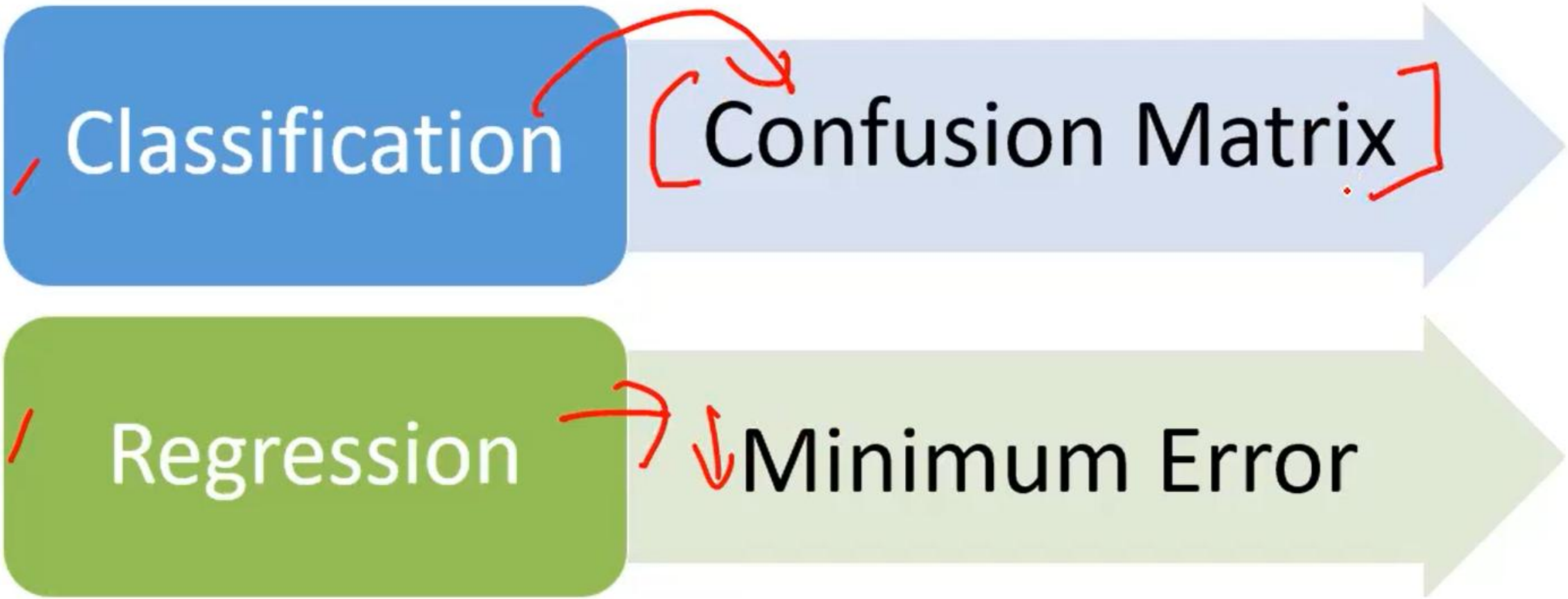
Validating Parameter For Supervised Learning



400 rows × 4 columns

Balanced

```
In [12]: dataset["Purchased"].value_counts()
```

```
Out[12]: 0    257
         1    143
         Name: Purchased, dtype: int64
```

400 rows × 4 columns

Imbalanced

```
In [12]: dataset["Purchased"].value_counts()
```

```
Out[12]: 0    257
         1    143
         Name: Purchased, dtype: int64
```

```
In [13]: indep=dataset[["Age","EstimatedSalary","Gender_Male"]]
         dep=dataset["Purchased"]
```

In [16]:
```
#split into training set and test
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(indep, dep, test_size = 1/3, random_state = 0)
```

In [17]:
```
from sklearn.ensemble import RandomForestClassifier
classifier = RandomForestClassifier(n_estimators = 10, criterion = 'entropy', random_state = 0)
classifier.fit(X_train, y_train)
```

Out[17]:
```
RandomForestClassifier(criterion='entropy', n_estimators=10, random_state=0)
```

