ROC_AUC

Prepared By: Dr.Mydhili K Nair, Professor, ISE Dept, RIT
For: Machine Learning Elective Class
Target Audience: Sem 6 Students

Receiver Operating Characteristic (ROC) and Area Under Curve(AUC) Curves

Prepared By: Dr.Mydhili K Nair, Prof, ISE Dept, Ramaiah Institute of Technology, Bengaluru

WW II - Signal Detection Theory

1970's

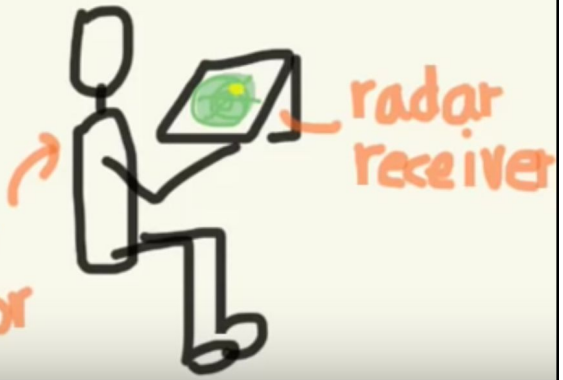
Started applying it to medical diagnosis of a disease

Bird/Friend
Aircraft/Enemy Aircraft

RADAR

true positive rate

false positive rate



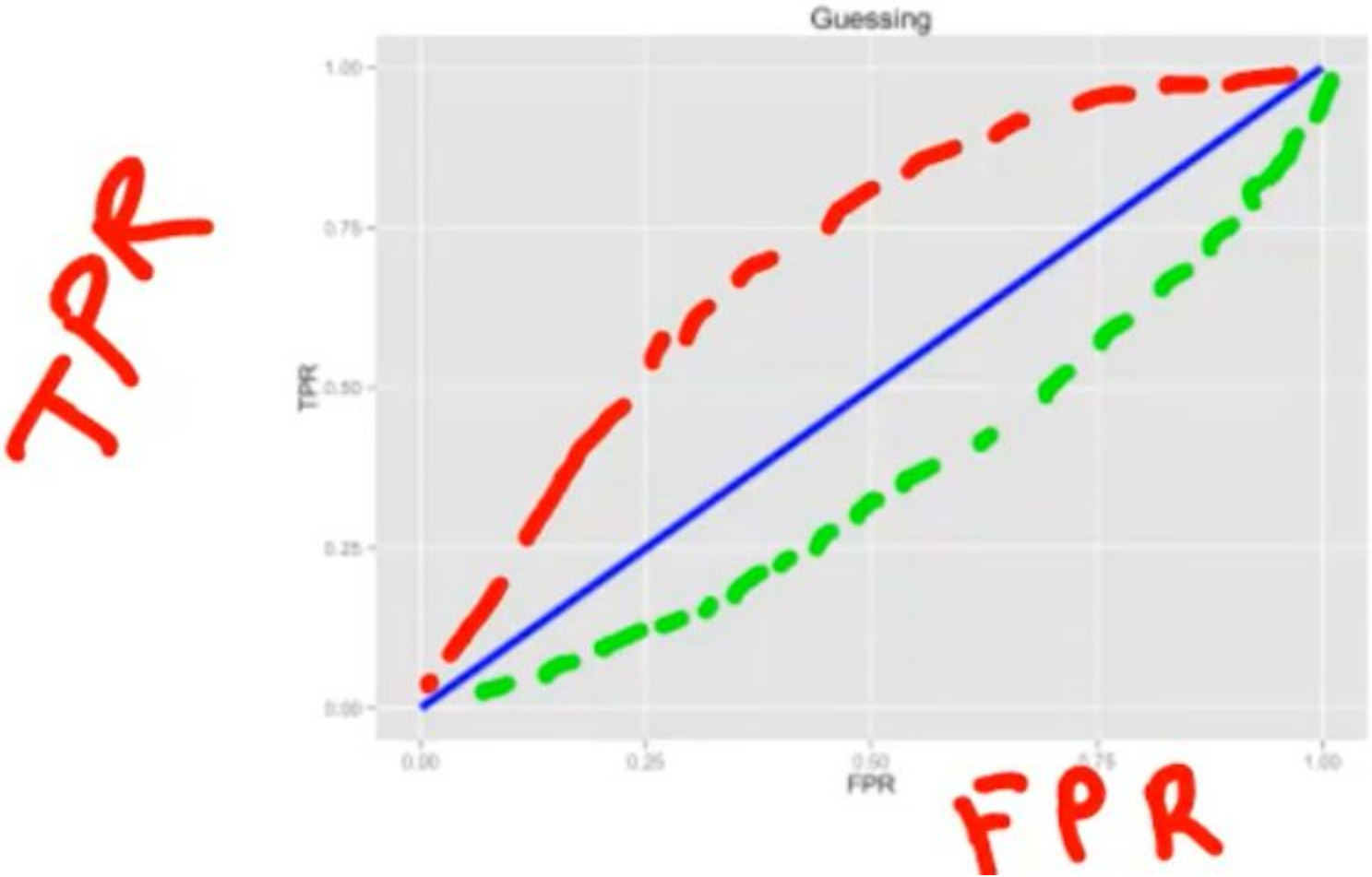
Radar monitor staff is called (hence the name)

