Introduction to Data Science

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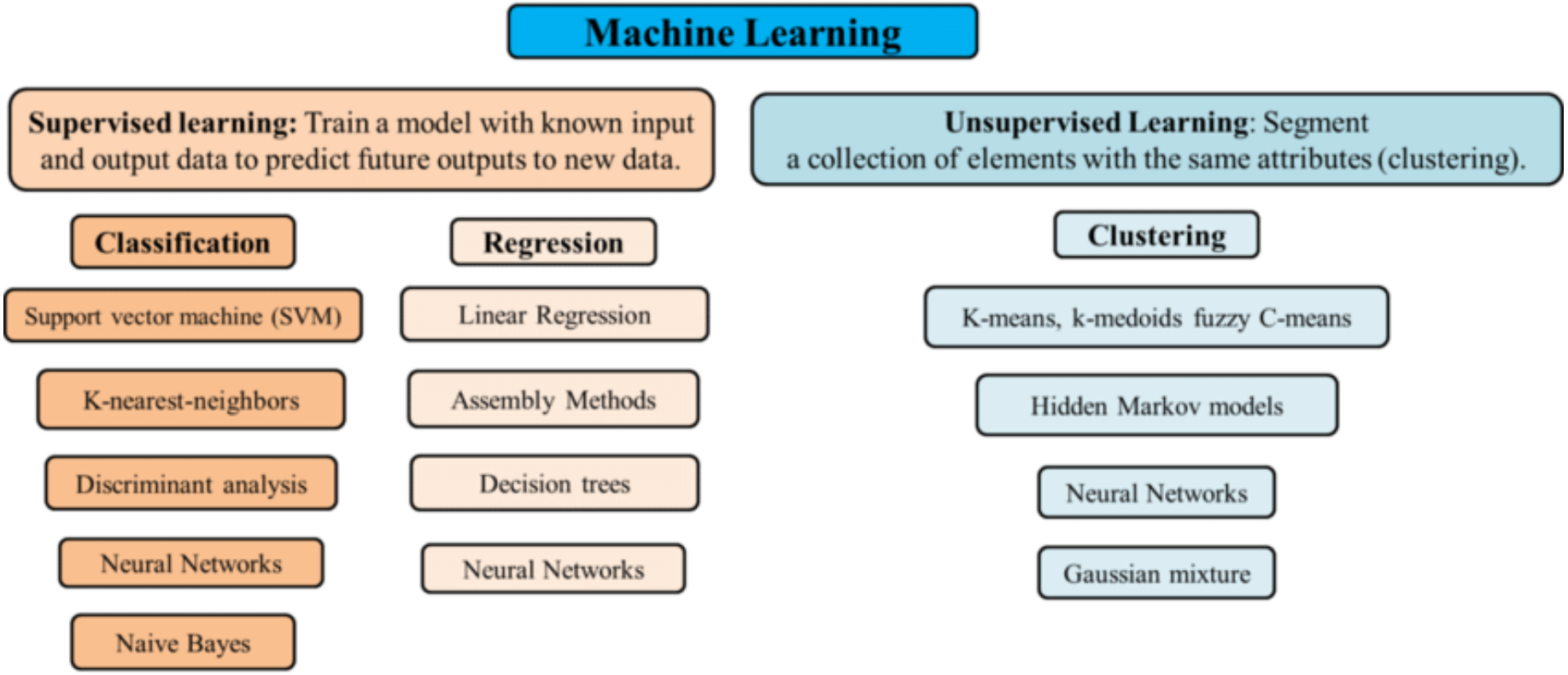
Outline