:
```
y_pred = classifier.predict(X_test)
```

:
```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
```

:
```
print(cm)
```

```
[[78  7]
 [ 6 43]]
```

In [21]:
```
from sklearn.metrics import classification_report
clf_report = classification_report(y_test, y_pred)
```

In [22]:
```
print(clf_report)
```

```
              precision    recall  f1-score   support

           0       0.93      0.92      0.92        85
           1       0.86      0.88      0.87        49

    accuracy                           0.90       134
   macro avg       0.89      0.90      0.90       134
weighted avg       0.90      0.90      0.90       134
```

Validating Parameter For Supervised Learning

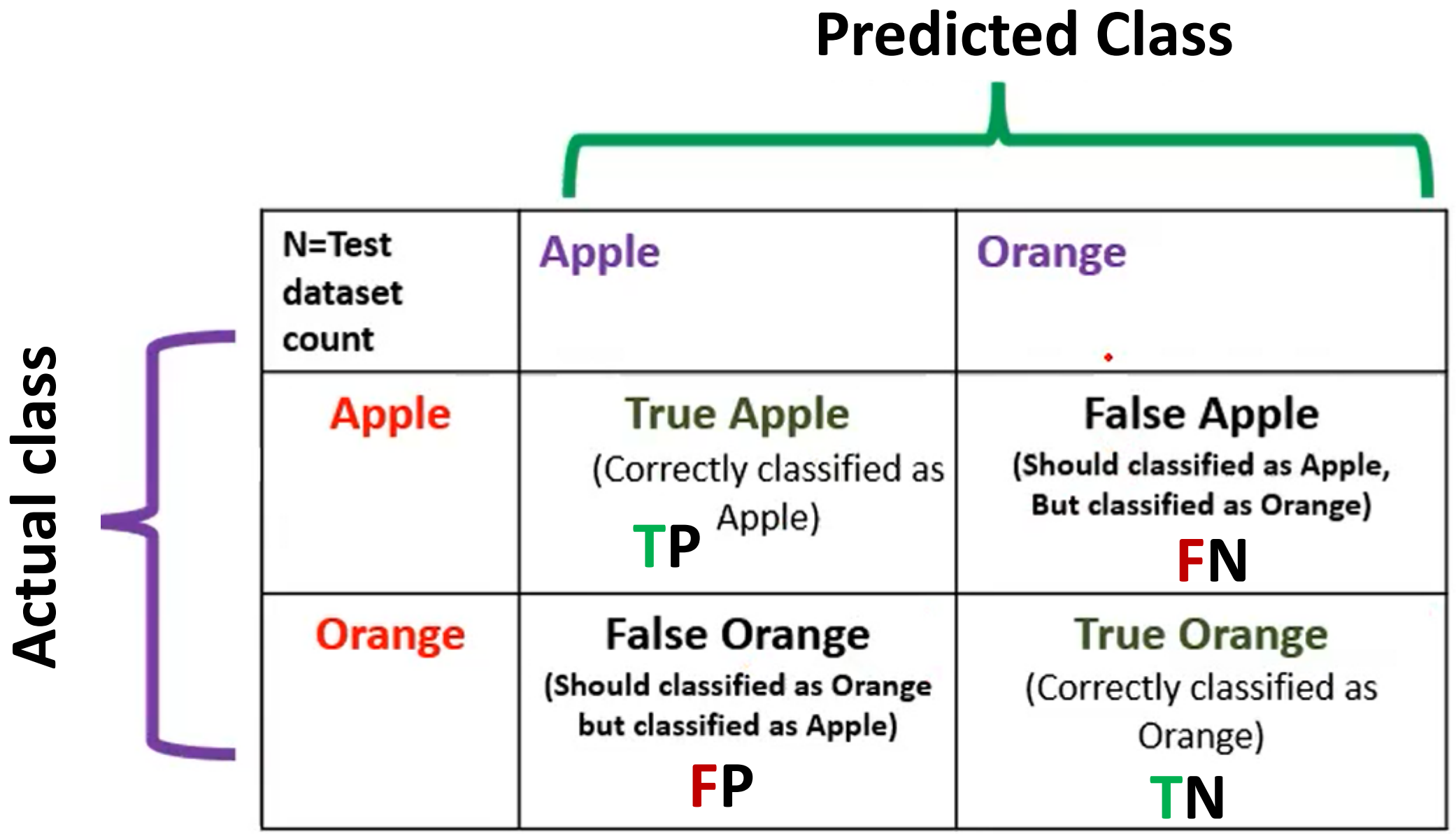
Classification → Confusion Matrix

Actual	Prediction +ve	Prediciton -ve
+ve	+ve TP	-ve FN
-ve	+ve FP	-ve TN

Predicted Class

Actual Class

N=	Positive	Negative	
Positive	True Positive (TP)	False Negative (FN) Error I	**Sensitivity** $\frac{TP}{(TP+FN)}$
Negative	False Positive (FP) Error II	True Negative (TN)	**Specificity** $\frac{TN}{(TN+FP)}$
	Precision $\frac{TP}{(TP+FP)}$	**Negative Predictive Value** $\frac{TN}{(TN+FN)}$	**Accuracy** $\frac{TP+TN}{(TP+TN+FP+FN)}$


Predicted Class
Actual class
N=Test dataset count
Apple
Orange
Apple
True Apple
(Correctly classified as Apple)
TP
False Apple
(Should classified as Apple, But classified as Orange)
FN
Orange
False Orange
(Should classified as Orange but classified as Apple)
FP
True Orange
(Correctly classified as Orange)
TN

Evaluation Metrics using Confusion Metrics

Accuracy

F1 Score

Recall

Macro Average

Precision

Weighed Average

Degree of Correctness → Precision

- It tells **how correct your positive predictions are**.
- Formula:

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

- Focuses on **quality** of positive predictions.

👉 Example: If your model predicts 10 patients as "disease-positive" but only 7 are truly positive → Precision = 70%.

✅ **Degree of Completeness → Recall**

- It tells **how many of the actual positives were captured**.
- Formula:

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

- Focuses on **coverage** of actual positives.

👉 Example: If there are 20 disease patients and your model finds 15 → Recall = 75%.

📌 **In short:**

- **Precision (correctness)** = Of the predicted positives, how many are truly positive?
- **Recall (completeness)** = Of the actual positives, how many did we successfully predict?

