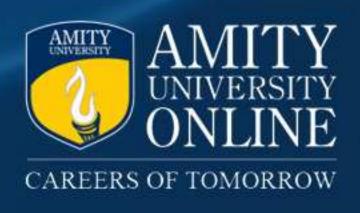
Accuracy measures the performance of classifier on basis of it performance on negative and positive class



# CLASSIFICATION METRICS VII

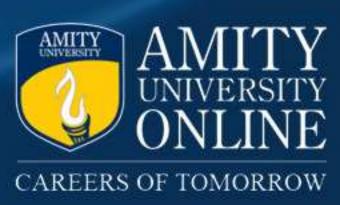
#### **Accuracy**

- Accuracy indicates the overall predictions performance of the classifier.
- Equation 7 represents the formula of computing accuracy.



Figure 54: Confusion Matrix Example

- Classification models with high accuracy are preferred. However, accuracy measure should only be used when the class distribution in the data set is nearly equal.
- In case of class imbalance, accuracy is not a good criteria to evaluate the performance of the classifier.



Precision is performance matrixes that judges how many true predictions were made by positive class.
 Recall is performance matrixes that calculates out of the total positive how many positive classes are

predicted by model.

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# CLASSIFICATION METRICS VIII

#### Precision

- Precision is the true predictions out of total prediction made by the model (including positive and negative).
- Precision can be measured for each individual class present in the data set.
- For the positive class, precision is the number of correct positive results divided by the number of positive results predicted by the classifier, refer 8.

Precision (positive class) = 
$$\frac{TP}{TP + FP}$$
 (8)

Precision for negative class is the number of correct negative results divided by the number of negative results predicted by the classifier, refer 9.

Precision (negative class) = 
$$\frac{TN}{TN + FN}$$
 (9)

For Confusion matrix in Figure 55,

Precision (positive class) = 
$$\frac{71}{71+7}$$
 = 91.02%

Precision (negative class) = 
$$\frac{62}{62 + 10}$$
 = 86.11%

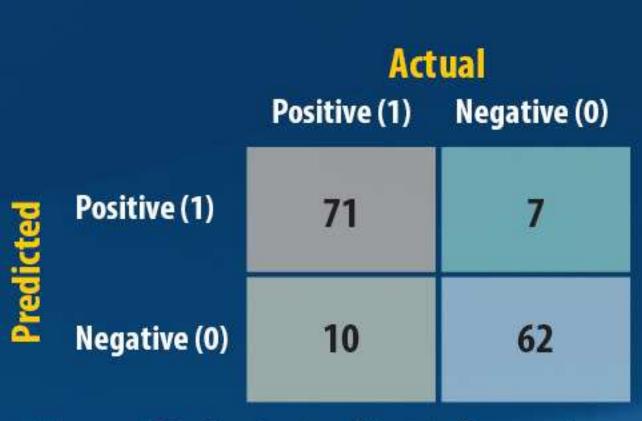
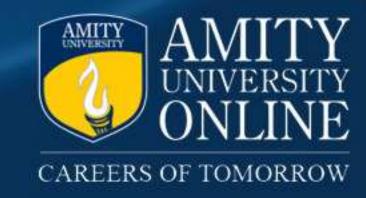


Figure 55: Confusion Matrix Example



## CLASSIFICATION METRICS IX

#### Recall

- Recall is the true predictions out of actual positive or negative class present in the data set.
- Recall can also be measured for each individual class present in the data set.
- For positive class (also known as sensitivity), it is the ratio of true positives to the actual positive samples present, refer Equation 10.

Recall (positive class) = 
$$\frac{TP}{TP+FN}$$
 (10)

 In case of negative class (also known as specificity), it is the ratio of true negatives to the actual negative samples present, refer Equation 11.

Recall (negative class) = 
$$\frac{TN}{TN+FP}$$
 (11)

