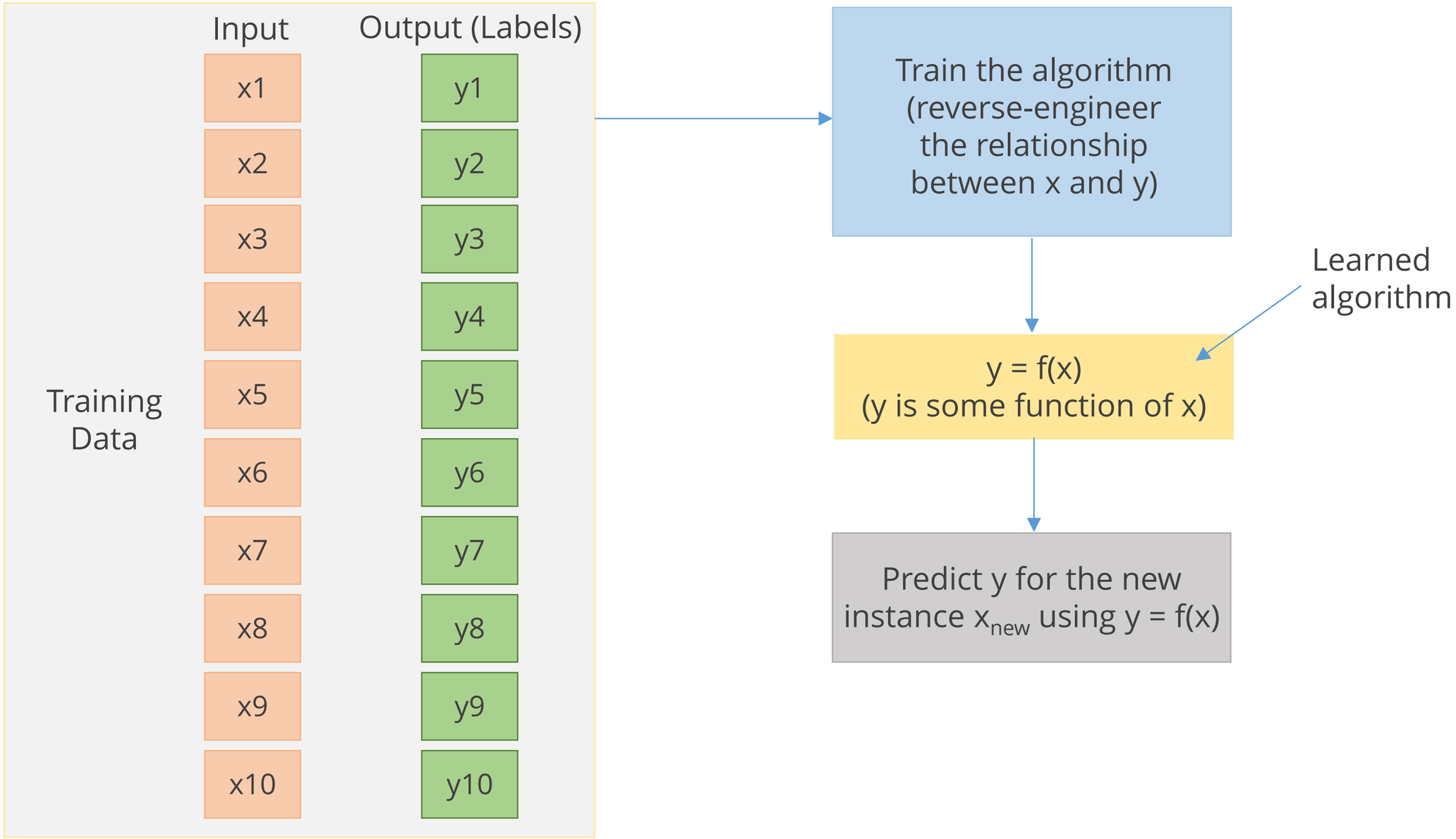
Supervised Learning: Case Study

Amazon uses **supervised learning** algorithms to predict what items the user may like based on the purchase history of similar classes of users.

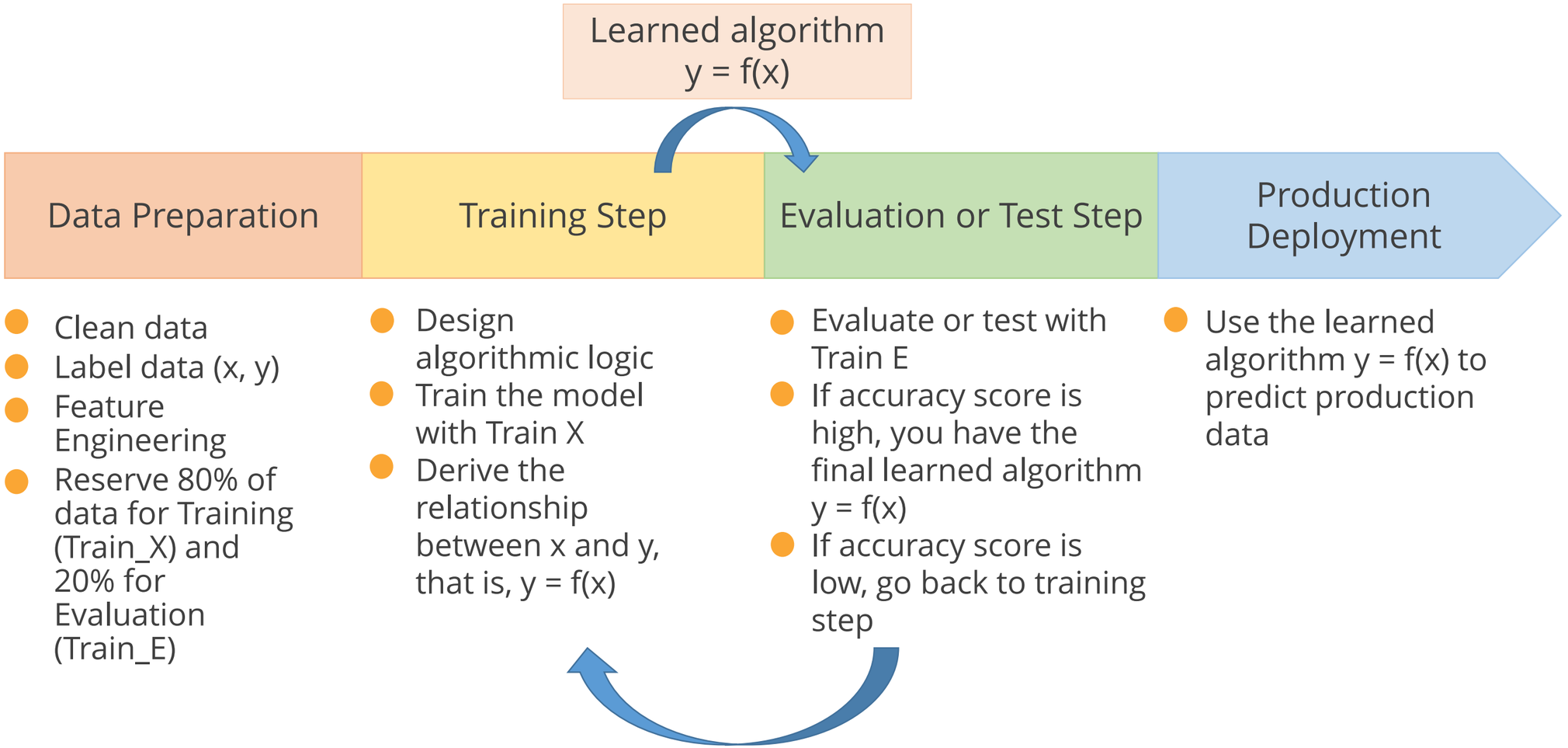
What Is Supervised Learning?