Evaluation Metrics-Accuracy

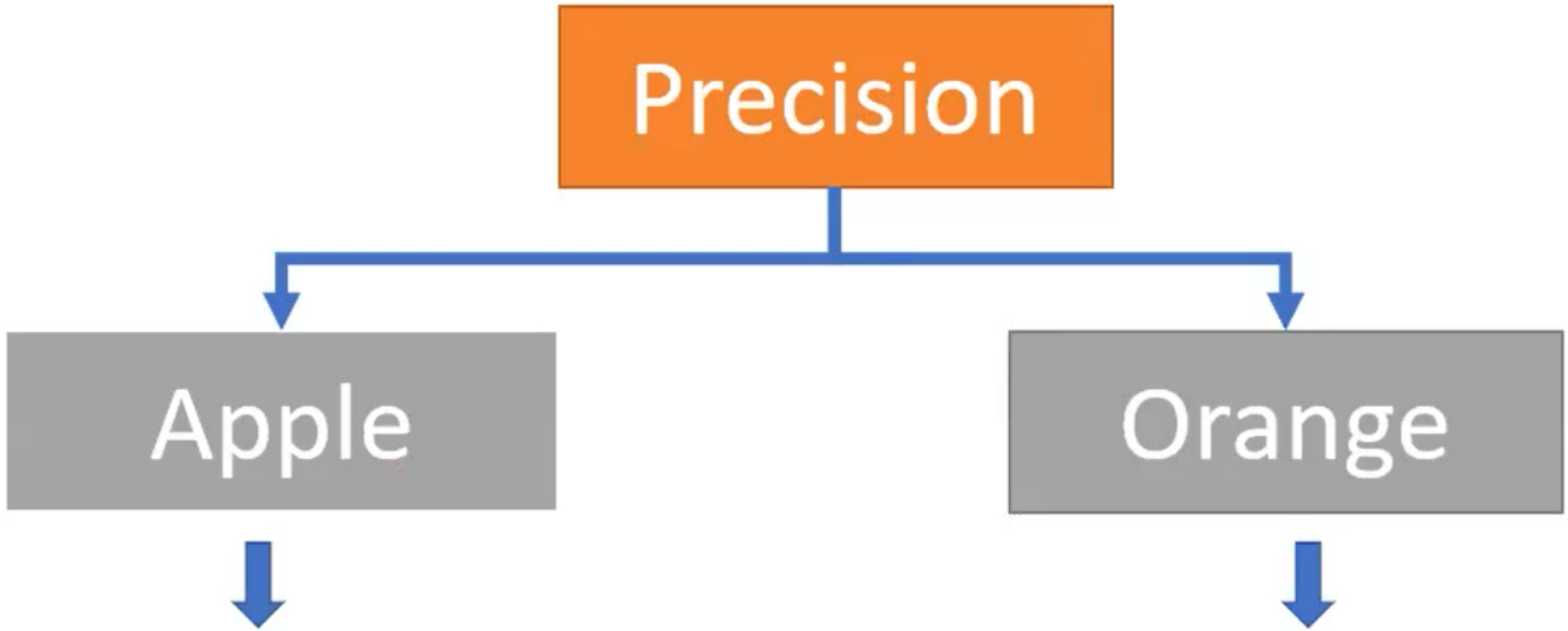
78	7
6	43

Question:

What is the percentage of correct classification of both(Apple & Orange) to the total input of the test set?

$$\text{Accuracy} \Rightarrow \frac{T(\text{Apple})+T(\text{orange})}{T(\text{Apple})+T(\text{Orange})+F(\text{Apple})+F(\text{Orange})}$$

$$\text{Accuracy} \Rightarrow \frac{78+43}{78+7+43+6} \Rightarrow \frac{121}{134} \Rightarrow 0.90$$



What is the percentage of correct classification of (Apple) to sum of correctly Classified as (Apple) and wrongly classified as (Apple) in the test set?

What is the percentage of correct classification of (Orange) to sum of correctly Classified as (Orange) and wrongly classified as (Orange) in the test set?

Precision talks about correctly and wrong classification of the class

Evaluation Metrics-Precision

Total count in the Test set=134
Total count of Apple in the Test set=85
Total count of Orange in the test set=49

78	7
6	43

Precision

Apple

What is the percentage of correct classification of (Apple) to sum of correctly Classified as (Apple) and wrongly classified as (Apple) in the test set?