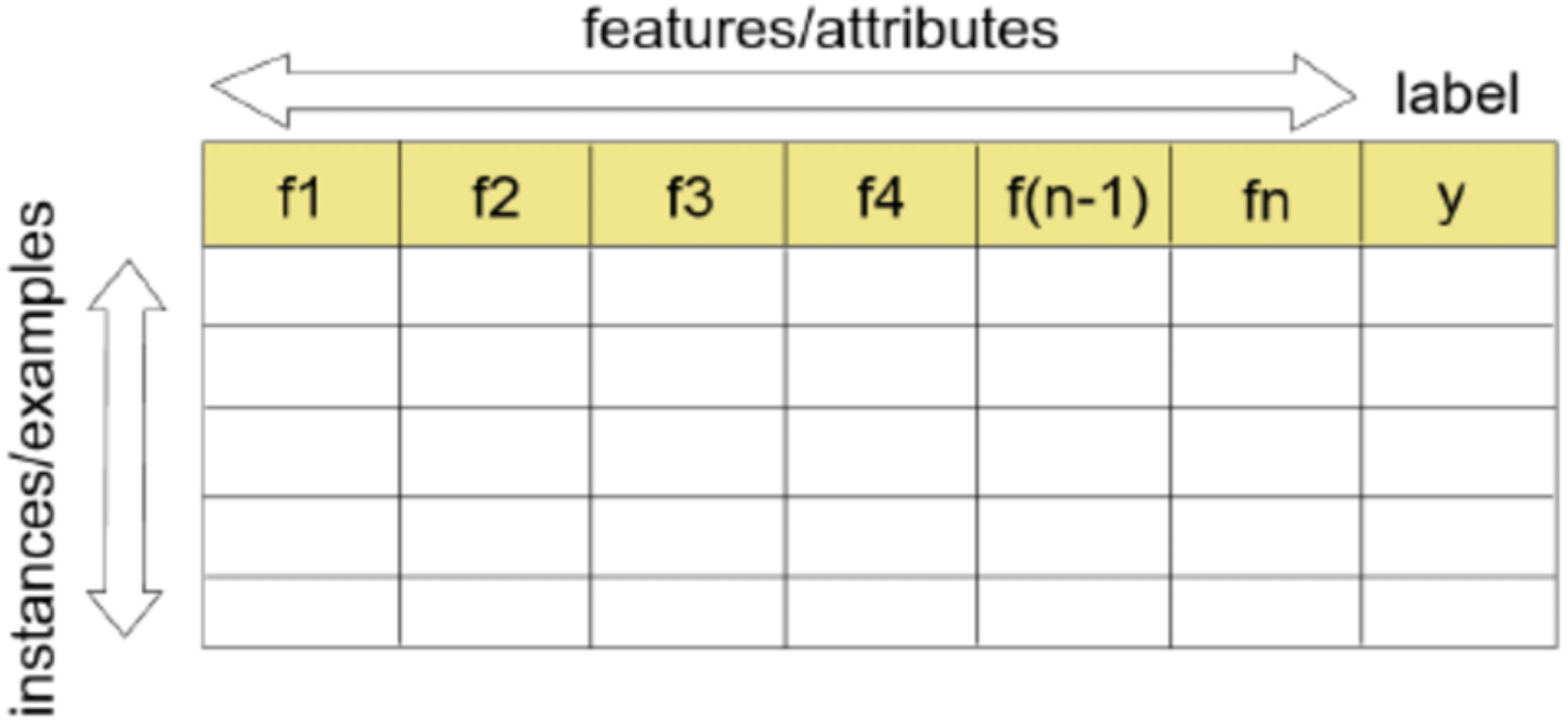
- Train-Test Split
- Confusion Matrix

Machine Learning Algorithms

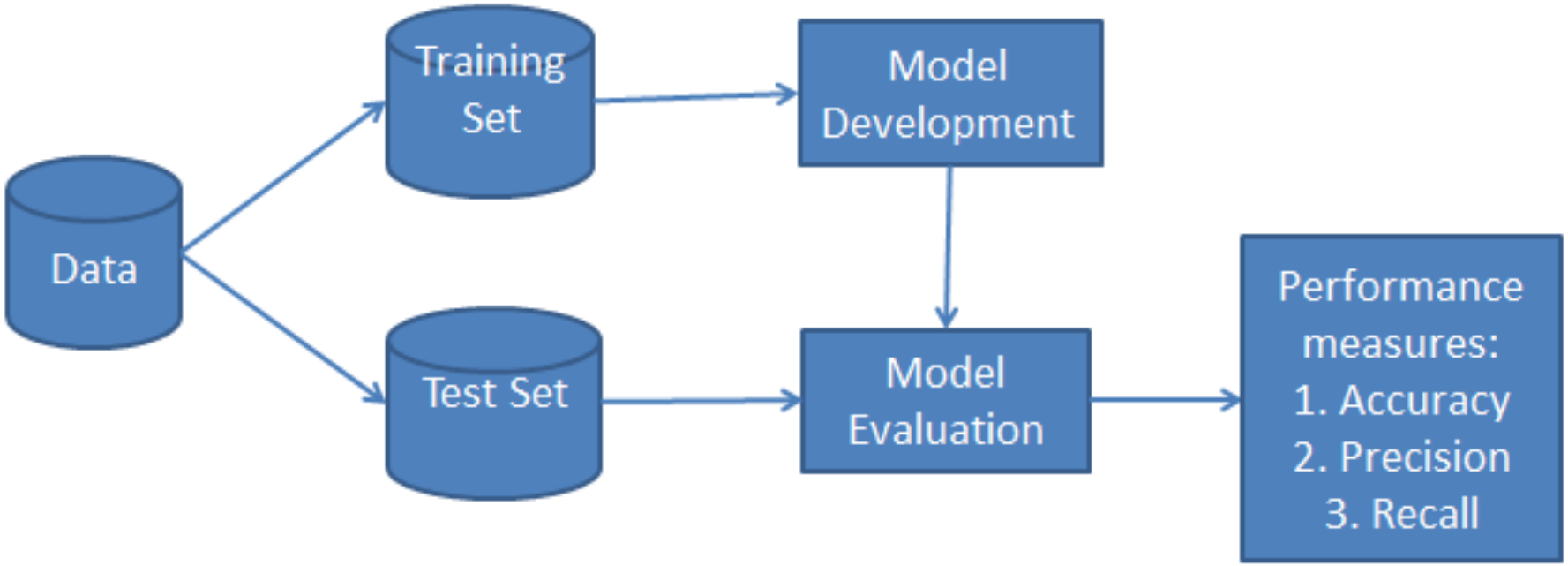


Supervised Machine Learning

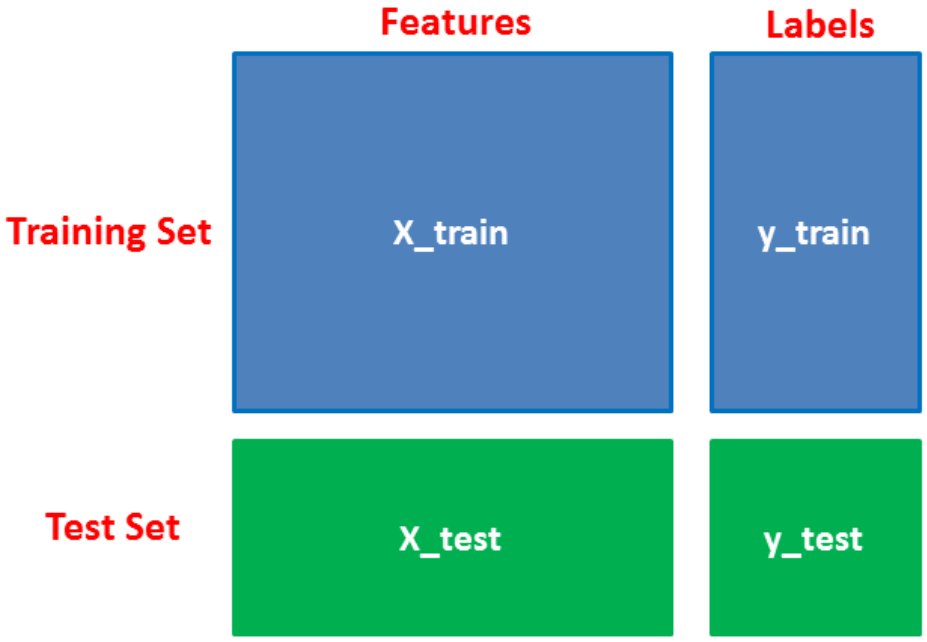
Supervised Machine Learning

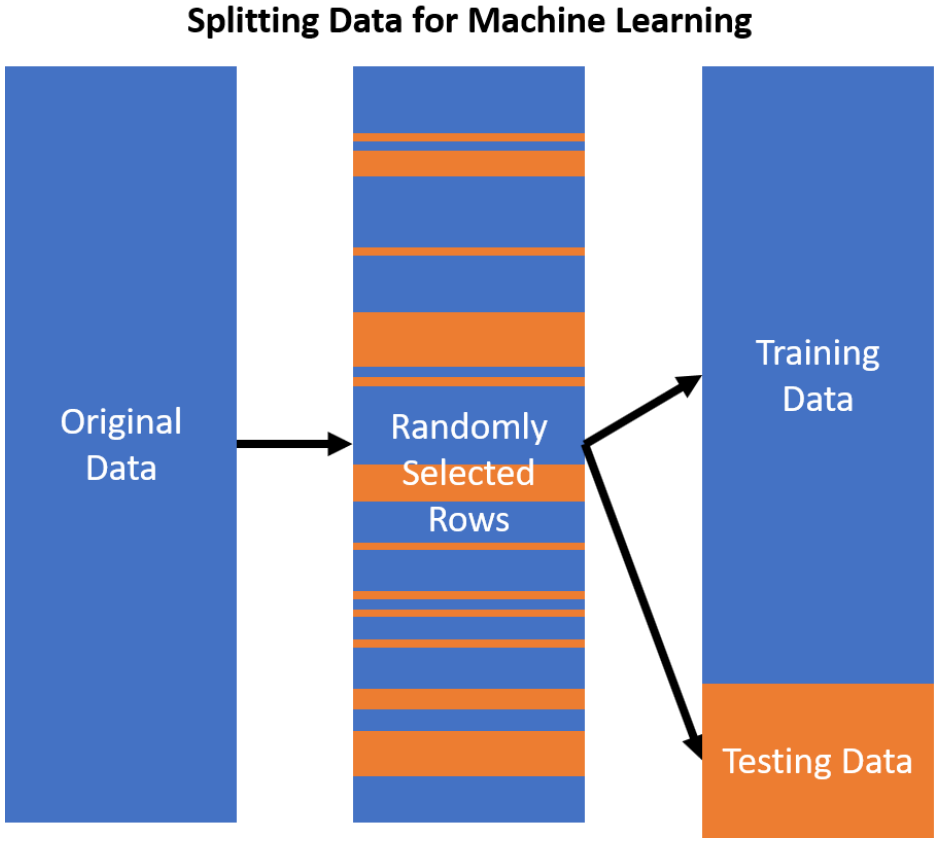


Train-Test-Split

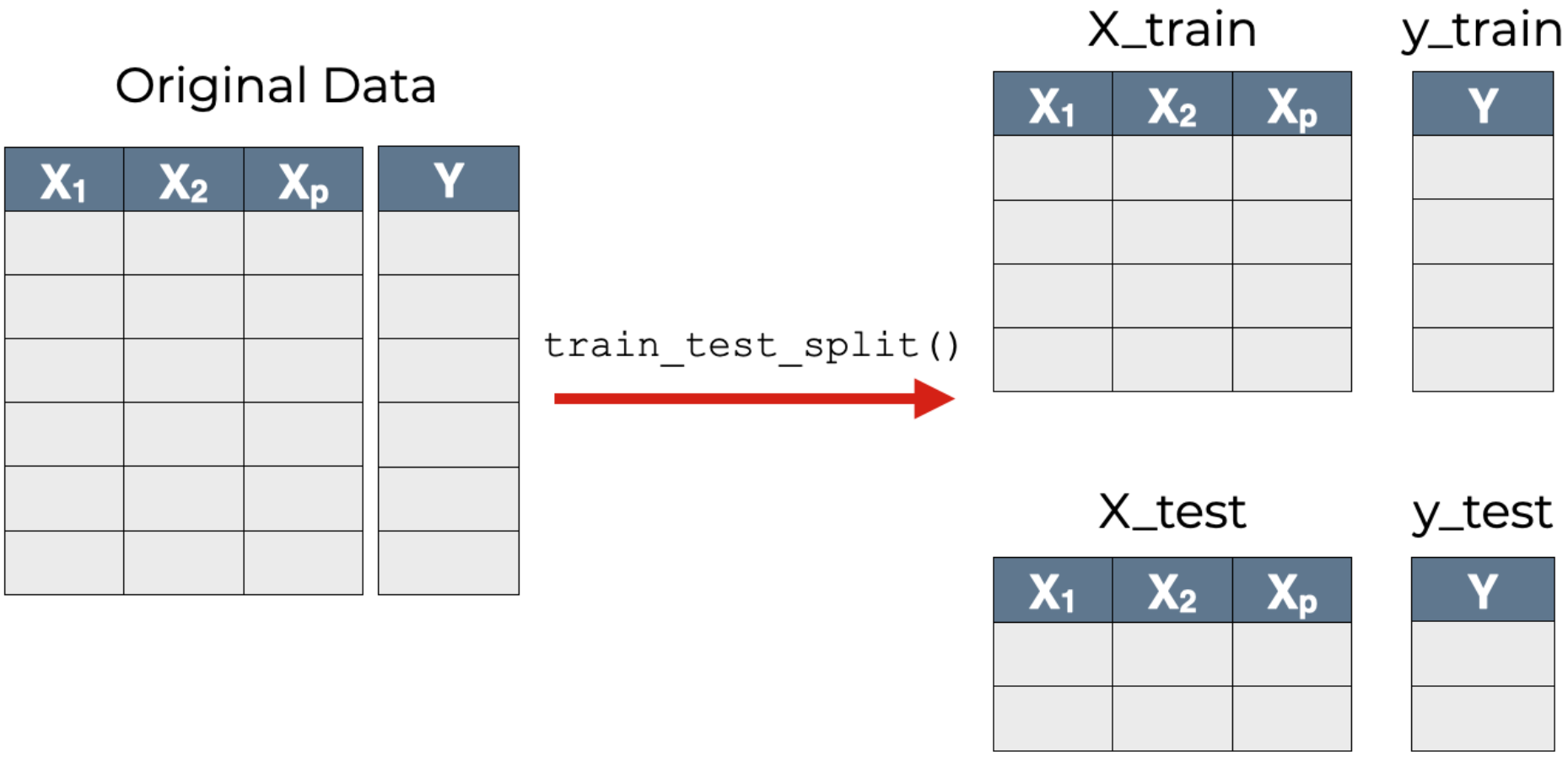


Train-Test-Split





TRAIN_TEST_SPLIT SPLITS DATA INTO TRAINING DATA AND TEST DATA



Classification Model

- Classification is a technique where we categorize data into a given number of classes.

- The main goal of a classification problem is to identify the category/class to which a new data will fall under.

Classification Model

- **Classifier:** An algorithm that maps the input data to a specific category.
- **Classification model:** A classification model tries to draw some conclusion from the input values given for training. It will predict the class labels/categories for the new data.
- **Feature:** A feature is an individual measurable property of a phenomenon being observed.
- **Binary Classification:** Classification task with two possible outcomes. Eg: Gender classification (Male / Female)
- **Multi-class classification:** Classification with more than two classes. In multi class classification each sample is assigned to one and only one target label. Eg: An animal can be cat or dog but not both at the same time
- **Multi-label classification:** Classification task where each sample is mapped to a set of target labels (more than one class). Eg: A news article can be about sports, a person, and location at the same time.

