One vs one, one vs all
Confusion matrix

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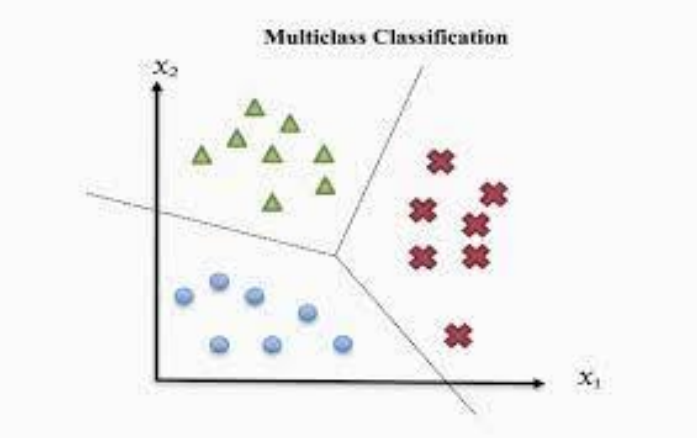
What is Multi-class Classification?

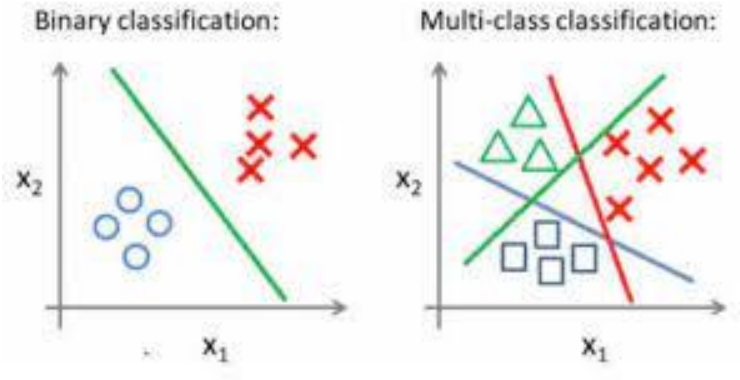
- Multi-class classification is the classification technique that allows us to categorize the test data into multiple class labels present in trained data as a model prediction.
- There are mainly two types of multi-class classification techniques:
  - One vs. All (one-vs-rest)
  - One vs. One



Binary classification vs. Multi-class classification

Binary Classification

- Only two class: instances are present in the dataset.
- It requires only one classifier model.
- Confusion Matrix is easy to derive and understand.
- Example:- Check email is spam or not, predicting gender b ased on height and weight.