$$\frac{T(Apple)}{T(Apple)+F(Orange)} \rightarrow \frac{78}{78+6}$$

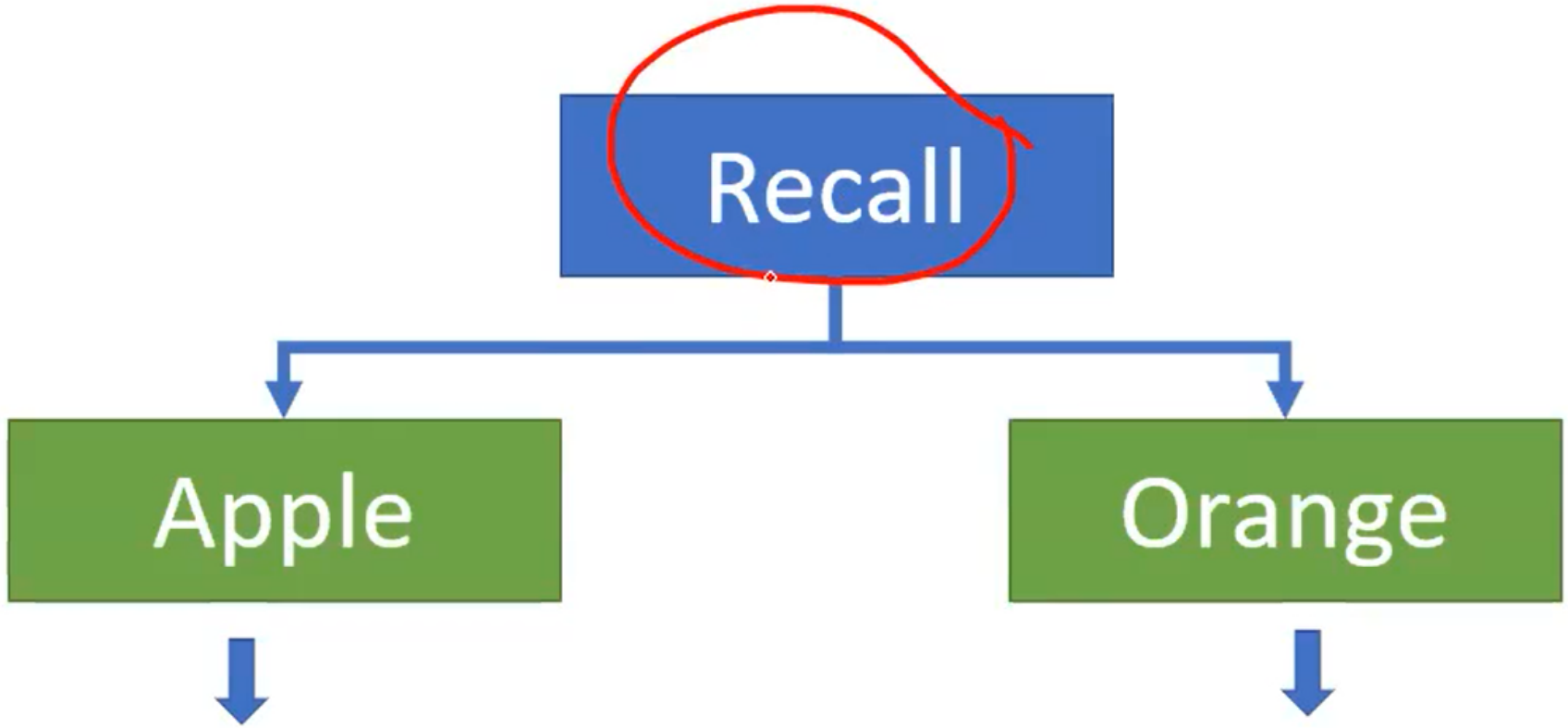
$$\frac{78}{84} \rightarrow 0.93$$

Orange

What is the percentage of correct classification of (Orange) to sum of correctly Classified as (Orange) and wrongly classified as (Orange) in the test set?

$$\frac{43}{50} \leftarrow 0.86$$

Evaluation Metrics-Recall



What is the percentage of correct classification of(Apple) to the total input of (Apple) in the test set?

What is the percentage of correct classification of(Orange) to the total input of (Orange) in the test set?

Recall talks about only correctly classified class

Evaluation Metric-Recall

Total count in the Test set=134
Total count of Apple in the Test set=85
Total count of Orange in the test set=49

78	7
6	43

Recall

Apple

Orange

Evaluation Metrics-Recall

What is the percentage of correct classification of(Apple) to the total input of (Apple) in the test set?