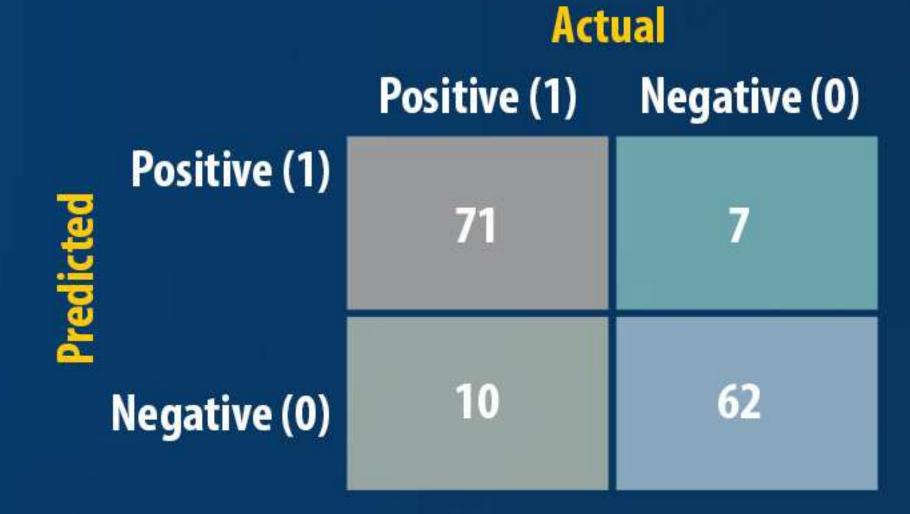
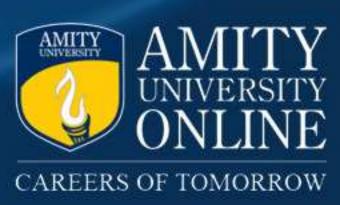


Figure 56: Confusion Matrix Example

• For Confusion matrix in Figure 56,

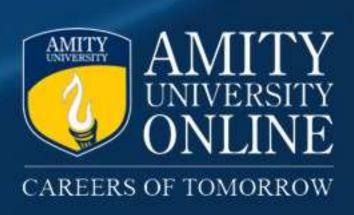
Recall (positive class) = 
$$\frac{71}{71+10} = 87.6\%$$

Recall (negative class) = 
$$\frac{62}{62+7}$$
 = 89.85%





Use Recall when most of the positive class has to be predicted.



## **CLASSIFICATION METRICS X**

#### **Precision and Recall**

- Precision and recall are very important measures to access the quality of classifier on bases of the classes present in the data set.
- A good classifier should give high precision and high recall. However, it also depends upon the application to fix the important measure between precision and recall.
- For example, in the problem of predicting email as "ham" or "spam", suppose the concern is good recall, i.e., we only worry
  about classification results where, classifier is able to find maximum samples belonging to a particular class correctly.

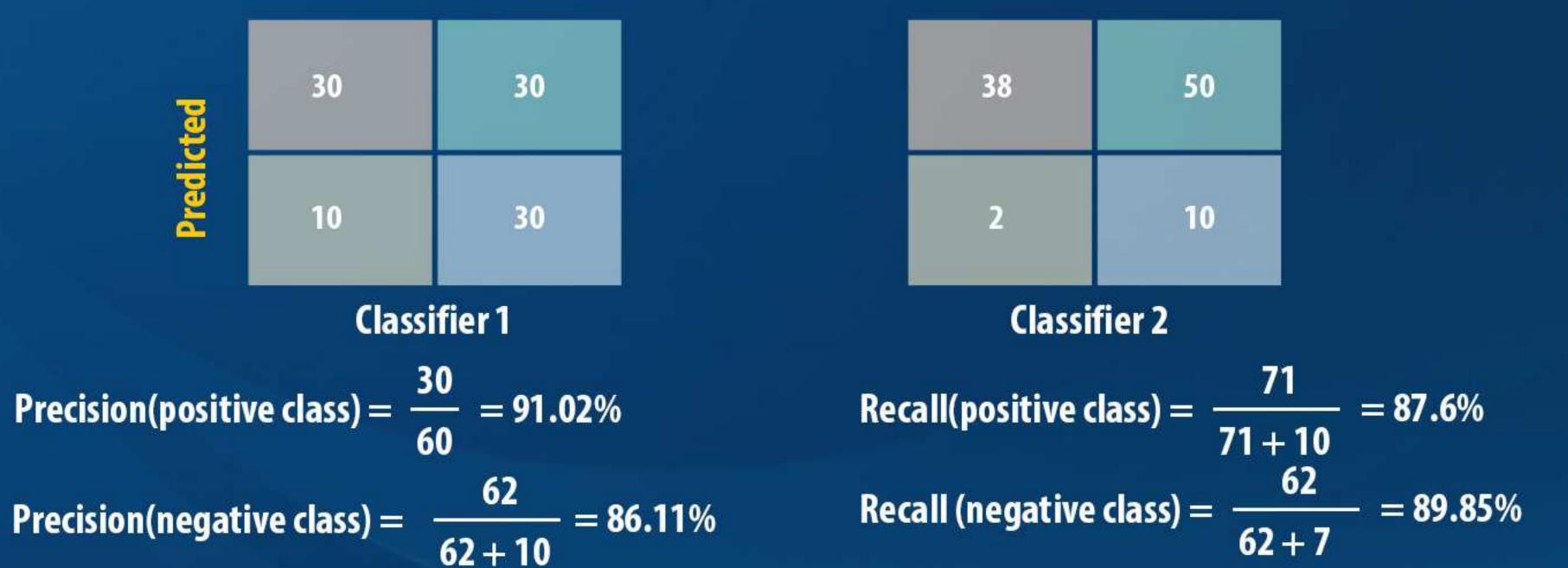
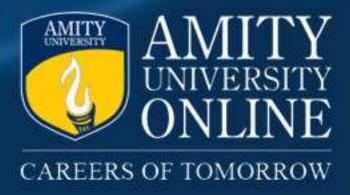
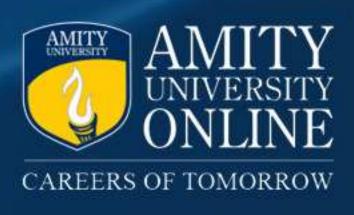