History of ROC Curves

- The first example is the simplest: a diagonal line.
- A diagonal line indicates that the classifier is just making completely random guesses.
- Since your classifier is only going to be correct 50% of the time, it stands to reason that your TPR and FPR will also be equal.

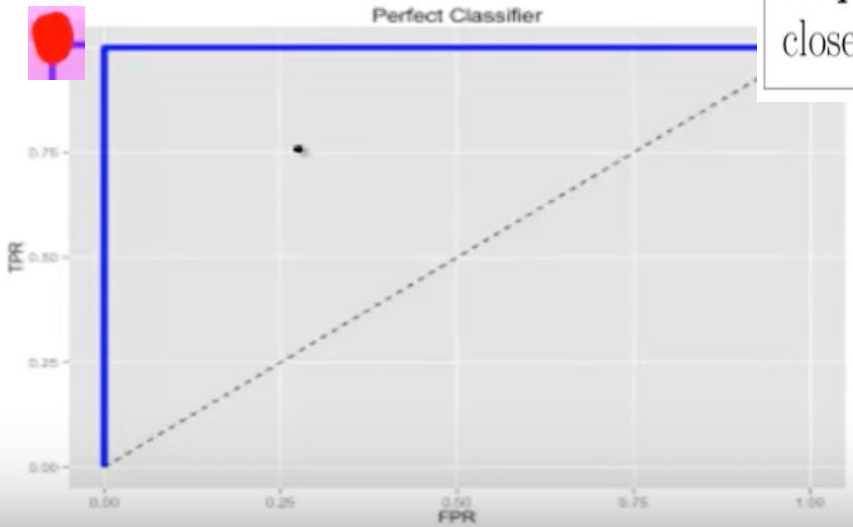
Any curve above the line will be "***Better than Guessing***"

Any curve below the line will be "***Worse than Guessing***"