Supervised Learning is a type of Machine Learning used to learn models from labeled training data. It allows us to predict output for future or unseen data.

Understanding the Algorithm

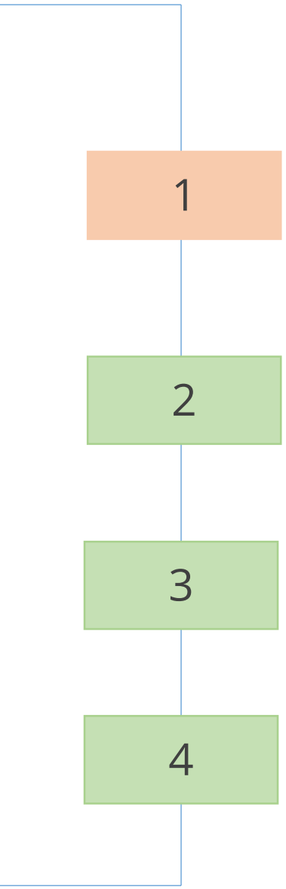


Supervised Learning Flow



The algorithm can be improved by more training data, capacity, or algo redesign.

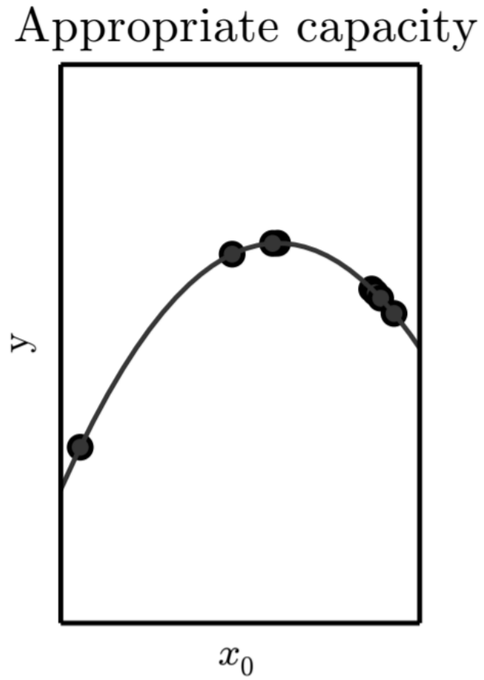
Testing the Algorithm



Once the algorithm is trained, test it with test data (a set of data instances that do not appear in the training set).

Testing the Algorithm

1. Once the algorithm is trained, test it with test data (a set of data instances that do not appear in the training set)
2. A well-trained algorithm can predict well for new test data.
3.
4.



Testing the Algorithm

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2. A well trained algorithm can predict well for new test data.
3. If the learning is poor, you have an **underfitted** situation. The algorithm will not work well on test data. Retraining may be needed to find a better fit.
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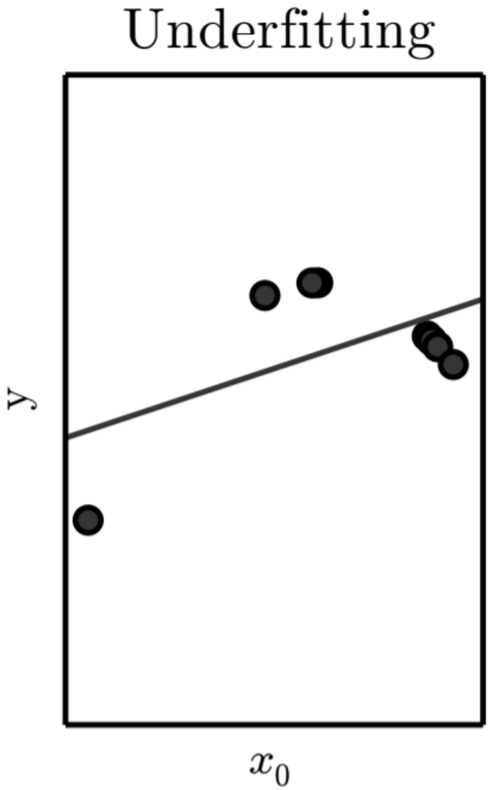

Testing the Algorithm

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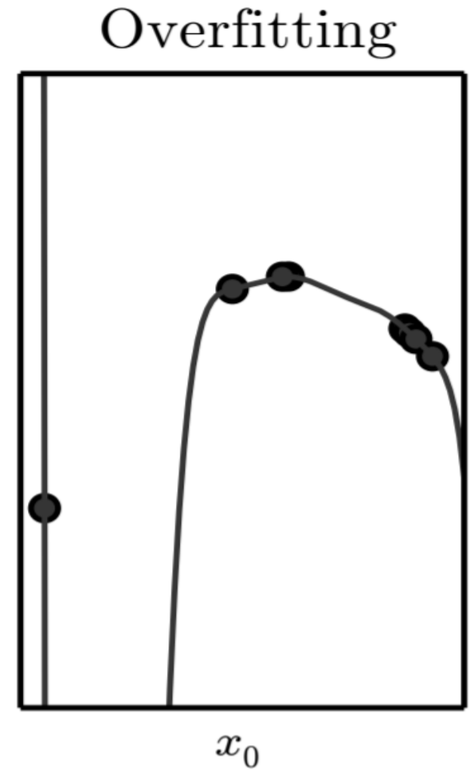
2. A well trained algorithm can predict well for new test data.

3. If the learning is poor, we have an **underfitted** situation. The algorithm will not work well on test data. Retraining may be needed to find a better fit.

4. If learning on training data is too intensive, it may lead to **overfitting** – a situation where the algorithm is not able to handle new testing data that it has not seen before. The technique to keep data generic is called regularization.

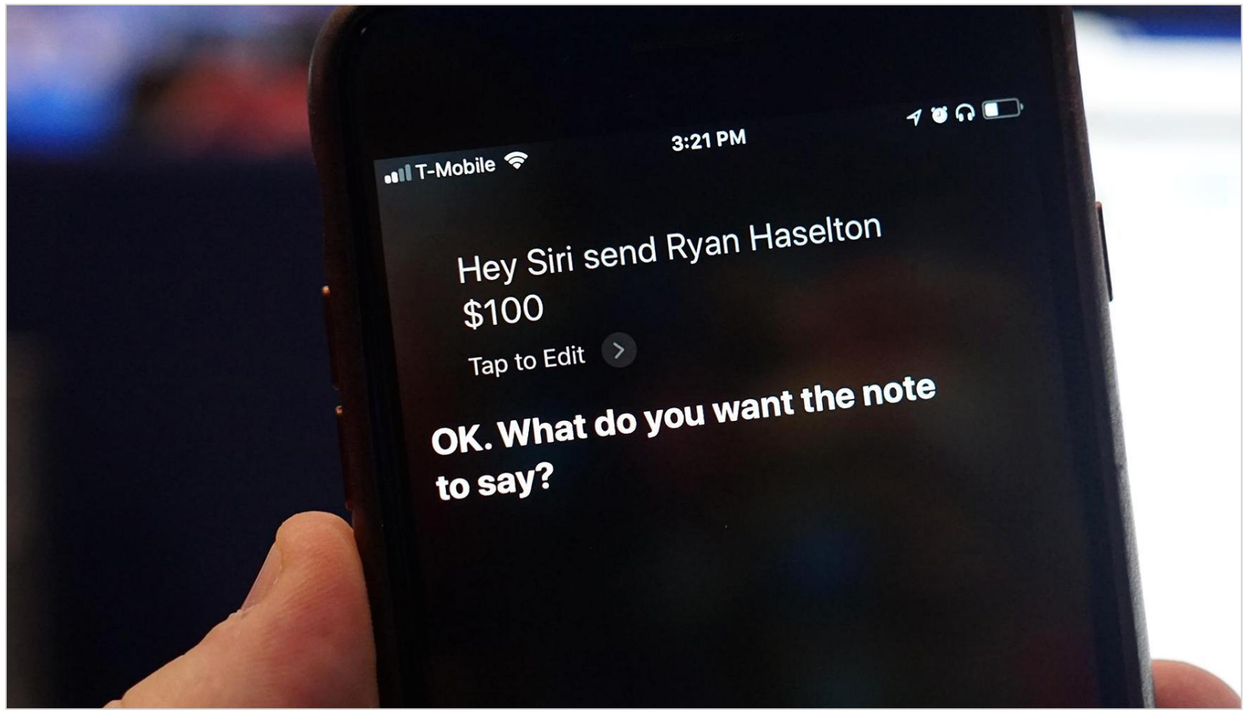


Examples of Supervised Learning

Example 1: Voice Assistants

Voice assistants like Apple Siri, Amazon Alexa, Microsoft Cortana, and Google Assistant are trained to understand human speech and intent.