Classification Model

The following are the steps involved in building a classification model:

- **Initialize** the classifier to be used.
- **Train the classifier:** All classifiers in scikit-learn uses a fit(X, y) method to fit the model(training) for the given train data X and train label y.
- **Predict the target:** Given an unlabeled observation X, the predict(X) returns the predicted label y.
- **Evaluate** the classifier model

Evaluating a Classification Model

```
> source('E:/Spring2021/RProgs/SpamFilter.R')
Loading required package: RColorBrewer
Loading required package: NLP
ham --> ham
 spam --> spam
 ham --> ham
 ham --> spam
 ham --> ham
 ham --> ham
 ham --> ham
 ham --> spam
 ham --> ham
 ham --> ham
[1] "Done"
```

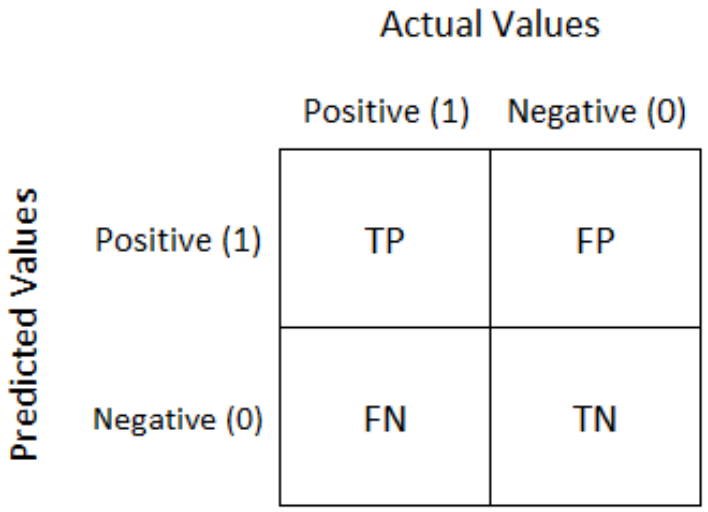
Actual

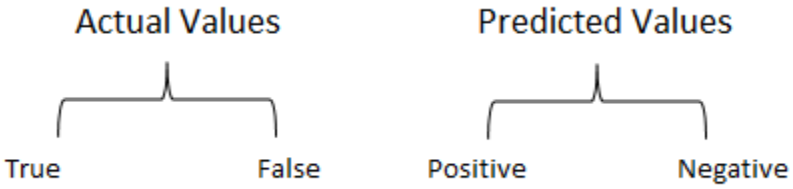
Predicted

Confusion Matrix

- A confusion matrix is a table that is often used to describe the **performance of a classification model** (or "classifier") on a set of test data for which the true values are known.

