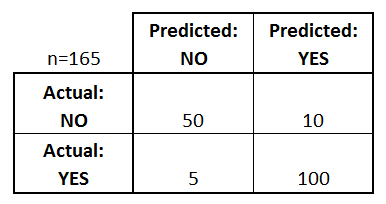
# **Confusion Matrix:**

Confusion Matrix as the name suggests gives us a matrix as output and describes the complete performance of the model. Lets assume, we have a binary classification problem. We have some samples belonging to two classes : YES or NO. Also, we have our own classifier which predicts a class for a given input sample. On testing our model on 165 samples ,we get the following result.



Confusion Matrix

What can we learn from this matrix?

* There are two possible predicted classes: "yes" and "no". If we were predicting the presence of a disease, for example, "yes" would mean they have the disease, and "no" would mean they don't have the disease.
* The classifier made a total of 165 predictions (e.g., 165 patients were being tested for the presence of that disease).
* Out of those 165 cases, the classifier predicted "yes" 110 times, and "no" 55 times.
* In reality, 105 patients in the sample have the disease, and 60 patients do not.

*There are 4 important terms:*

* **True Positives**  (TP): The cases in which we predicted YES, and the actual output was also YES.
* **True Negatives**  (TN): The cases in which we predicted NO, and the actual output was NO.
* **False Positives**  (FP): The cases in which we predicted YES, and the actual output was NO. (Also known as a "Type I error.")
* **False Negatives** (FN): The cases in which we predicted NO, and the actual output was YES. (Also known as a "Type II error.")

Note:

Type 1 error:It is the **rejection** of a true NULL Hypothesis. i.e.  to falsely infer the existence of something that is not there (confirming to common belief with false information).

Type 2 error: It is the **failure to reject** a false NULL Hypothesis. i.e. to falsely infer the absence of something that is present (going against the common belief with false information).

I've added these terms to the confusion matrix, and also added the row and column totals:



This is a list of rates that are often computed from a confusion matrix :

* **Accuracy:** Accuracy for the matrix can be calculated by taking average of the values lying across the**“main diagonal”.**

https://cdn-images-1.medium.com/max/1600/1*NDD6vdbTcLPzXVbCKi87RA.gif

It can also be stated as, Overall, how often is the classifier correct?

From the above **confusion matrix** accuracy:

* =0.91
* **Misclassification Rate:** Overall, how often is it wrong?

It is also known as "Error Rate”.

It can be calculated using:

* = 1-Accuracy

From the above **confusion matrix:**

* **True Positive Rate:**

 When it's actually yes, how often does it predict yes?

It Is also known as "Sensitivity" or "Recall"

It can be calculated:

* = 1-False Negative Rate

From the above **confusion matrix:**

* **False Positive Rate:**

When it's actually no, how often does it predict yes

It can be calculated Using:

From the above **confusion matrix:**

* **True Negative Rate:** When it's actually no, how often does it predict no?

It Is equivalent to 1 minus False Positive Rate

It Is also known as "Specificity"

It can be calculated Using:

From the above **confusion matrix:**

* **Precision:** When it predicts yes, how often is it correct?

It can be calculated Using:

From the above **confusion matrix:**

* **Prevalence:** How often does the yes condition actually occur in our sample ?

It can be calculated:

From the above **confusion matrix:**

Let us define  **P** positive instances and **N** negative instances for some condition. The four outcomes can be formulated in a 2×2 *confusion matrix*, as follows:

|  |  |
| --- | --- |
| **True condition** | |
|  | [Total population](https://en.wikipedia.org/wiki/Statistical_population) | Condition positive | Condition negative | [Prevalence](https://en.wikipedia.org/wiki/Prevalence) = Σ Condition positive/Σ Total population | [Accuracy](https://en.wikipedia.org/wiki/Accuracy_and_precision) (ACC) = Σ True positive + Σ True negative/Σ Total population | |
| **Predicted condition** | Predicted condition positive | [**True positive**](https://en.wikipedia.org/wiki/True_positive), [Power](https://en.wikipedia.org/wiki/Statistical_power) | [**False positive**](https://en.wikipedia.org/wiki/False_positive), [Type I error](https://en.wikipedia.org/wiki/Type_I_error) | [Positive predictive value](https://en.wikipedia.org/wiki/Positive_predictive_value) (PPV), [Precision](https://en.wikipedia.org/wiki/Precision_(information_retrieval)) = Σ True positive/Σ Predicted condition positive | [False discovery rate](https://en.wikipedia.org/wiki/False_discovery_rate) (FDR) = Σ False positive/Σ Predicted condition positive | |
| Predicted condition negative | [**False negative**](https://en.wikipedia.org/wiki/False_negative), [Type II error](https://en.wikipedia.org/wiki/Type_II_error) | [**True negative**](https://en.wikipedia.org/wiki/True_negative) | [False omission rate](https://en.wikipedia.org/wiki/False_omission_rate) (FOR) = Σ False negative/Σ Predicted condition negative | [Negative predictive value](https://en.wikipedia.org/wiki/Negative_predictive_value) (NPV) = Σ True negative/Σ Predicted condition negative | |
|  | | [True positive rate](https://en.wikipedia.org/wiki/True_positive_rate) (TPR), [Recall](https://en.wikipedia.org/wiki/Recall_(information_retrieval)), [Sensitivity](https://en.wikipedia.org/wiki/Sensitivity_(tests)), probability of detection = Σ True positive/Σ Condition positive | [False positive rate](https://en.wikipedia.org/wiki/False_positive_rate) (FPR), [Fall-out](https://en.wikipedia.org/wiki/Information_retrieval), probability of false alarm = Σ False positive/Σ Condition negative | [Positive likelihood ratio](https://en.wikipedia.org/wiki/Positive_likelihood_ratio) (LR+) = TPR/FPR | [Diagnostic odds ratio](https://en.wikipedia.org/wiki/Diagnostic_odds_ratio) (DOR) = LR+/LR− | [F1 score](https://en.wikipedia.org/wiki/F1_score) = 1/1/Recall + 1/Precision/2 |
| [False negative rate](https://en.wikipedia.org/wiki/False_negative_rate) (FNR), Miss rate = Σ False negative/Σ Condition positive |  |  |