Based on human interactions, these chatbots take appropriate action.

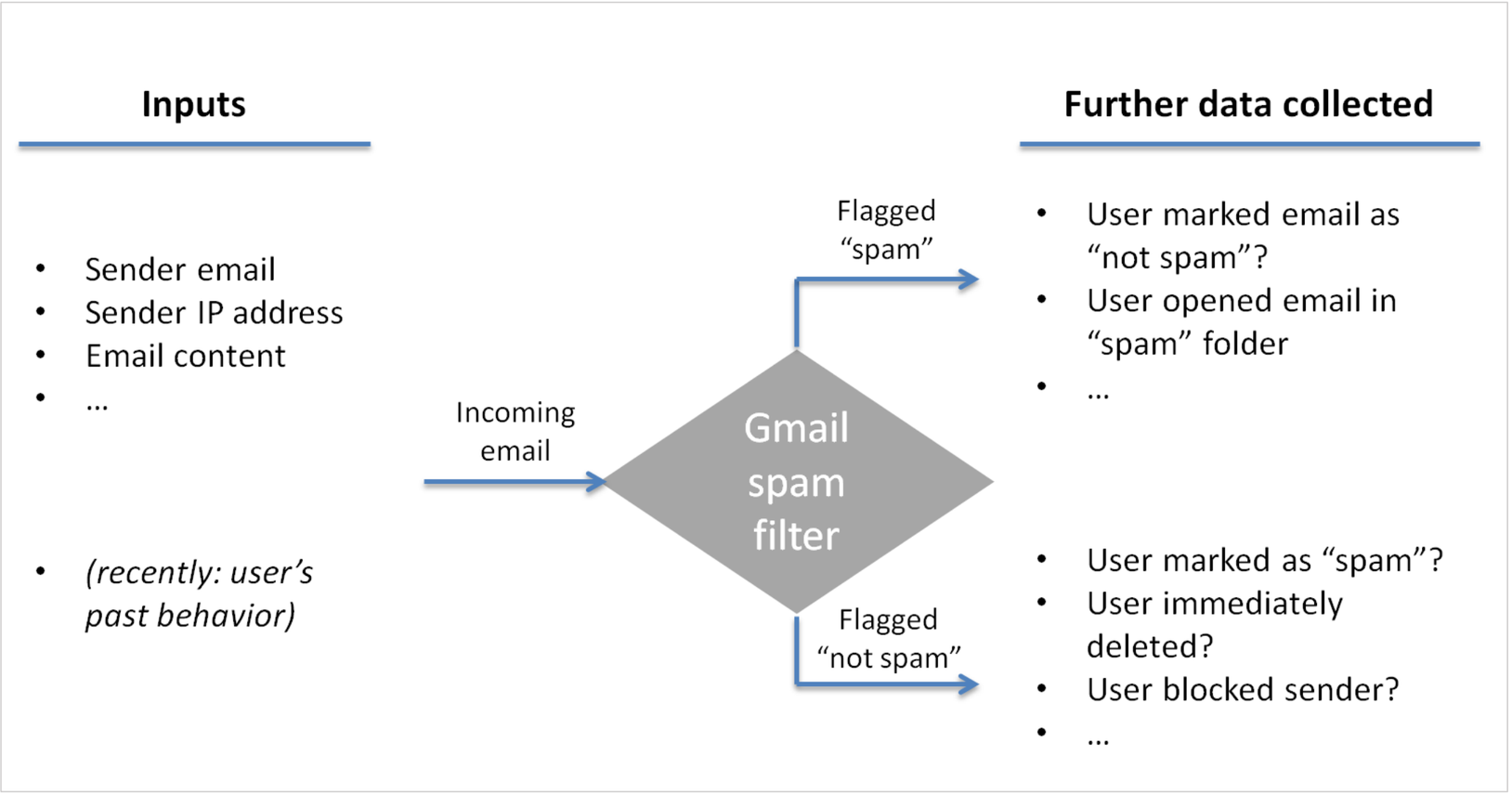


https://www.cnbc.com/2017/08/11/how-to-send-money-using-siri-on-an-iphone.html

Examples of Supervised Learning

Example 2: Gmail Filters

Gmail filters a new email into Inbox (normal) or Junk folder (Spam) based on past information about what you consider spam.



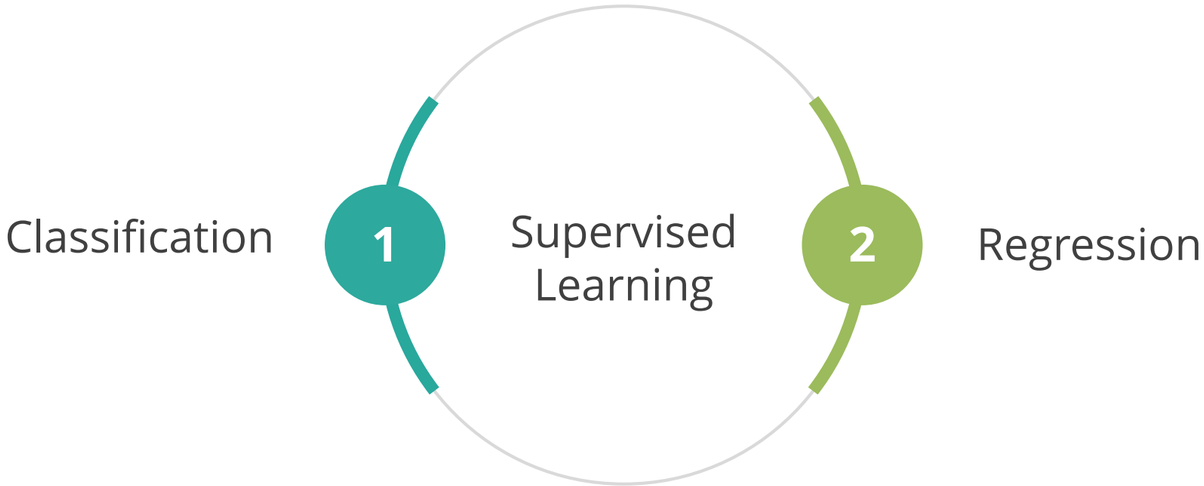
https://digit.hbs.org/submission/gmail-ensuring-a-spam-free-inbox-with-machine-learning/

Examples of Supervised Learning

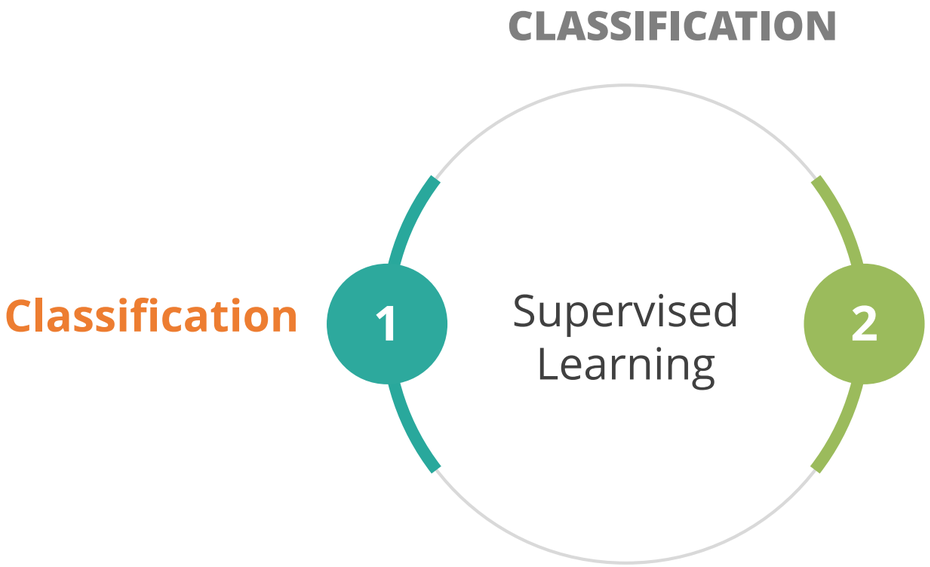
Example 3: Weather Apps

The predictions made by weather apps at a given time are based on some prior knowledge and analysis of how the weather has been over a period of time for a particular place.

