Thresholding

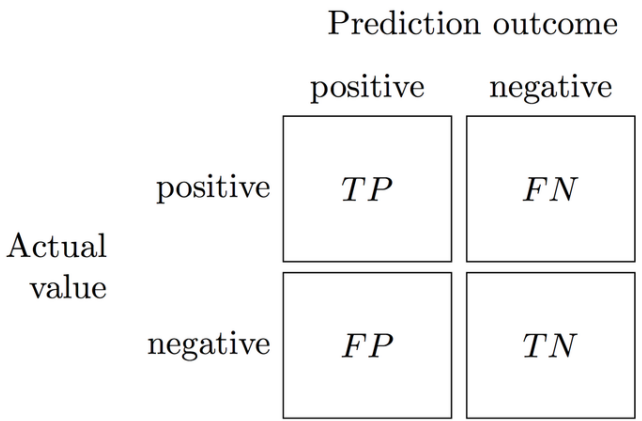
Confusion Matrix

		Prediction outcome: positive	Prediction outcome: negative
Actual value	positive	TP	FN
	negative	FP	TN

Confusion Matrix

$$TPR = \frac{TP}{TP + FN}$$

$$TNR = \frac{TN}{FP + TN}$$



$$FPR = \frac{FP}{FP + TN}$$

$$FNR = \frac{FN}{TP + FN}$$

Calculating Different Metrics

ID	Actual Values	Predicted Values
ID1	1	1
ID2	0	1
ID3	1	0
ID4	1	0
ID5	0	0
ID6	1	1
ID7	1	1
ID8	0	1

Calculating Different Metrics

ID	Actual Values	Predicted Values	
ID1	1	1	TP
ID2	0	1	FP
ID3	1	0	FN
ID4	1	0	FN
ID5	0	0	TN
ID6	1	1	TP
ID7	1	1	TP
ID8	0	1	FP

True Positive Rate and False Positive Rate

ID	Actual Values	Predicted Values	
ID1	1	1	TP
ID2	0	1	FP
ID3	1	0	FN
ID4	1	0	FN
ID5	0	0	TN
ID6	1	1	TP
ID7	1	1	TP
ID8	0	1	FP

$$TPR = \frac{TP}{TP + FN}$$

$$FPR = \frac{FP}{FP + TN}$$

Analytics Vidhya
Learn everything about analytics

True Negative Rate and False Negative Rate

ID	Actual Values	Predicted Values	
ID1	1	1	TP
ID2	0	1	FP
ID3	1	0	FN
ID4	1	0	FN
ID5	0	0	TN
ID6	1	1	TP
ID7	1	1	TP
ID8	0	1	FP

$$TNR = \frac{TN}{FP + TN}$$

$$FNR = \frac{FN}{TP + FN}$$

Analytics Vidhya
Learn everything about analytics

Predicted Probabilities

ID	Actual Values	Predicted probabilities
ID1	1	0.9
ID2	0	0.51
ID3	1	0.47
ID4	1	0.32
ID5	0	0.1
ID6	1	0.94
ID7	1	0.78
ID8	0	0.56

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At 0.5
ID1	1	0.9	1
ID2	0	0.51	1
ID3	1	0.47	0
ID4	1	0.32	0
ID5	0	0.1	0
ID6	1	0.94	1
ID7	1	0.78	1
ID8	0	0.56	1

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At 0.5	
ID1	1	0.9	1	TP
ID2	0	0.51	1	FP
ID3	1	0.47	0	FN
ID4	1	0.32	0	FN
ID5	0	0.1	0	TN
ID6	1	0.94	1	TP
ID7	1	0.78	1	TP
ID8	0	0.56	1	FP

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At 0.5	
ID1	1	0.9	1	TP
ID2	0	0.51	1	FP
ID3	1	0.47	0	FN
ID4	1	0.32	0	FN
ID5	0	0.1	0	TN
ID6	1	0.94	1	TP
ID7	1	0.78	1	TP
ID8	0	0.56	1	FP

