**Is Confusion Matrix confusing?**

It might sound scary but a confusion matrix is just a performance measurement tool. It is a powerful tool to assess classification models.  
Confusion Matrix is basically a table with the number of correctly and incorrectly predicted classes. A binary classification confusion matrix looks like:

###### Confusion Matrix

|  | **Predicted True** | **Predicted False** |
| --- | --- | --- |
| **Actual True** | True Positive **TP** | False Negative **FN** |
| **Actual False** | False Positive **FP** | True Negative **TN** |

Say, we have two possible values for our binary classification problem, i.e. TRUE and FALSE:

1. TP – This field denotes the number of values correctly predicted as TRUE
2. TN – Count of the values correctly predicted as FALSE
3. FP – Count of values incorrectly predicted as TRUE when the actual value was FALSE. This is also the **Type I Error**
4. FN – Count of values incorrectly predicted as FALSE when they were actually TRUE. This is often referred to as the **Type II Error**

###### Confusion Matrix Evaluation:

We can derive the below information from the confusion matrix:

1. **TPR** (True Positive Rate): Also known as **Recall/Sensitivity** is the ratio of True Positives with total of actual True values.  
   Mathematically:  
   TPR = TP/(TP + FN)
2. **FPR** (False Positive Rate): Also known as **Precision**, it is the ratio of False Positives to the total of predicted True values.  
   Formula:  
   FPR = TP/(TP+FP)
3. **Accuracy**: Ratio of correctly predicted values with the total of all values.  
   Formula:  
   (TP+TN)/(TP+TN+FP+FN)
4. **F-score**: It is the harmonic mean of Recall and Precision.  
   Formula  
   (2 x Recall x Precision)/(Recall+Precision)

###### Why different formulas?

We consider different values to measure the performance depending upon the business scenario.  
Say for example, cancer detection model would be measured on Recall because we cannot afford to have False Negatives as it can have huge real-life impact. Hence, based on situation we need to decide the appropriate metric.

###### Example

Consider a sample of 100 where 50 people are Covid+. Our classification model detects 40 Covid+ patients out of which 10 are incorrect predictions. Considering the threshold as 50%, construct a confusion matrix.

###### Confusion Matrix

| **N=100** | **Predicted True** | **Predicted False** |
| --- | --- | --- |
| **Actual True** | **30** | **20** |
| **Actual False** | **10** | **40** |

Let us calculate the various metrices:

1. TPR = 30 / (10 + 30) =75%
2. FPR = 30 / (30 + 20) = 60%
3. Accuracy = (30 + 40) / (30 + 20 + 10 + 40) = 70%
4. F-score = (2 x (0.75) x (0.60)) / ((0.75) + (0.60)) = 66.7%

Thank you for reading!

Resources:  
<https://towardsdatascience.com/understanding-confusion-matrix-a9ad42dcfd62>  
<https://www.geeksforgeeks.org/confusion-matrix-machine-learning/>