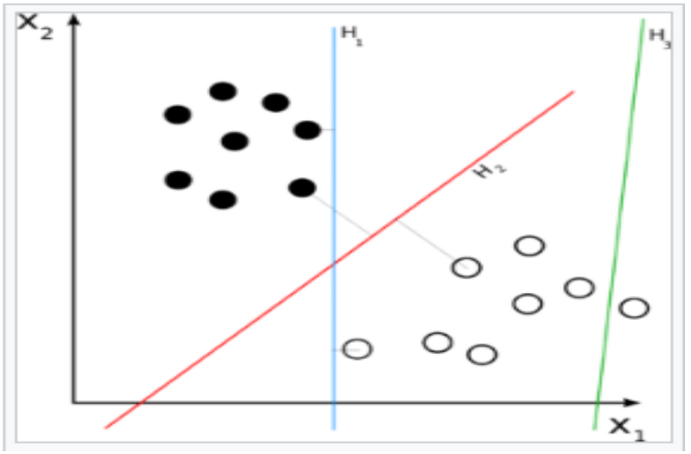
Types of Supervised Learning



Types of Supervised Learning



- Answers “What class?”
- Applied when the output has finite and discreet values
  Example: Social media sentiment analysis has three potential outcomes, positive, negative, or neutral

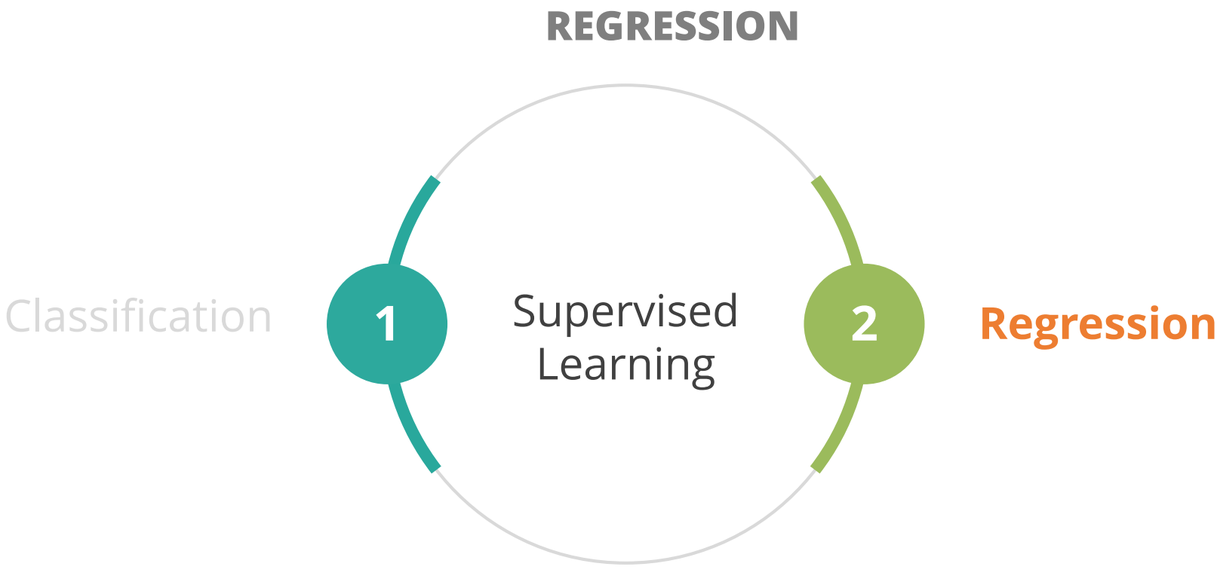


Demo

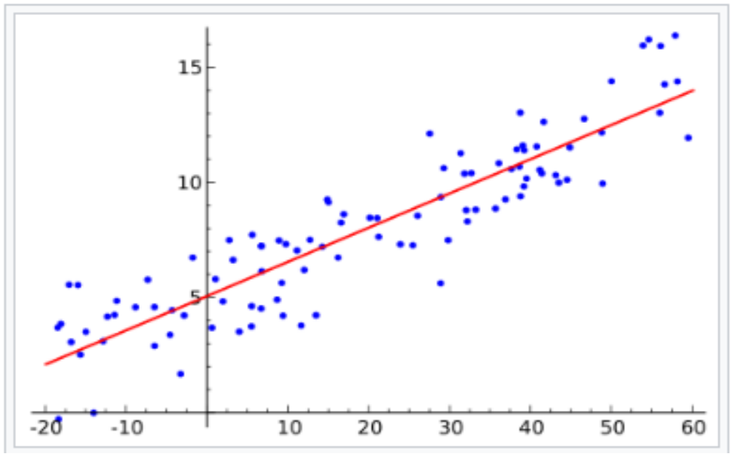
Classification: Logistic Regression

Given the age and salary of consumers, predict whether they will be interested in purchasing a house.
You can perform this in your lab environment with the dataset available in the LMS.

Types of Supervised Learning



- Answers "How much?"
- Applied when the output is a continuous number
- A simple regression algorithm: $y = wx + b$. Example: relationship between environmental temperature (y) and humidity levels (x)



Demo

Linear Regression

Given the details of the area a house is located, predict the prices. You can perform this in your lab environment with the dataset available in the LMS.

Machine Learning

Topic 2—Unsupervised Learning

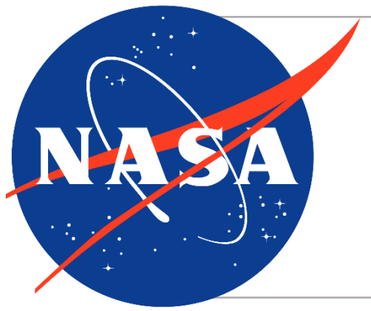
Unsupervised Learning: Case Study

Ever wondered how NASA discovers a new heavenly body and identifies that it is different from a previously known astronomical object?