Confusion Matrix



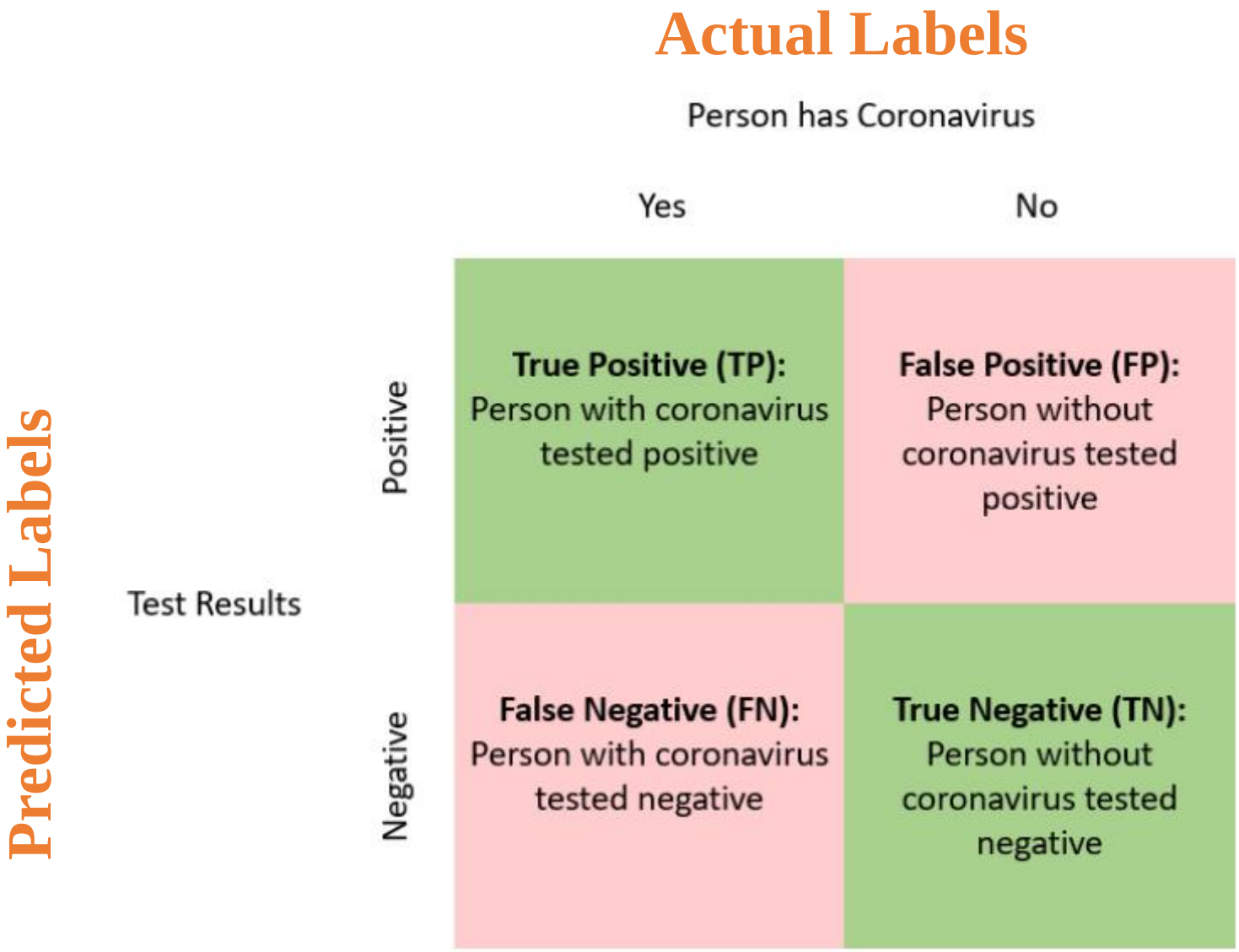


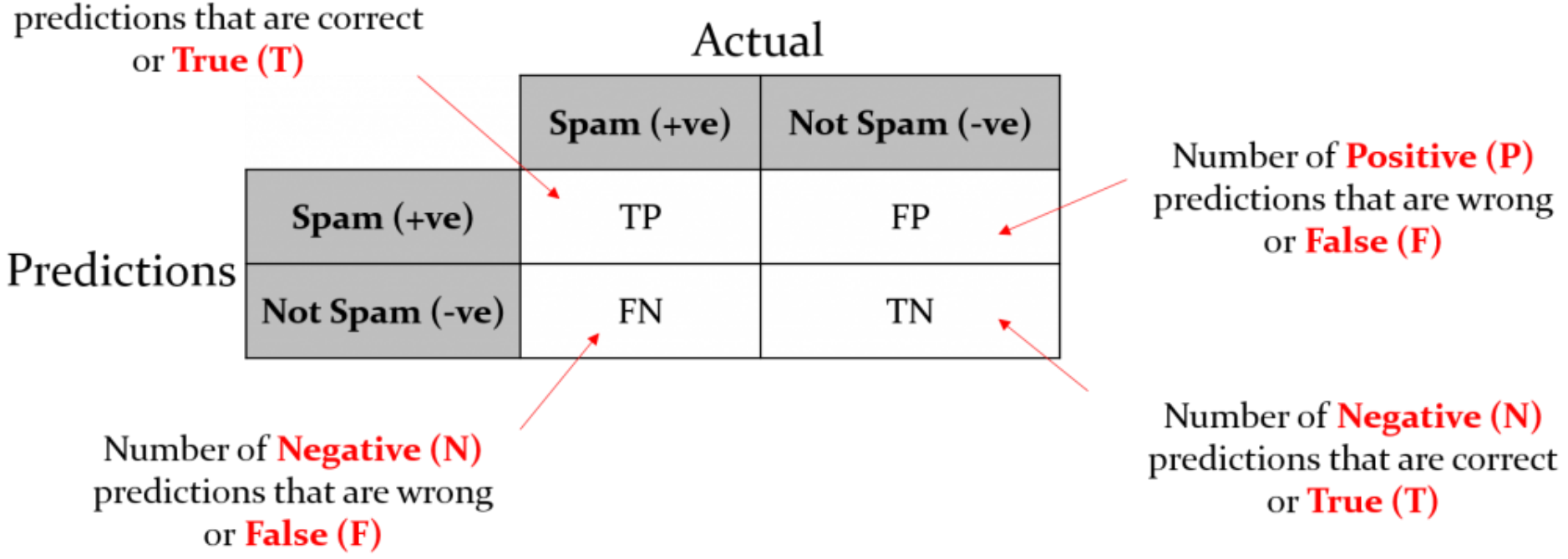
True Positive (TP): You predicted positive and it's true.