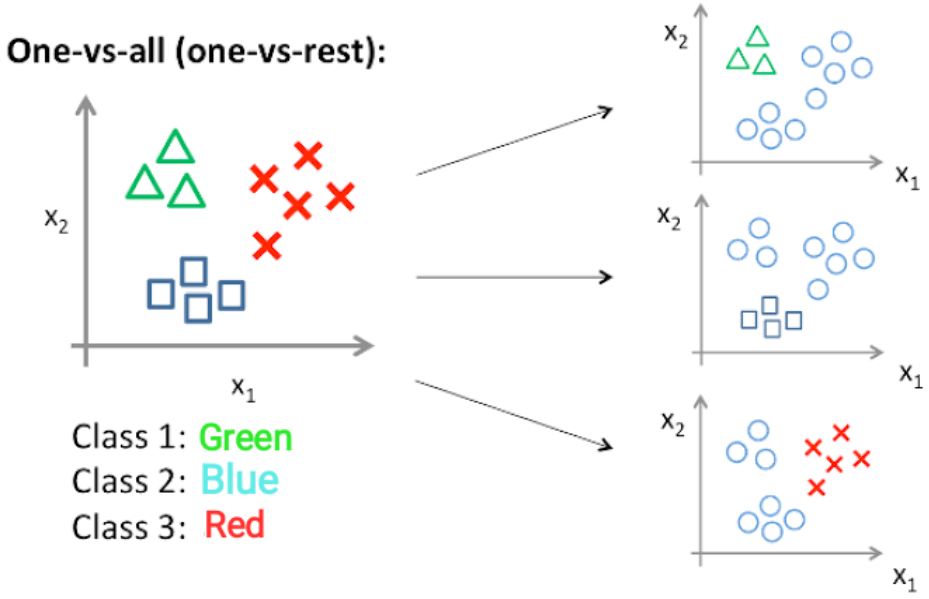


Binary classification vs. Multi-class classification

Multi-class Classification

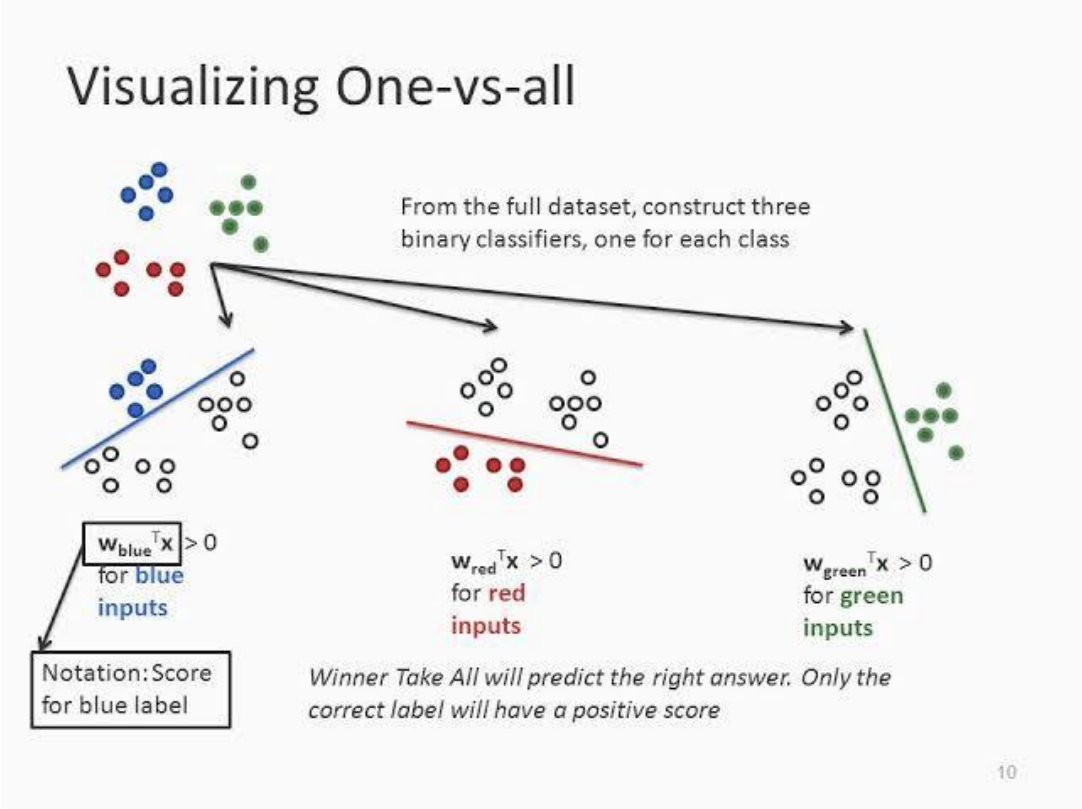
- Multiple class labels are present in the dataset.
- The number of classifier models depends on the classification technique we are applying to.
- One vs. All: N-class instances then N binary classifier models
- One vs. One: N-class instances then N* (N-1)/2 binary classifier models
- The Confusion matrix is easy to derive but complex to understand.
- Example: Check whether the fruit is apple, banana, or orange.