It has no knowledge about these new bodies but classifies them into proper categories.

https://space.desktopnexus.com/wallpaper/1515289/

Unsupervised Learning: Case Study

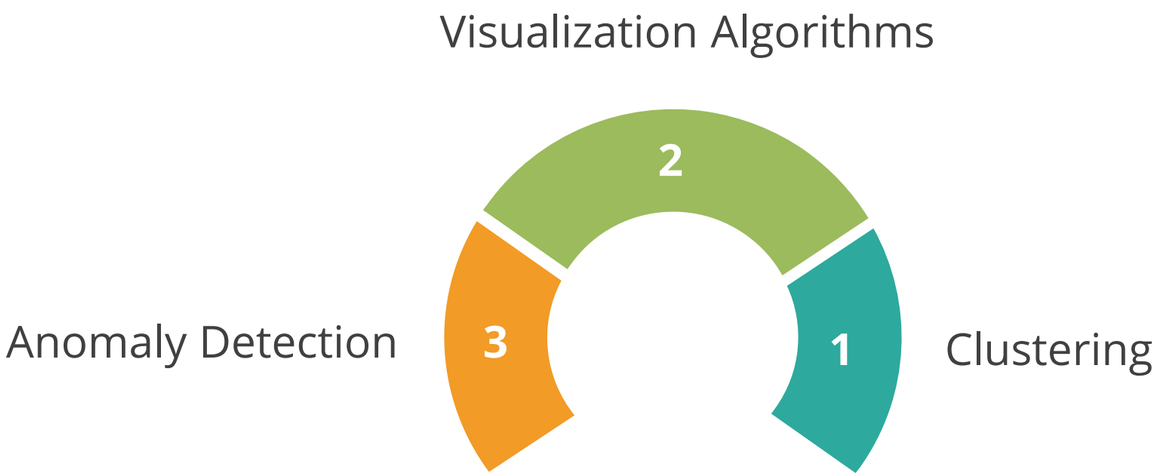


NASA uses **unsupervised learning** to create clusters of heavenly bodies, with each cluster containing objects of a similar nature.

What Is Unsupervised Learning?

Unsupervised Learning is a subset of Machine Learning used to extract inferences from datasets that consist of input data without labeled responses.

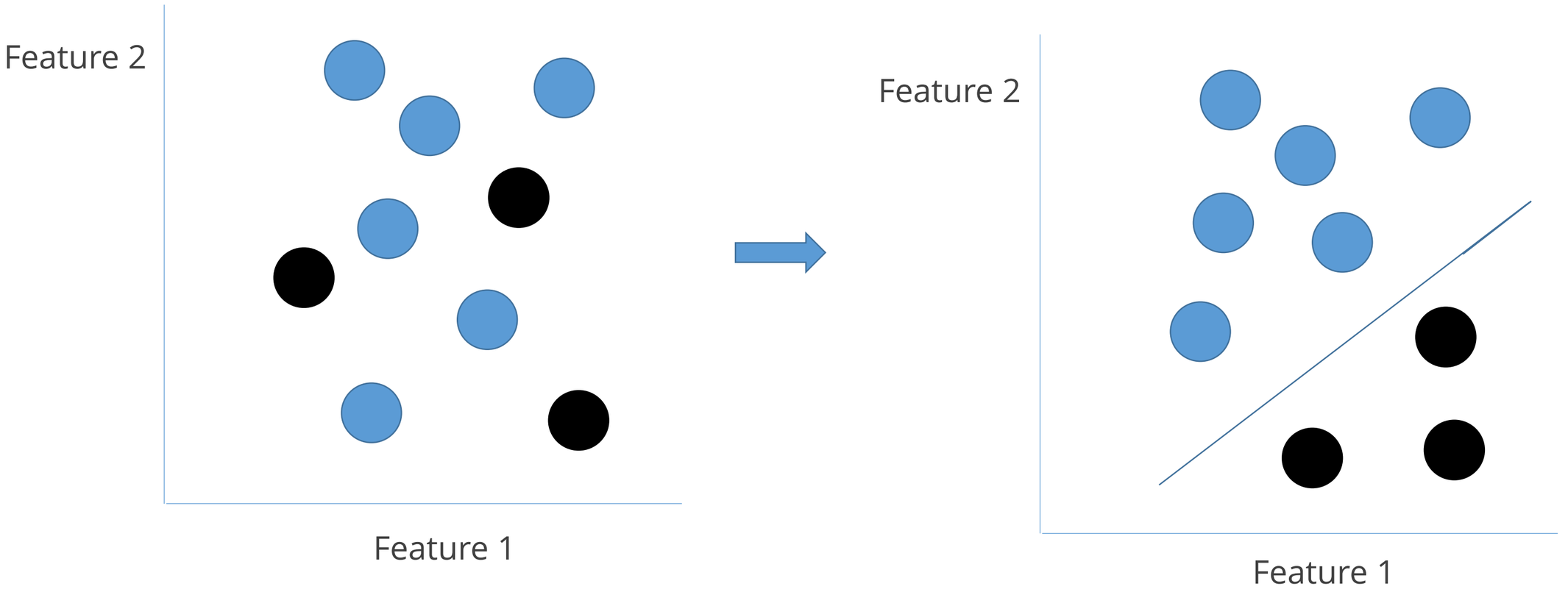
Types of Unsupervised Learning



Types of Unsupervised Learning

CLUSTERING

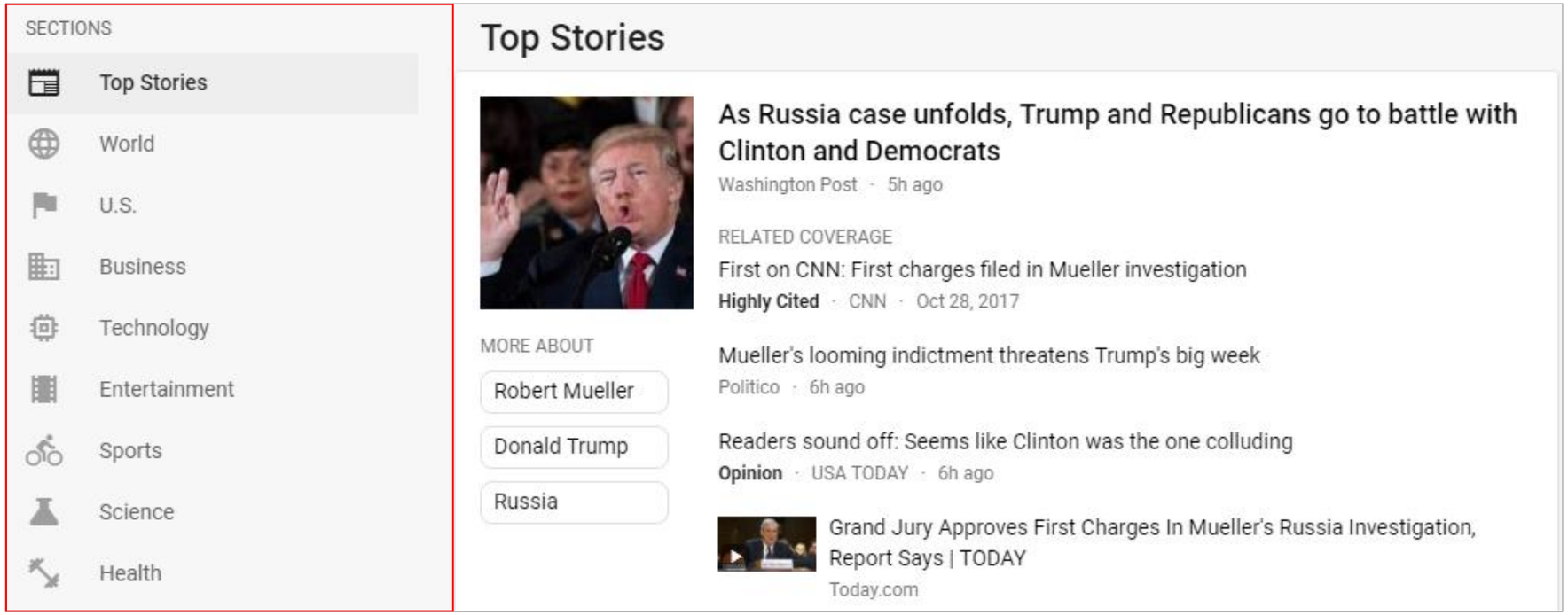
The most common unsupervised learning method is cluster analysis. It is used to find data clusters so that each cluster has the most closely matched data.



Types of Unsupervised Learning

CLUSTERING

Example: An online news portal segments articles into various categories like Business, Technology, Sports, etc.