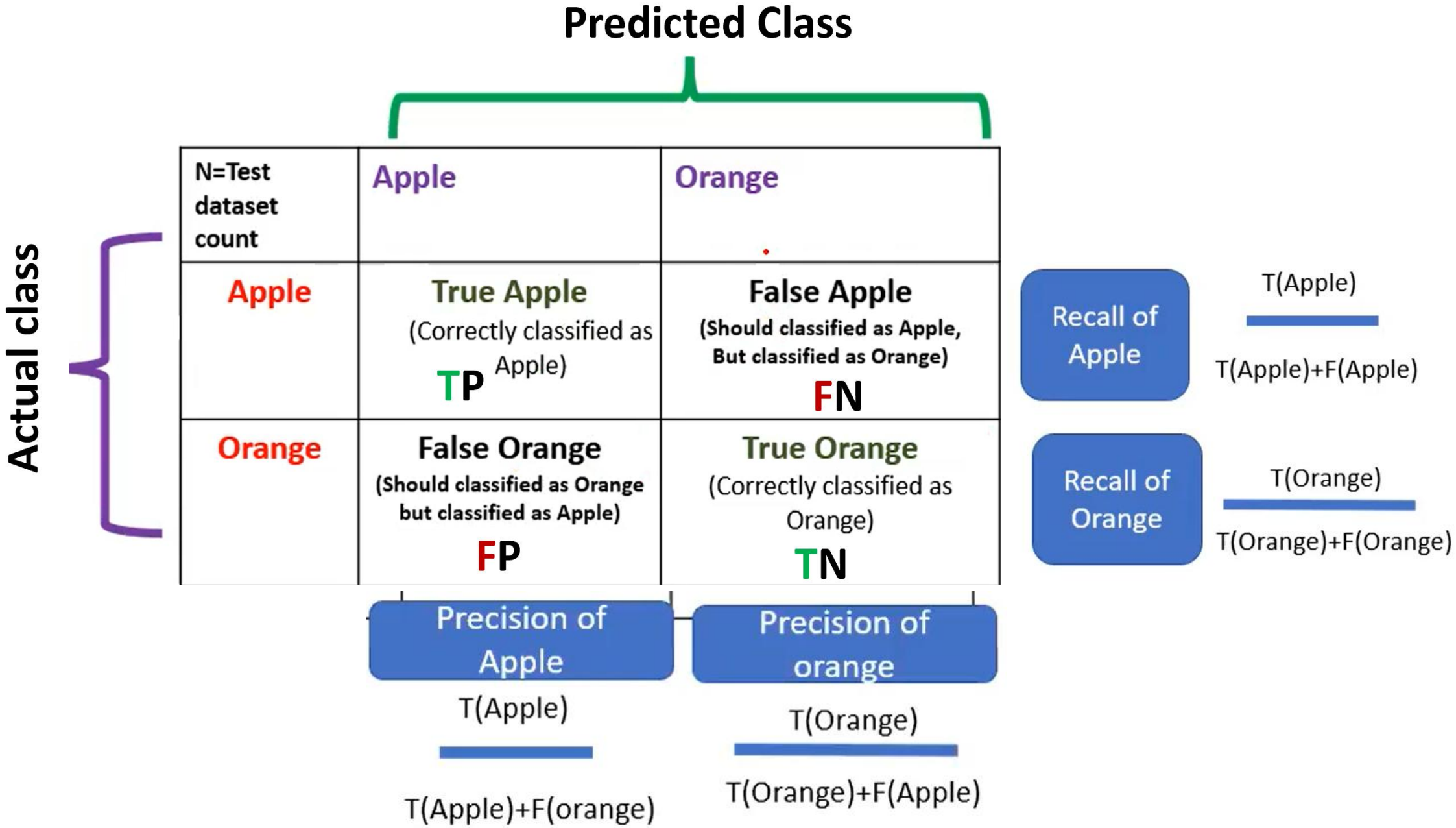
$$\frac{T(Apple)}{\text{Total input(Apple) in the test set}} \rightarrow \frac{T(Apple)}{T(Apple)+F(Apple)}$$

$$\frac{78}{85} \rightarrow 0.92$$

What is the percentage of correct classification of(Orange) to the total input of (Orange) in the test set?

$$\frac{T(Orange)}{\text{Total input(Orange) in the test set}} \leftarrow \frac{T(Orange)}{T(Orange)+F(Orange)}$$