One vs. All (One vs rest)

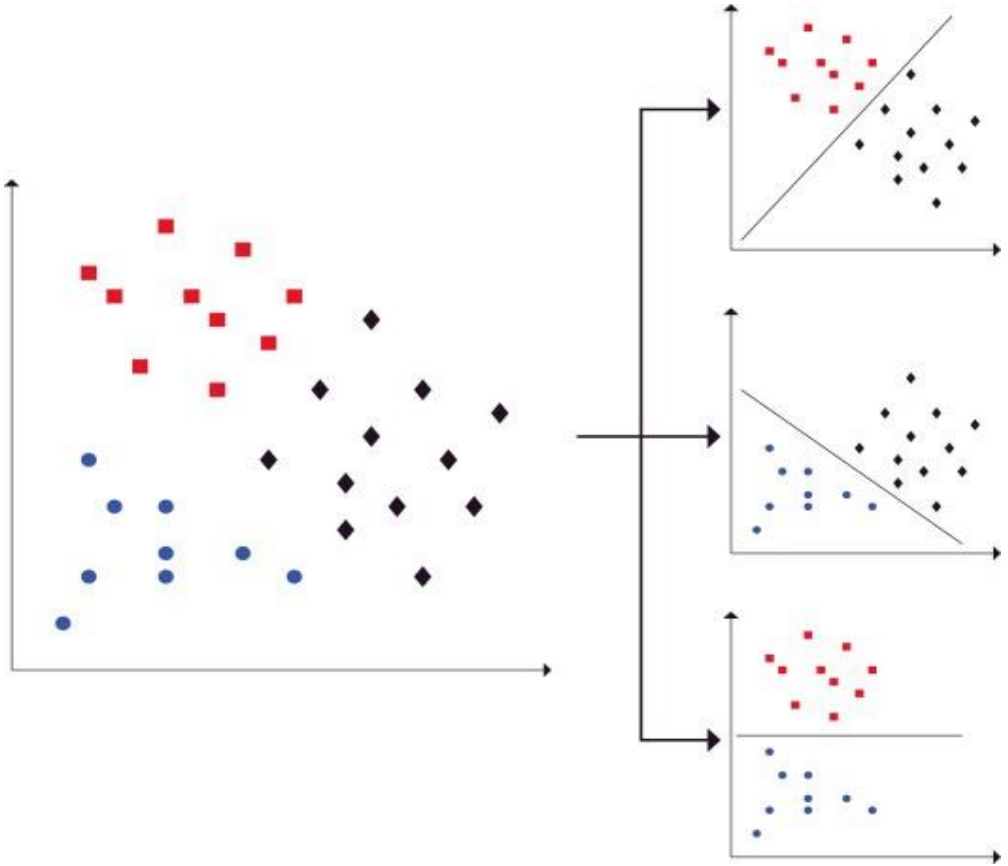


Classifier 1:- [Green] vs [Red, Blue]
Classifier 2:- [Blue] vs [Green, Red]
Classifier 3:- [Red] vs [Blue, Green]

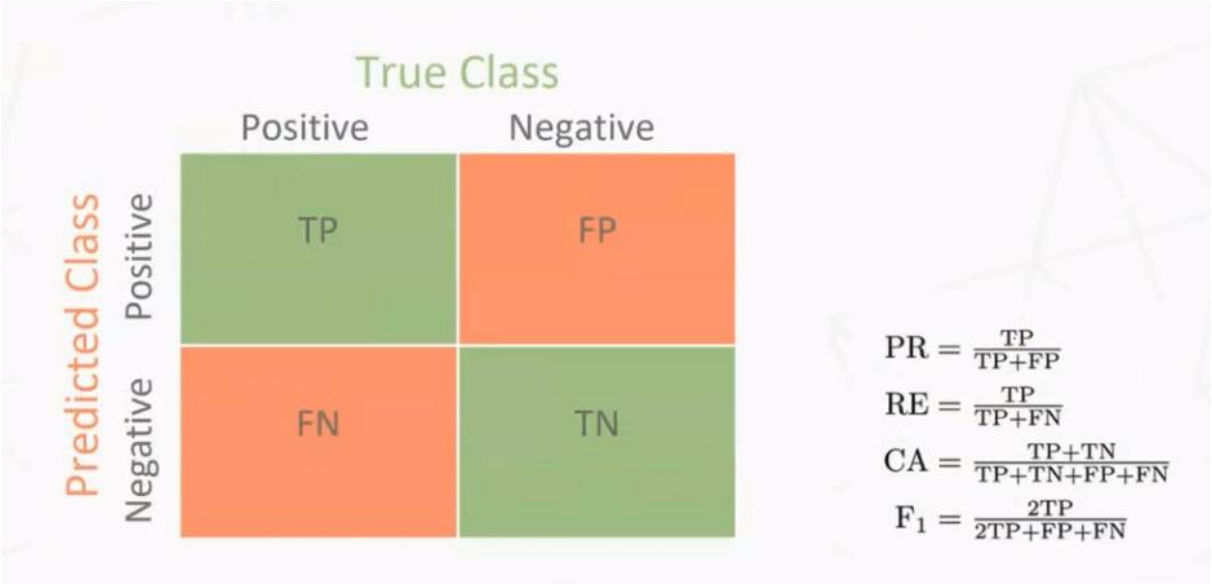
One vs. All (One vs rest)