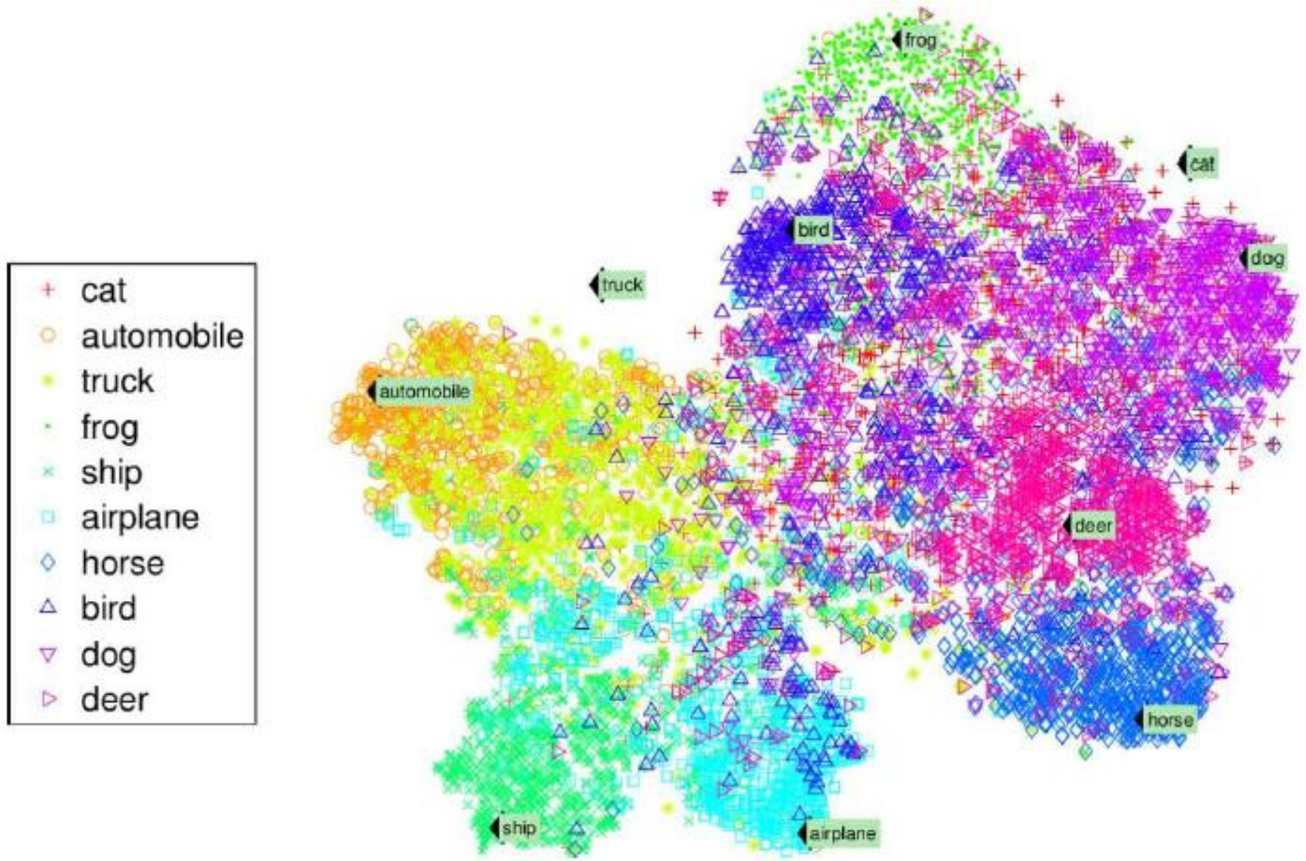
Types of Unsupervised Learning

VISUALIZATION ALGORITHMS

Visualization algorithms are unsupervised learning algorithms that accept unlabeled data and display this data in an intuitive 2D or 3D format. The data is separated into somewhat clear clusters to aid understanding.

Example:

In the figure, the animals are rather well separated from vehicles. Horses are close to deer but far from birds, and so on.



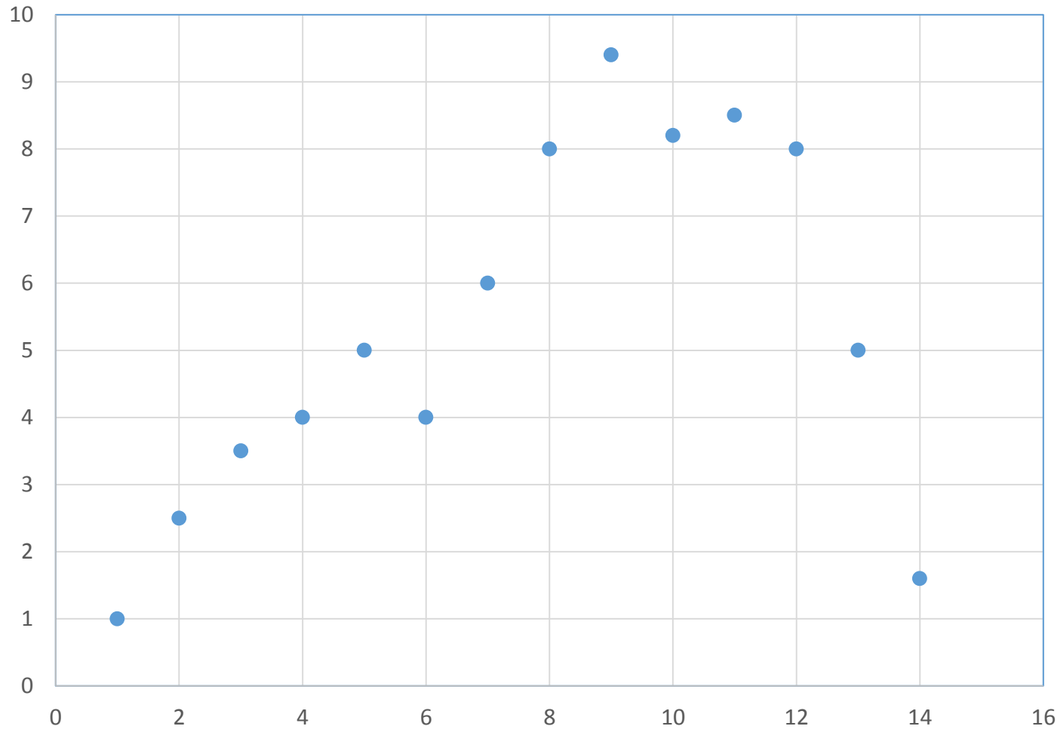
Types of Unsupervised Learning

ANOMALY DETECTION

This algorithm detects anomalies in data without any prior training.

Example:

It can detect suspicious credit card transactions and differentiate a criminal from a set of people.



Machine Learning

Topic 3—Semi-supervised Learning and Reinforcement Learning

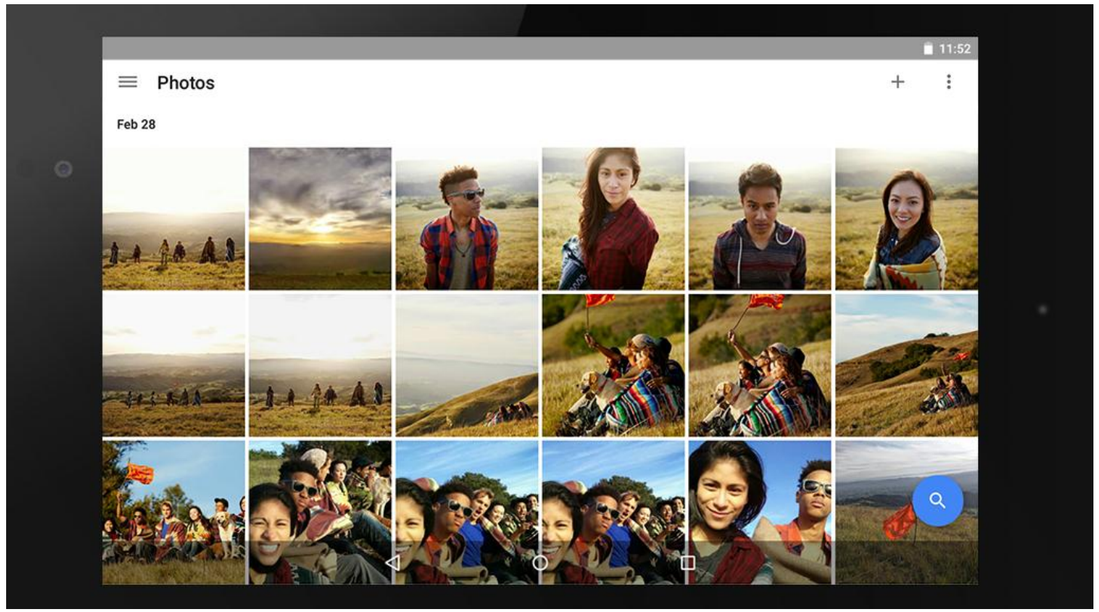
What Is Semi-supervised Learning?