Guessing
TPR
FPR
1.00
0.75
0.50
0.25
0.00
0.00
0.25
0.50
0.75
1.00
TPR
FPR

A Perfect Classifier

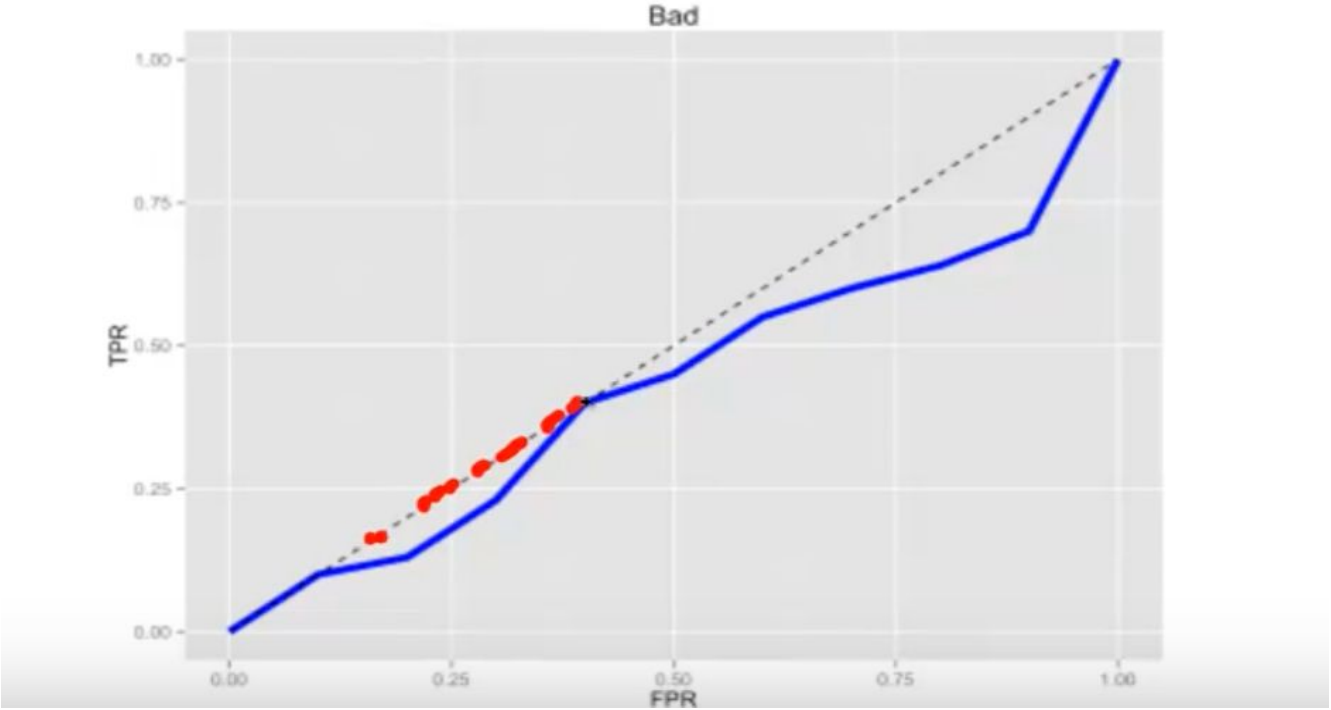
- A perfect classifier will yield a perfect trade-off between TPR and FPR (meaning you'll have a TPR of 1 and an FPR of 0).
- In that case, your ROC curve looks something like this.



Important: The better your classifier, the more closer the curve will be to the top left corner.