$$\frac{43}{49} \leftarrow 0.88$$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TP
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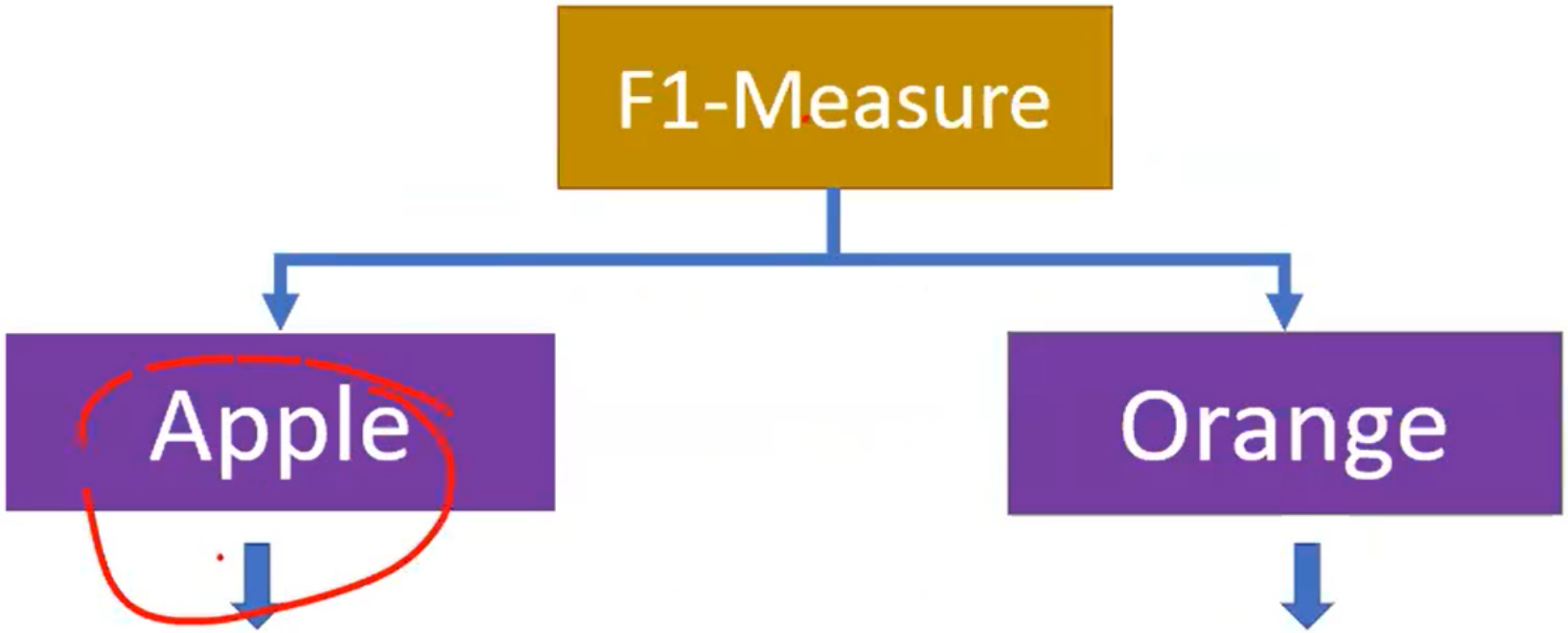
(Should classified as Apple, But classified as Orange)
FN
Orange
False Orange
(Should classified as Orange but classified as Apple)
FP
True Orange
(Correctly classified as Orange)
TN
Recall of Apple
T(Apple)
T(Apple)+F(Apple)
Recall of Orange
T(Orange)
T(Orange)+F(Orange)
Precision of Apple
T(Apple)
T(Apple)+F(orange)
Precision of orange
T(Orange)
T(Orange)+F(Apple)

Evaluation Metrics-F1 Measure



What is the overall performance of Apple?

What is the overall performance of Orange?

What if the recall value is high and Precision value is low. How will you validate your model performance?

Evaluation Metrics-F1 measure

Total count in the Test set=134
Total count of Apple in the Test set=85
Total count of Orange in the test set=49

78	7
6	43

F1 -measure

Apple

What is the overall performance of Apple?

$$2* \frac{\text{Recall}*\text{Precision}}{\text{Recall} + \text{Precision}} \rightarrow \frac{2*0.92*0.93}{0.92+0.93}$$