TPR = 0.6

FNR = 0.4

TNR = 0.33

FPR = 0.66

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At 0.5	
ID1	1	0.9	1	TP
ID2	0	0.51	**1**	FP
ID3	1	0.47	**0**	FN
ID4	1	0.32	**0**	FN
ID5	0	0.1	0	TN
ID6	1	0.94	1	TP
ID7	1	0.78	1	TP
ID8	0	0.56	**1**	FP

TPR = 0.6

FNR = 0.4

TNR = 0.33

FPR = 0.66

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At 0.5	
ID1	1	0.9	1	TP
ID2	0	0.51	**1**	FP
ID3	1	0.47	**0**	FN
ID4	1	0.32	**0**	FN
ID5	0	0.1	0	TN
ID6	1	0.94	1	TP
ID7	1	0.78	1	TP
ID8	0	0.56	**1**	FP

1. Retrain Model

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At 0.5	
ID1	1	0.9	1	TP
ID2	0	0.51	**1**	FP
ID3	1	0.47	**0**	FN
ID4	1	0.32	**0**	FN
ID5	0	0.1	0	TN
ID6	1	0.94	1	TP
ID7	1	0.78	1	TP
ID8	0	0.56	**1**	FP

1. Retrain Model
2. Change

   Threshold

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At threshold 0.4
ID1	1	0.9	1
ID2	0	0.51	**1**
ID3	1	0.47	1
ID4	1	0.32	**0**
ID5	0	0.1	0
ID6	1	0.94	1
ID7	1	0.78	1
ID8	0	0.56	**1**

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At threshold 0.4	
ID1	1	0.9	1	TP
ID2	0	0.51	**1**	**FP**
ID3	1	0.47	1	TP
ID4	1	0.32	**0**	**FN**
ID5	0	0.1	0	TN
ID6	1	0.94	1	TP
ID7	1	0.78	1	TP
ID8	0	0.56	**1**	**FP**

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At threshold 0.4	
ID1	1	0.9	1	TP
ID2	0	0.51	**1**	**FP**
ID3	1	0.47	1	TP
ID4	1	0.32	**0**	**FN**
ID5	0	0.1	0	TN
ID6	1	0.94	1	TP
ID7	1	0.78	1	TP
ID8	0	0.56	**1**	**FP**

TPR = 0.8

FNR = 0.2

TNR = 0.33

FPR = 0.66

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At threshold 0.6
ID1	1	0.9	1
ID2	0	0.51	0
ID3	1	0.47	**0**
ID4	1	0.32	**0**
ID5	0	0.1	0
ID6	1	0.94	1
ID7	1	0.78	1
ID8	0	0.56	0

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At threshold 0.6	
ID1	1	0.9	1	TP
ID2	0	0.51	0	TN
ID3	1	0.47	**0**	**FN**
ID4	1	0.32	**0**	**FN**
ID5	0	0.1	0	TN
ID6	1	0.94	1	TP
ID7	1	0.78	1	TP
ID8	0	0.56	0	TN

Predicted Probabilities

ID	Actual Values	Predicted probabilities	At threshold 0.6	
ID1	1	0.9	1	TP
ID2	0	0.51	0	TN
ID3	1	0.47	**0**	**FN**
ID4	1	0.32	**0**	**FN**
ID5	0	0.1	0	TN
ID6	1	0.94	1	TP
ID7	1	0.78	1	TP
ID8	0	0.56	0	TN

TPR = 0.6

FNR = 0.4

TNR = 1

FPR = 0

Predicted Probabilities

TPR = 0.8

FNR = 0.2

TNR = 0.33

FPR = 0.66

Threshold
0.4

Predicted Probabilities

TPR = 0.8

FNR = 0.2

TNR = 0.33

FPR = 0.66

Threshold 0.4

TPR = 0.6

FNR = 0.4

TNR = 0.33

FPR = 0.66

Threshold 0.5

Predicted Probabilities

Threshold 0.4	Threshold 0.5	Threshold 0.6
TPR = 0.8	TPR = 0.6	TPR = 0.6
FNR = 0.2	FNR = 0.4	FNR = 0.4
TNR = 0.33	TNR = 0.33	TNR = 1
FPR = 0.66	FPR = 0.66	FPR = 0