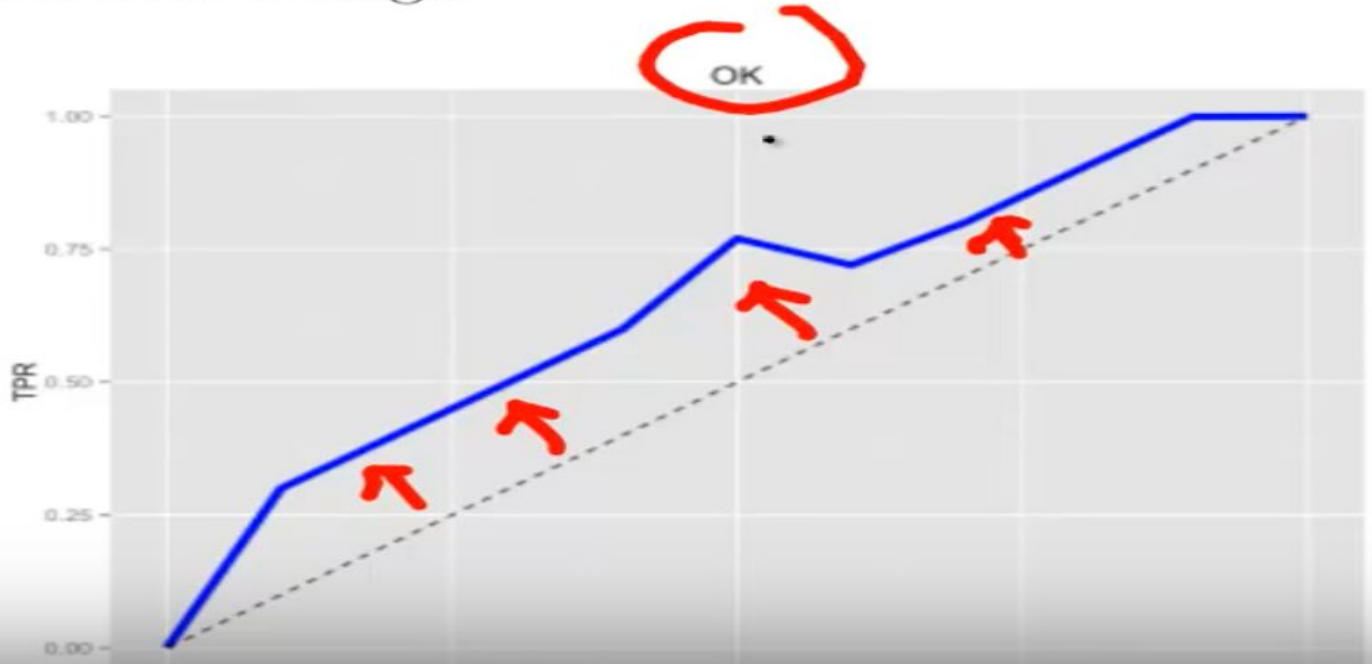
Worse than guessing

A bad classifier (i.e. something that's worse than guessing) will appear mostly below the random line.



Better than guessing

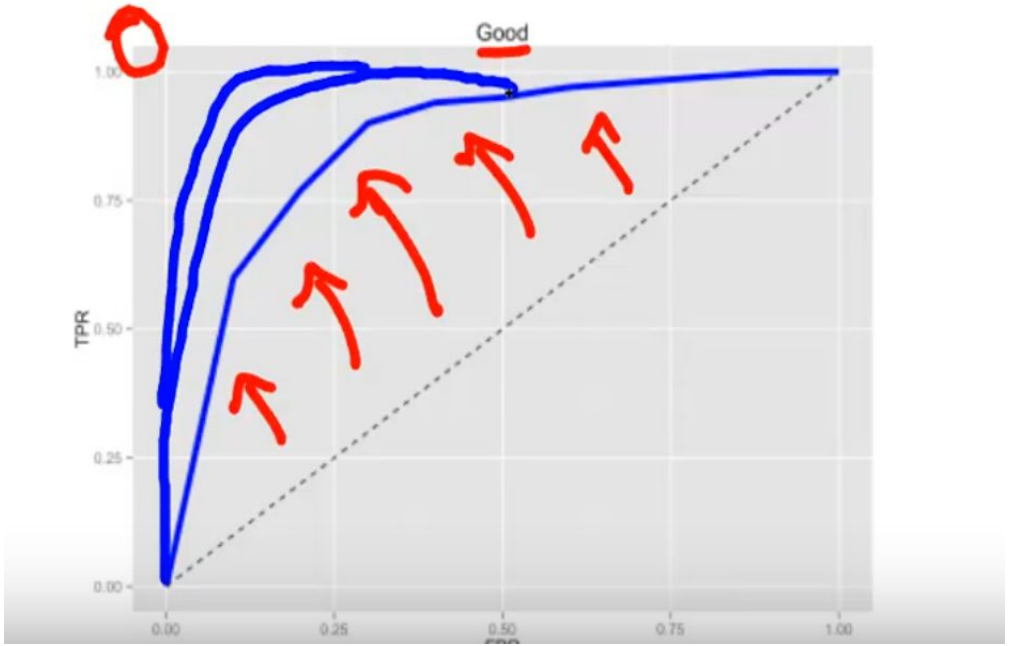
A much more interesting activity is attempting to decipher the difference between an "OK" and a "Good" classifier. The chart below shows an example of a very mediocre classifier. It is still better than guess at random though.