0.92

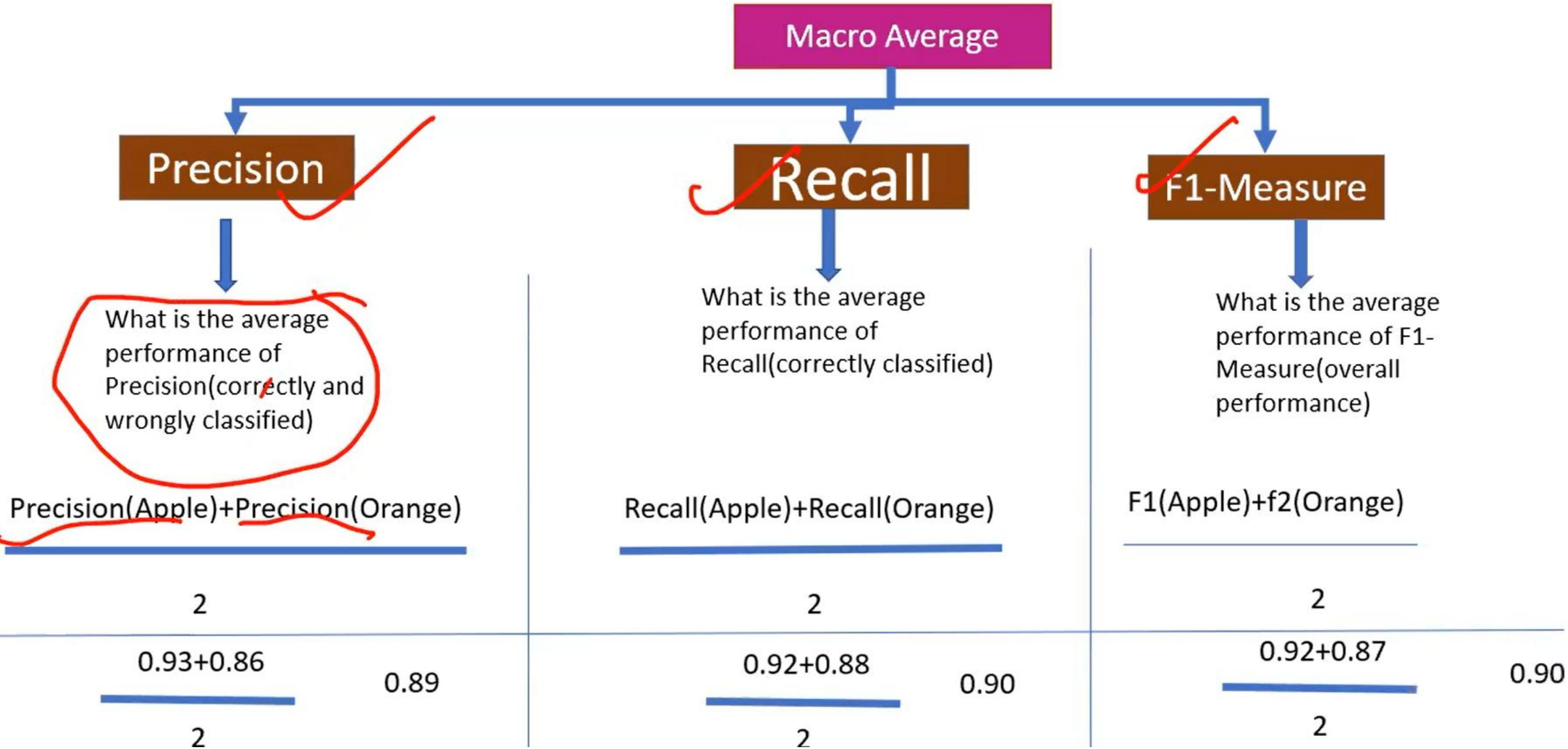
Orange

What is the overall performance of Orange?

$$2* \frac{\text{Recall}*\text{Precision}}{\text{Recall} + \text{Precision}} \leftarrow \frac{2*0.88*0.86}{0.88+0.86}$$

0.87

Evaluation Metrics-Macro Average



Evaluation Metrics: Weighted Average

Total count in the Test set=134
Total count of Apple in the Test set=85
Total count of Orange in the test set=49

78	7
6	43

Weighted Average

Precision	Recall	F1-Measure
What is the sum of product of proportion rate(Weight) of each class?	What is the sum of product of proportion rate(Weight) of each class?	What is the sum of product of proportion rate(Weight) of each class?
Precision(Apple)*(85/134)+Precision(Orange)*(49/134)	Recall(Apple) *(85/134)+Recall(Orange) *(49/134)	F1(Apple) *(85/134)+ f2(Orange) *(49/134)
0.90	0.90	0.90

Confusion Matrix for Multiple Class