Figure 57: Confusion matrixes by two different classifiers



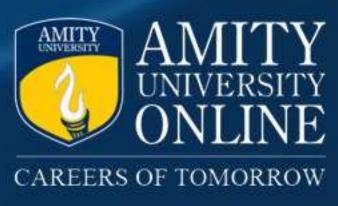
F1 Score is needed when you want to seek a balance between Precision and Recall as it takes both Precision and Recall into consideration.



## CLASSIFICATION METRICS XI

### F1-score

- F1-score is the weighted average of Precision and Recall.
- It is particularly important when it is hard to figure out what model to select on the basis of precision and recall.
- F1 score selects a model based on a balance between precision and recall. It is measured using Equation 12,



### **CLASSIFICATION METRICS XII**

### **F1-score Example**

Consider confusion matrixes in Figure 58 produced by two different models. Using F1-score, we need to find the better model with a balance of precision and recall.

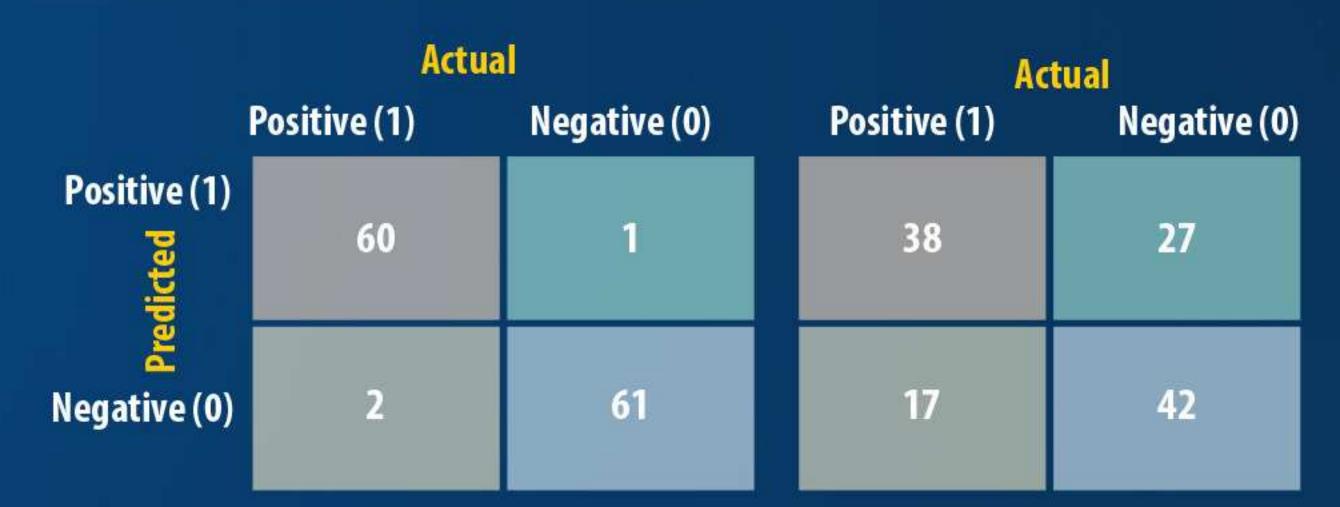


Figure 58: Confusion matrixes by two different classifiers

Using Equation 12, the F1-score of classifier 1 on positive class is as in Equation 13.

F 1 – score (classifier 1) = 
$$2 \times \frac{0.92 \times 0.98}{0.92 + 0.98} = 0.94$$
 (13)

F1-score on classifier 2 is computed using Equation 14.

F 1 – score (classifier 1) = 
$$2 \times \frac{0.58 \times 0.69}{0.58 + 0.69} = 0.62$$
 (14)

Based on F1-score, classifier 1 is better than classifier 2.