It is a hybrid approach (combination of Supervised and Unsupervised Learning) with some labeled and some non-labeled data.

Example of Semi-Supervised Learning

Google Photos automatically detects the same person in multiple photos from a vacation trip (clustering – unsupervised).

One has to just name the person once (supervised), and the name tag gets attached to that person in all the photos.



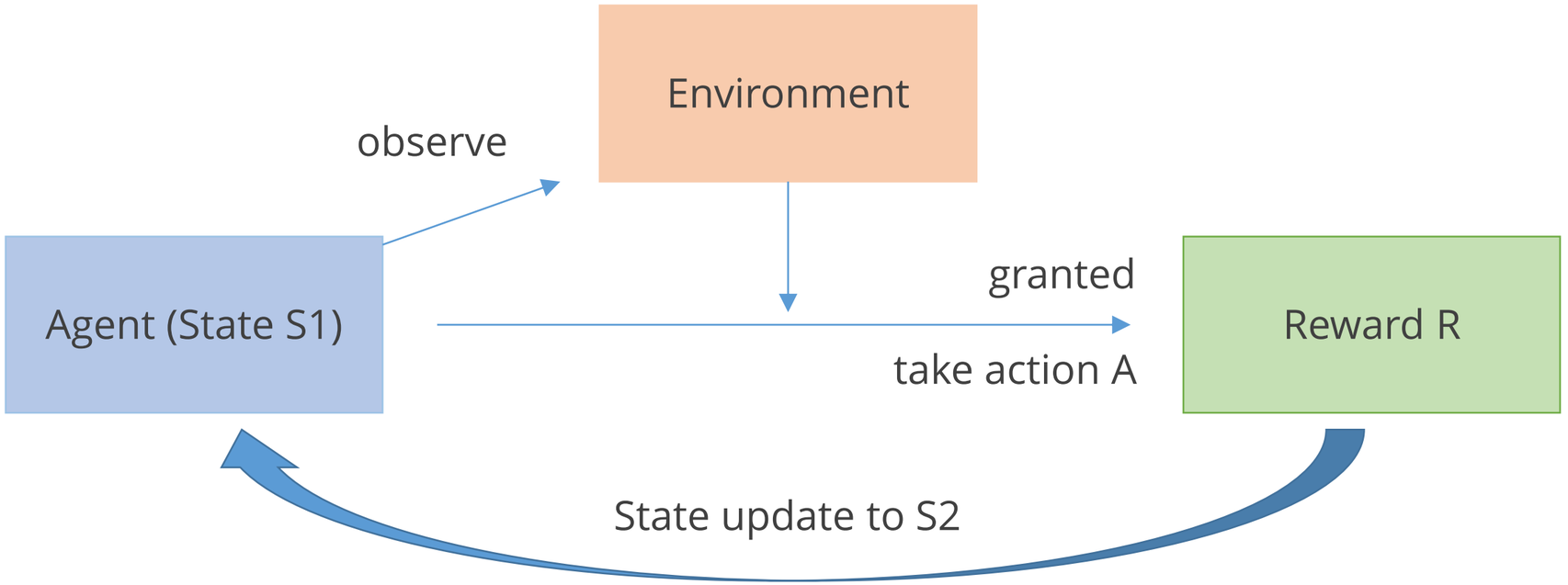
https://play.google.com/store/apps/details?id=com.google.android.apps.photos

What Is Reinforcement Learning?

Reinforcement Learning is a type of Machine Learning that allows the learning system to observe the environment and learn the ideal behavior based on trying to maximize some notion of cumulative reward.

Features of Reinforcement Learning

- The learning system (agent) observes the environment, selects and takes certain actions, and gets rewards in return (or penalties in certain cases).
- The agent learns the strategy or policy (choice of actions) that maximizes its rewards over time.



Example of Reinforcement Learning

In a manufacturing unit, a robot uses deep reinforcement learning to identify a device from one box and put it in a container.

The robot learns this by means of a rewards-based learning system, which incentivizes it for the right action.

http://4tsi.com/automation-not-trade-main-cause-of-factory-job-losses/

Machine Learning

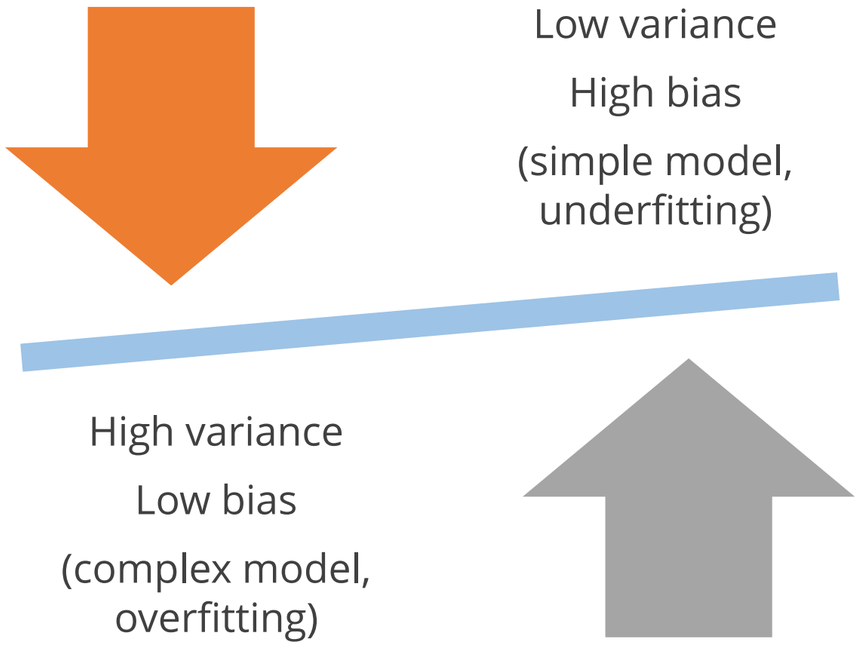
Topic 4—Some Important Considerations in Machine Learning

Bias and Variance Tradeoff

- Bias refers to error in the machine learning model due to wrong assumptions. A high-bias model will **underfit** the training data.

- Variance refers to problems caused due to overfitting. This is a result of over-sensitivity of the model to small variations in the training data. A model with many degrees of freedom (such as a high-degree polynomial model) is likely to have high variance and thus **overfit** the training data.