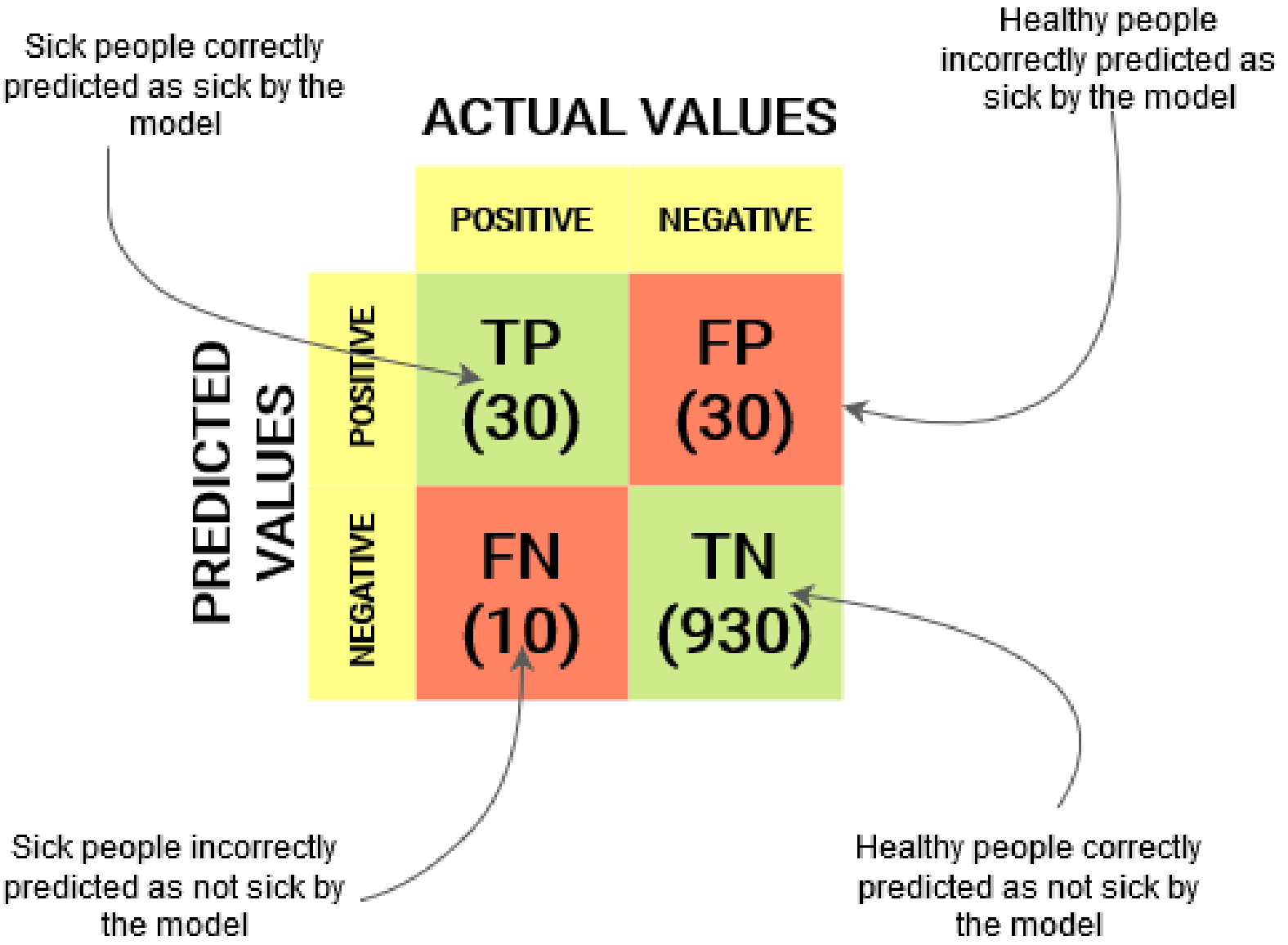
True Negative (TN): You predicted negative and it's true.

False Positive (FP): You predicted positive and it's false.

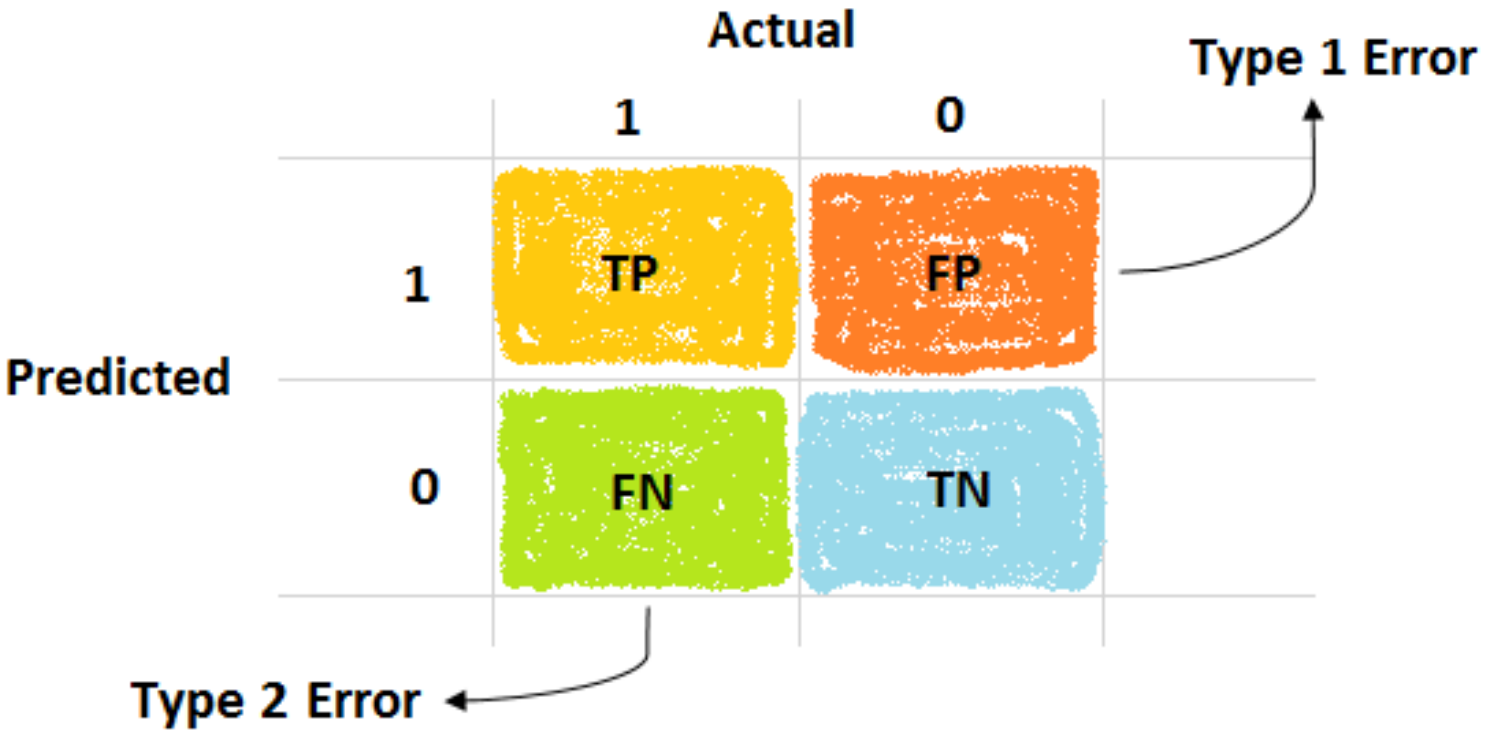
False Negative (FN): You predicted negative and it's false.


