COURSE NAME: ARTIFICIAL INTELLIGENCE
COURSE CODE: CIS 412

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CONFUSION MATRIX

- **Confusion Matrix:** A confusion matrix is a performance measurement for machine learning algorithms.

	Predicted class		
Actual Class		Class = Yes	Class = No
	Class = Yes	True Positive	False Negative
	Class = No	False Positive	True Negative

TRUE POSITIVE, TRUE NEGETIVE

- **True Positive (TP):** These are the correctly predicted positive values which means that the value of actual class is yes and the value of predicted class is also yes. Example: If actual class value indicates that this passenger survived and predicted class tells you the same thing.
- **True Negative (TN):** These are the correctly predicted negative values which means that the value of actual class is no and value of predicted class is also no. Example: if actual class says this passenger did not survive and predicted class tells you the same thing.

		Predicted class	
Actual Class		Class = Yes	Class = No
	Class = Yes	True Positive	False Negative
	Class = No	False Positive	True Negative

FALSE POSITIVE, FALSE NEGATIVE

- **False Positive (FP):** When actual class is no and predicted class is yes. Example: if actual class says this passenger did not survive but predicted class tells you that this passenger will survive.
- **False Negative (FN):** When actual class is yes but predicted class is no. Example: if actual class indicates that this passenger survived and predicted class tells you that passenger will die.

		Predicted class	
Actual Class		Class = Yes	Class = No
	Class = Yes	True Positive	False Negative
	Class = No	False Positive	True Negative

PRECISION

- **Precision:** Precision is the ratio of correctly predicted positive observations to the total predicted positive observations. High precision relates to the low false positive rate.
- **Example:** you would want greater precision is **spam filters**. A greater number of false positives in a spam filter would mean that one or more important emails could be tagged as spam and moved in spam folders.

$$
\begin{aligned}
precision &= \frac{TP}{TP + FP} \\
recall &= \frac{TP}{TP + FN} \\
F1 &= \frac{2 \times precision \times recall}{precision + recall} \\
accuracy &= \frac{TP + TN}{TP + FN + TN + FP} \\
specificity &= \frac{TN}{TN + FP}
\end{aligned}
$$

RECALL

- **Recall:** Recall is the ratio of correctly predicted positive observations to the all observations in actual class-yes.
- **Example:** In medical diagnosis, the recall score should be extremely high otherwise greater number of false negative would prove to be fatal for life of patients.

$$
\begin{aligned}
precision &= \frac{TP}{TP + FP} \\
recall &= \frac{TP}{TP + FN} \\
F1 &= \frac{2 \times precision \times recall}{precision + recall} \\
accuracy &= \frac{TP + TN}{TP + FN + TN + FP} \\
specificity &= \frac{TN}{TN + FP}
\end{aligned}
$$

F1 SCORE

- **F1-Score:** F1 score is the weighted average of Precision and Recall. That is, a good F1 Score means that you have low false positive and low false negatives. An F1 score is considered perfect when it's 1, while the model is a total failure when it's 0.

$$
\begin{aligned}
precision &= \frac{TP}{TP + FP} \\
recall &= \frac{TP}{TP + FN} \\
F1 &= \frac{2 \times precision \times recall}{precision + recall} \\
accuracy &= \frac{TP + TN}{TP + FN + TN + FP} \\
specificity &= \frac{TN}{TN + FP}
\end{aligned}
$$