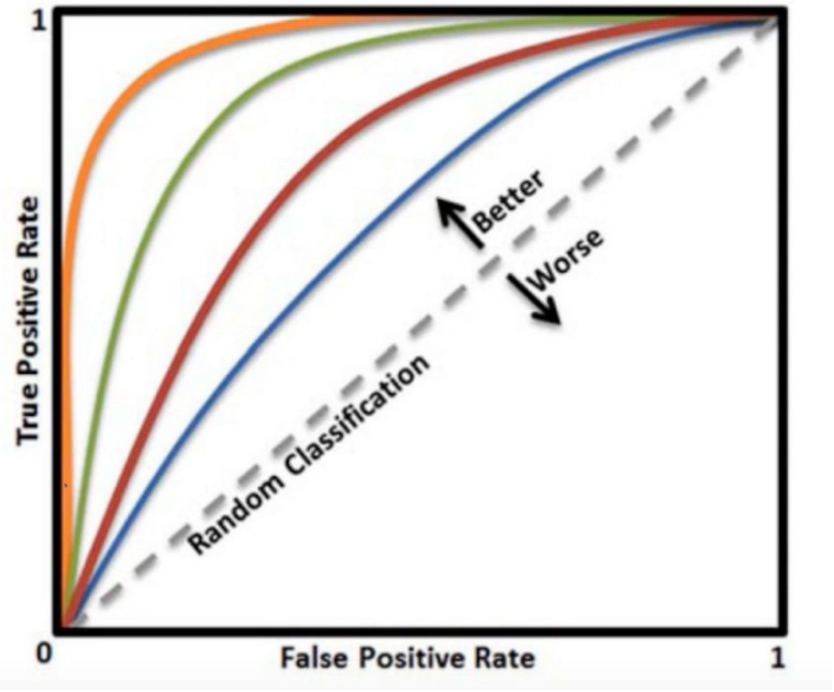


Reasonably Good

In practice, most decent classification systems have a ROC curve like this.

Recall that better a prediction system is, the closer it is to the top left.