Bias and Variance Dependencies



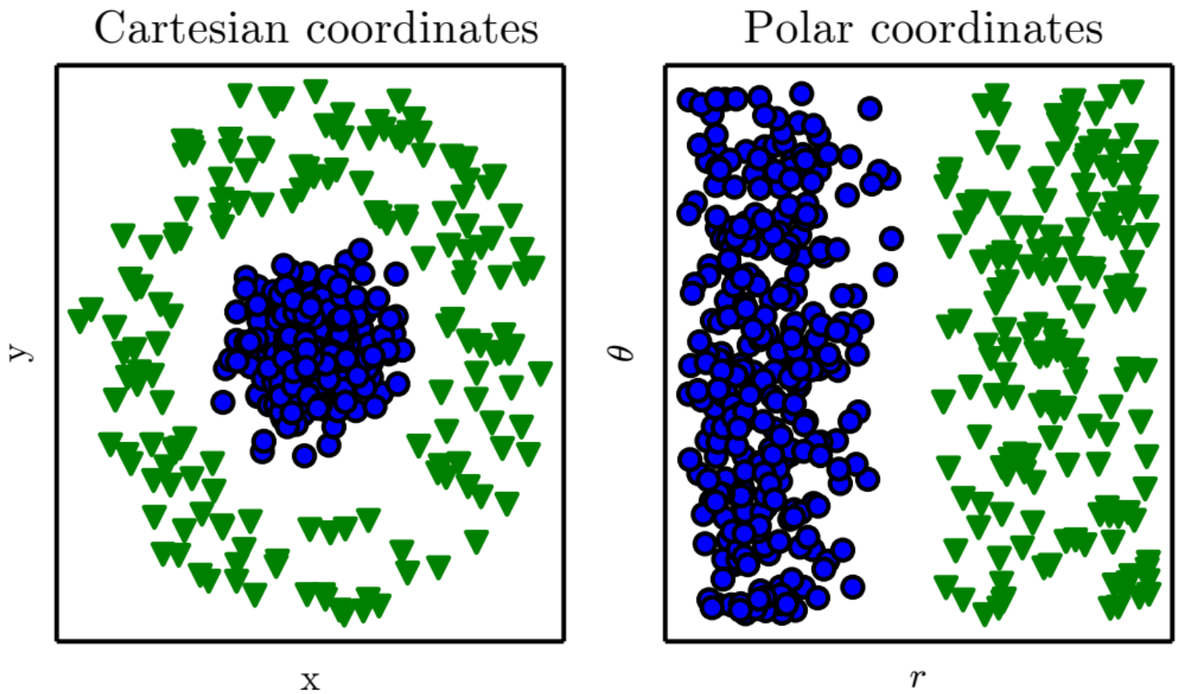
Increasing a model's complexity will reduce its bias and increase its variance.

Conversely, reducing a model's complexity will increase its bias and reduce its variance. This is why it is called a tradeoff.

What Is Representation Learning?

In Machine Learning, Representation refers to the way the data is presented. This often make a huge difference in understanding.

Example of Representation Learning



The figure shows sample data in Cartesian coordinates and polar coordinates.

In this particular case, categorization becomes easier when data is presented in a different coordinate system. Hence, representation matters.

Linearly Separable or Not

- The convergence of the learning algorithms (like perceptron) is only guaranteed if the two classes are linearly separable and the learning rate is sufficiently small.

- If the two classes can't be separated by a linear decision boundary, you can set a maximum number of passes over the training dataset (epochs) and/or a threshold for the number of tolerated misclassifications. The perceptron would never stop updating the weights otherwise.

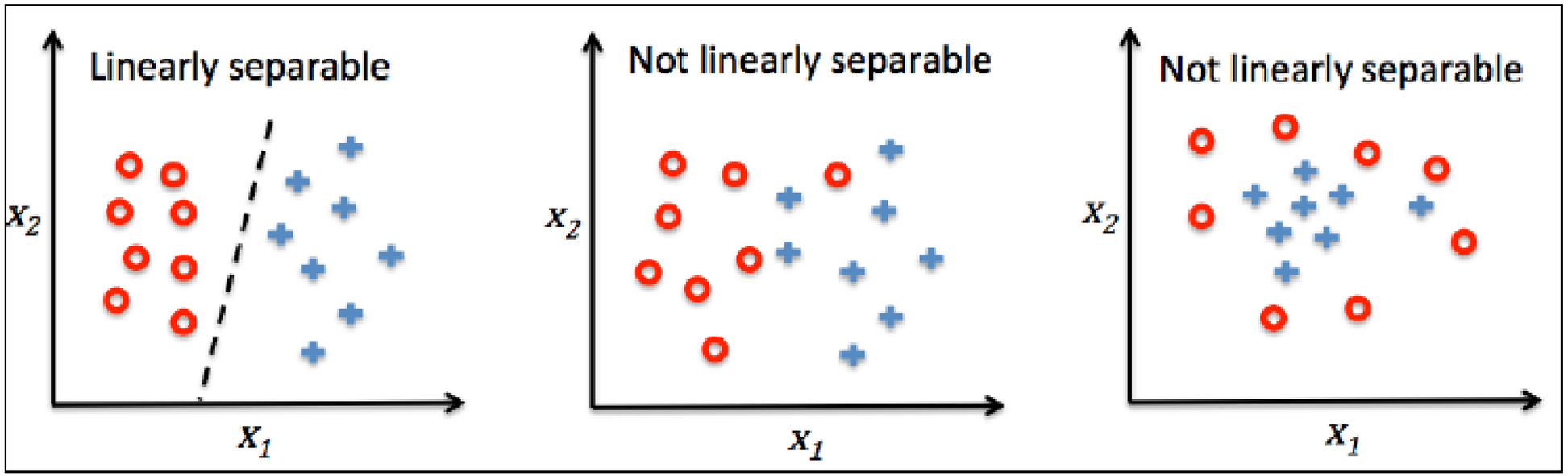


Image Credit : “Python Machine Learning” by Sebastian Raschka

Other Machine Learning Techniques

Probabilistic Models	Decision Trees	Clustering	Associated Rules	Deep Learning	Support Vector Machines
• Model the probability distribution of a data set and use it to predict future outcomes	• Arrive at a hierarchical decisioning tree structure	• Classify data based on closest data points appearing in the same cluster	• A method to discover what items tend to occur together in a sample space	• Based on Artificial Neural Network models • Contains inter-connected neurons organized in layers. This network learns to predict outcomes	• Method to classify data by discovering hyperplanes (separating layers) that segregate types of data

This will be discussed in detail in the upcoming lessons.

Key Takeaways

- Supervised Learning is a type of Machine Learning used to learn models from labeled training data. It allows us to predict output for future or unseen data. Two major types of Supervised Learning are Regression and Classification.
- The ML process (for supervised learning) entails data pre-processing, training the model, and testing the trained model and production deployment.
- If the training is poor, it may lead to underfitting (model does not satisfy the test data). If the training is too intensive, it may lead to overfitting (the model is not able to handle new unseen test data).
- Unsupervised Learning is a subset of Machine Learning used to extract inferences from datasets that consist of input data without labelled responses. Some examples of Unsupervised Learning include Clustering and Visualization algorithms.

Quiz

QUIZ 1

Training data in supervised learning contains:

a. Input and desired output data

b. Desired input and desired output data

c. Any input and desired output data

d. All of the above

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The correct answer is **a. Input and desired output data**

Training data in supervised learning contains input and desired output data.

QUIZ 2

Classification and Regression are types of _____ learning.

a. Supervised

b. Unsupervised

c. Reinforcement

d. Semi-supervised

QUIZ 2

Classification and Regression are types of _____ learning.

a. Supervised

b. Unsupervised

c. Reinforcement

d. Semi-supervised

The correct answer is **a. Supervised Learning**

Classification and Regression are types of Supervised Learning.

Hands-on Assignments

Demo File	Assignment	What it demonstrates?
LogisticRegression.py	What issues do you see in the plot produced by the code in reference with the above problem statement?	Predicts whether consumers will buy houses or not, given their age and salary.
LinearRegression.py	What is the approximate price of the house with area 1700 and 1900 respectively?	Predicts house prices based on area of the house.

This concludes “Techniques of Machine Learning.”

The next lesson is “Data Preprocessing.”