Actual Labels
Person has Coronavirus
Yes
No
Predicted Labels
Test Results
Positive
Negative
True Positive (TP): Person with coronavirus tested positive
False Positive (FP): Person without coronavirus tested positive
False Negative (FN): Person with coronavirus tested negative
True Negative (TN): Person without coronavirus tested negative


Number of Positive (P) predictions that are correct or True (T)
Actual
Spam (+ve)
Not Spam (-ve)
Predictions
Spam (+ve)
Not Spam (-ve)
TP
FP
FN
TN
Number of Positive (P) predictions that are wrong or False (F)
Number of Negative (N) predictions that are wrong or False (F)
Number of Negative (N) predictions that are correct or True (T)


Sick people correctly predicted as sick by the model
Healthy people incorrectly predicted as sick by the model
ACTUAL VALUES
POSITIVE
NEGATIVE
PREDICTED VALUES
POSITIVE
NEGATIVE
TP (30)
FP (30)
FN (10)
TN (930)
Sick people incorrectly predicted as not sick by the model
Healthy people correctly predicted as not sick by the model

Confusion Matrix



Confusion Matrix Terminology

- Classification **Accuracy** is the ratio of correct predictions to total predictions made.

$$\text{Accuracy} = \frac{Correct\ Predictions}{Total\ Predictions}$$

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN}$$

Confusion Matrix Terminology

- **Precision** is calculated as the number of correct positive predictions divided by the total number of positive predictions.

$$\text{Precision} = \frac{TP}{TP + FP}$$

- **Recall** is calculated as the number of correct positive predictions divided by the total number of positives.

$$\text{Recall} = \frac{TP}{TP + FN}$$

Confusion Matrix Terminology

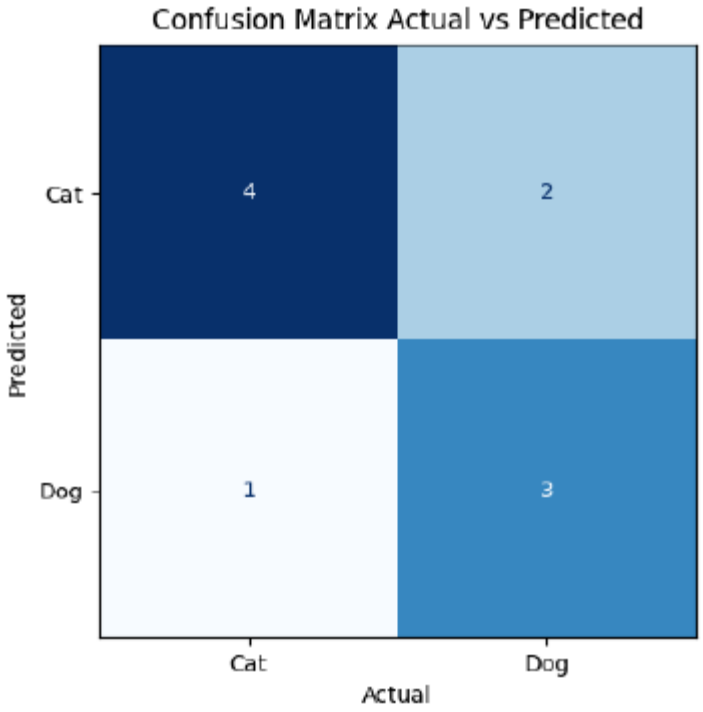
- **F1-score** is the harmonic mean of precision and recall and is a better measure than accuracy.

$$\text{F1-score} = \frac{2 * Recall * Precision}{Recall + Precision}$$

Confusion Matrix Example

a) The output of a machine learning classifier is given below in the form of actual and predicted data. Draw the Confusion Matrix of this classifier and calculate its accuracy.

Actual	Dog	Dog	Cat	Dog	Cat	Cat	Cat	Dog	Dog	Cat
Predicted	Cat	Dog	Cat	Dog	Dog	Cat	Cat	Dog	Cat	Cat



Confusion Matrix Implementation

- Implementation of Confusion Matrix

Summary

- Train Test Split
- Confusion Matrix