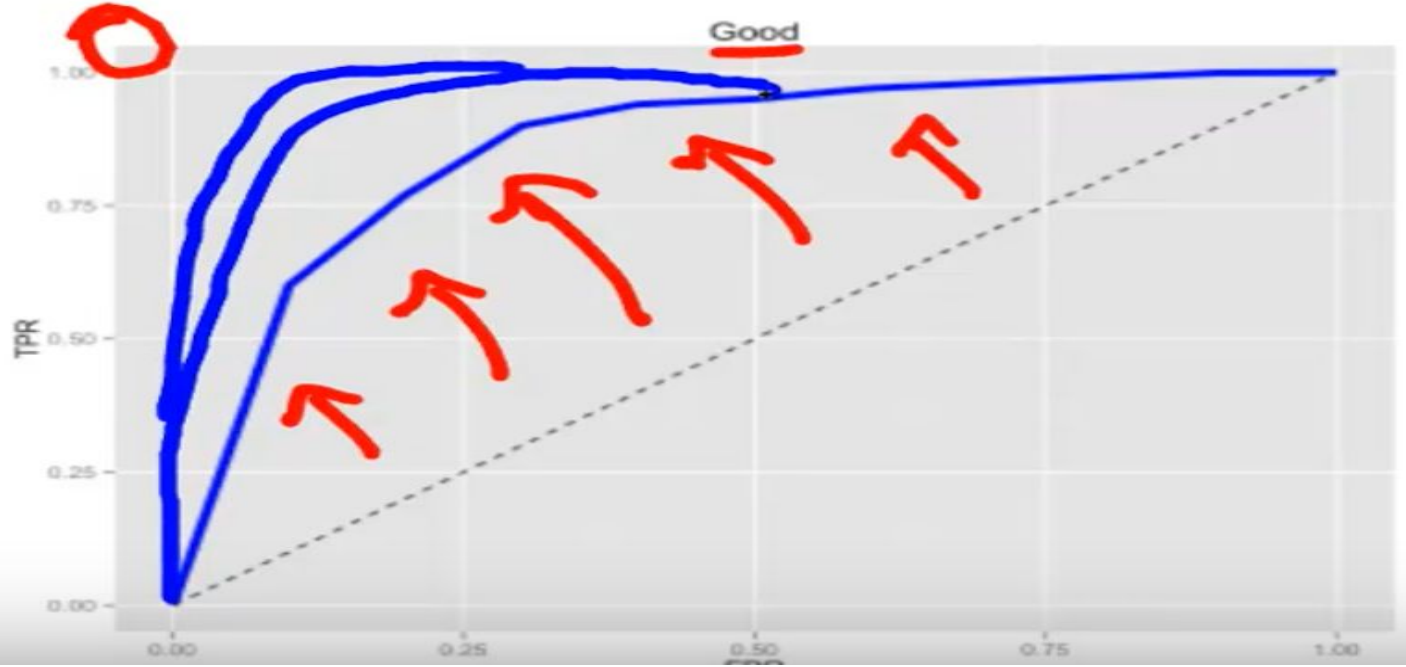


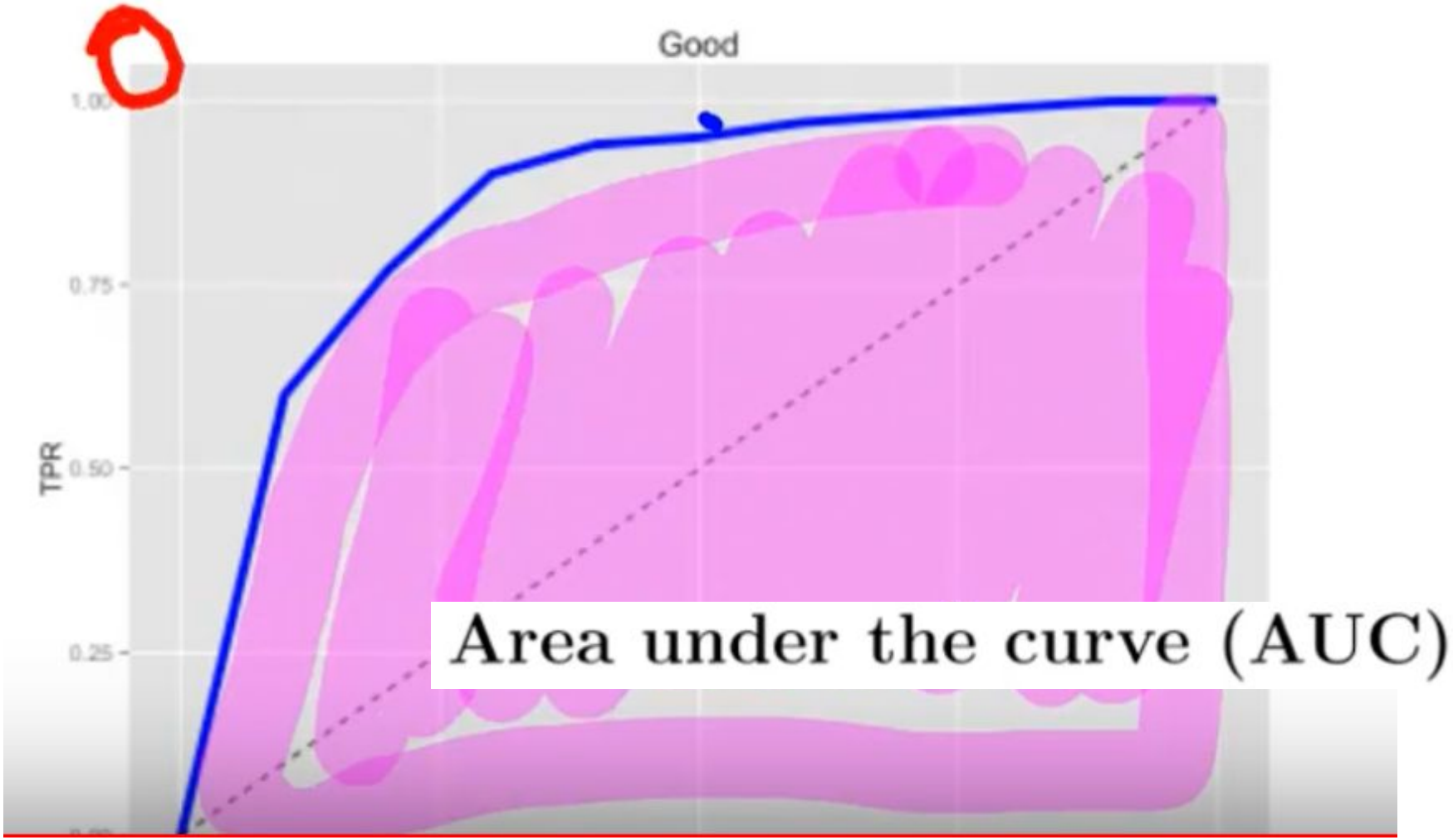


Reasonably Good

In practice, most decent classification systems have a ROC curve like this.

Recall that better a prediction system is, the closer it is to the top left.




Good
TPR
1.00
0.75
0.50
0.25
Area under the curve (AUC)

Area under the curve (AUC)