One vs. One



Confusion matrix



$$\mathrm{PR} = \frac{\mathrm{TP}}{\mathrm{TP}+\mathrm{FP}}$$

$$\mathrm{RE} = \frac{\mathrm{TP}}{\mathrm{TP}+\mathrm{FN}}$$

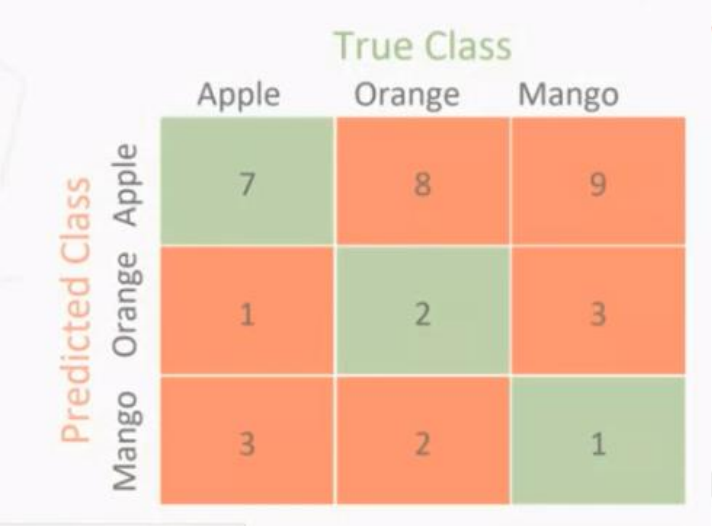
$$\mathrm{CA} = \frac{\mathrm{TP}+\mathrm{TN}}{\mathrm{TP}+\mathrm{TN}+\mathrm{FP}+\mathrm{FN}}$$

$$\mathrm{F}_1 = \frac{2\mathrm{TP}}{2\mathrm{TP}+\mathrm{FP}+\mathrm{FN}}$$

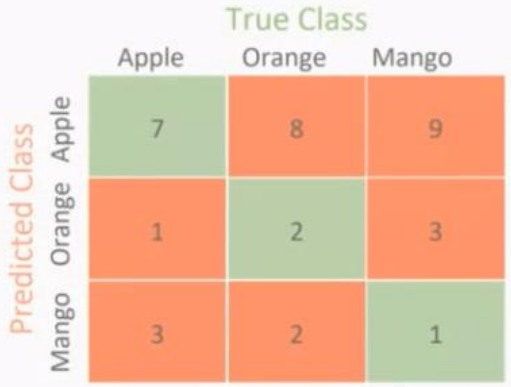
Confusion matrix

Unlike binary classification, there are no positive or negative classes here. At first, it might be a little difficult to find TP, TN, FP and FN since there are no positive or negative or negative classes, but it's actually Pretty easy. What we have to do here is to find TP, TN, FP and FN for each individual class. For example, if we take class Apple, then let's see what are the values of the metrics from the confusion matrix.

- TP = 7
- TN = (2+3+2+1) = 8
- FP = (8+9) = 17
- FN = (1+3) = 4
- Precision = 7/(7+17) = 0.29
- Recall = 7/(7+4) = 0.64
- F1-score = 0.40



Confusion matrix



Class	Precision	Recall	F1-score
Apple	0.29	0.64	0.40
Orange	0.33	0.17	0.22
Mango	0.17	0.08	0.11

Thanks!!!

Any question?