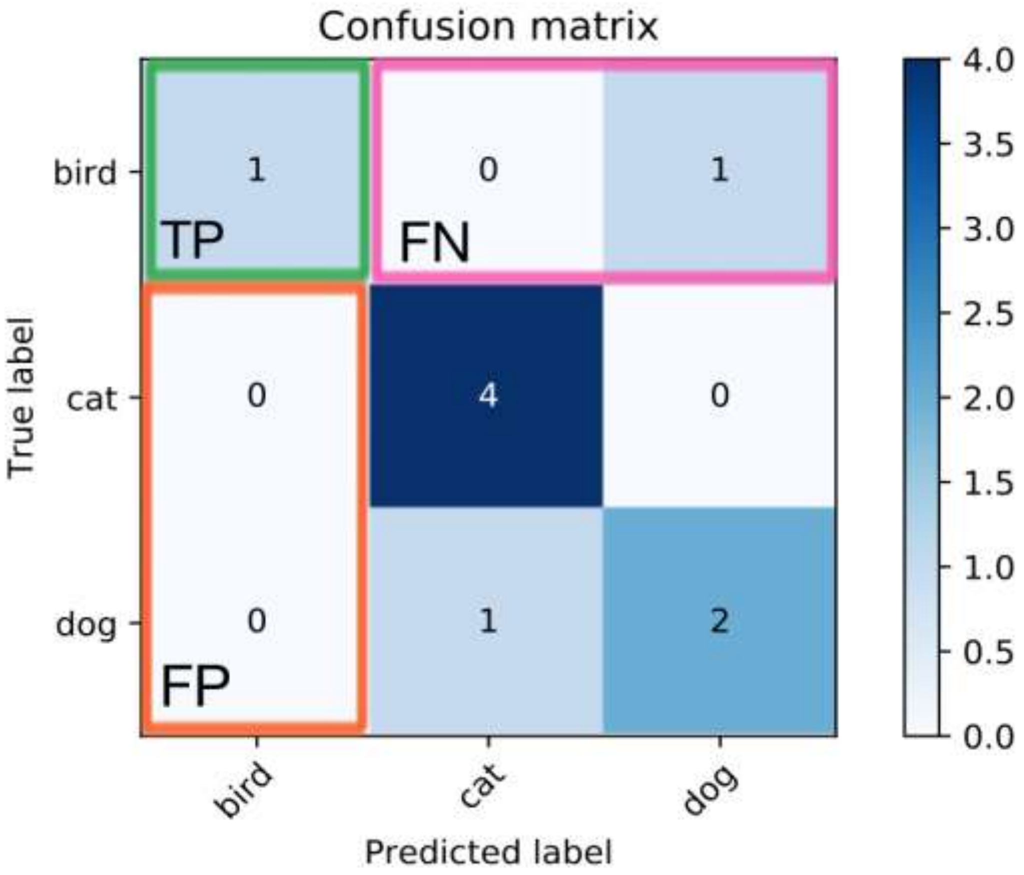
ACCURACY

- **Accuracy:** Accuracy is the most intuitive performance measure and it is simply a ratio of correctly predicted observation to the total observations.
- Accuracy can tell us immediately whether a model is being trained correctly and how it perform generally.

$$
\begin{aligned}
precision &= \frac{TP}{TP + FP} \\
recall &= \frac{TP}{TP + FN} \\
F1 &= \frac{2 \times precision \times recall}{precision + recall} \\
accuracy &= \frac{TP + TN}{TP + FN + TN + FP} \\
specificity &= \frac{TN}{TN + FP}
\end{aligned}
$$

KNN

Setosa
Versicolor
Virginica
True label
13
0
0
0
20
0
0
0
12
Setosa
Versicolor
Virginica
Predicted label
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0



Confusion matrix
bird
cat
dog
True label
1
0
1
TP
FN
0
4
0
0
1
2
FP
bird
cat
dog
Predicted label
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

EXAMPLE

TRUE POSITIVE

FALSE NEGATIVE

FALSE POSITIVE

TRUE NEGATIVE

EXAMPLE

- We will now go back to the earlier example of classifying 100 people (which includes 40 pregnant women and the remaining 60 are not pregnant women and men with a fat belly) as pregnant or not pregnant. Out of 40 pregnant women 30 pregnant women are classified correctly and the remaining 10 pregnant women are classified as not pregnant by the machine learning algorithm. On the other hand, out of 60 people in the not pregnant category, 55 are classified as not pregnant and the remaining 5 are classified as pregnant.

	Predicted Positives	Predicted Negatives
Positives	True Positives	False Negatives
Negatives	False Positives	True Negatives

EXAMPLE

- **TN = 55, FP = 5, FN = 10, TP = 30**

- PRECISION=TP/(TP+FP)=30/(30+5) = 0.857
- RECALL=TP/(TP+FN)=30/(30+10) = 0.75
- F1-SCORE=2*(PRECISION * RECALL)/
  (PRECISION + RECALL)=
  2*(0.857*0.75)/(0.857+0.75)=0.799
-
- ACCURACY= (TN+TP)/(TN+FP+TP+FN)=
  (55+30)/(55+5+30+10) = 0.85