There is an aggregate metric to determine how good the prediction system is: AUC or Area Under the Curve.

The AUC is the amount of space underneath the ROC curve

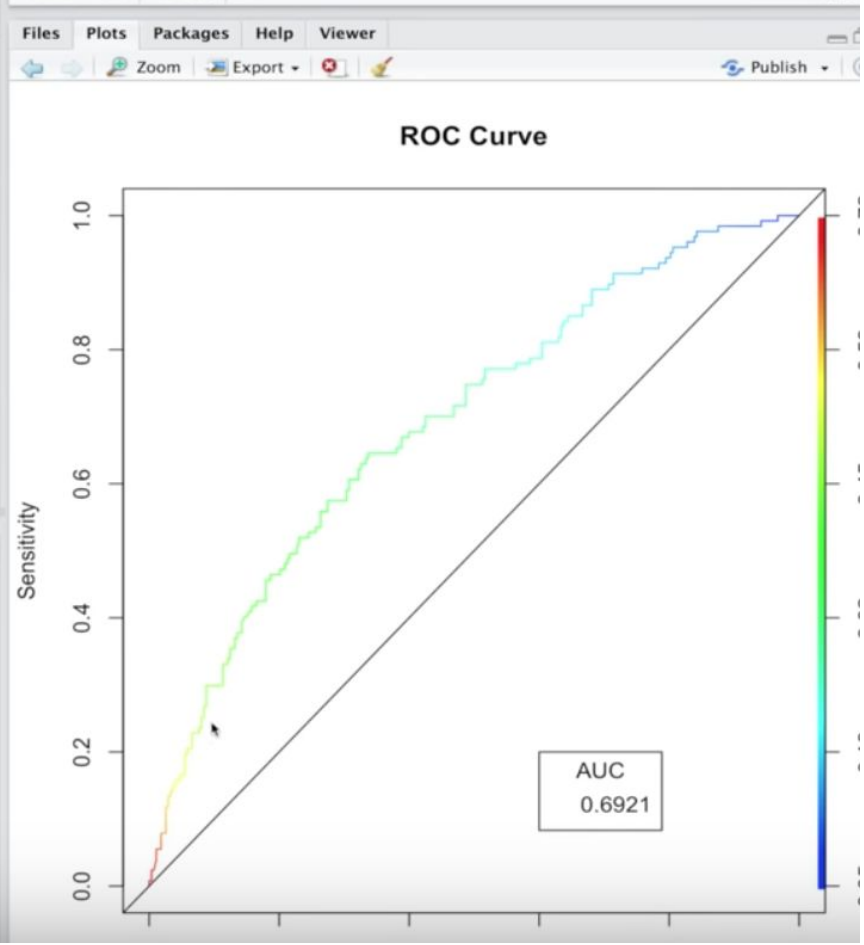
- AUC $= 0$: Perfectly Bad
- AUC < 0.5 : Worse than guessing at random
- AUC $= 0.5$: same as guessing at random
- AUC > 0.5 : Good. better than guessing at random
- AUC $= 1$: Perfectly Good

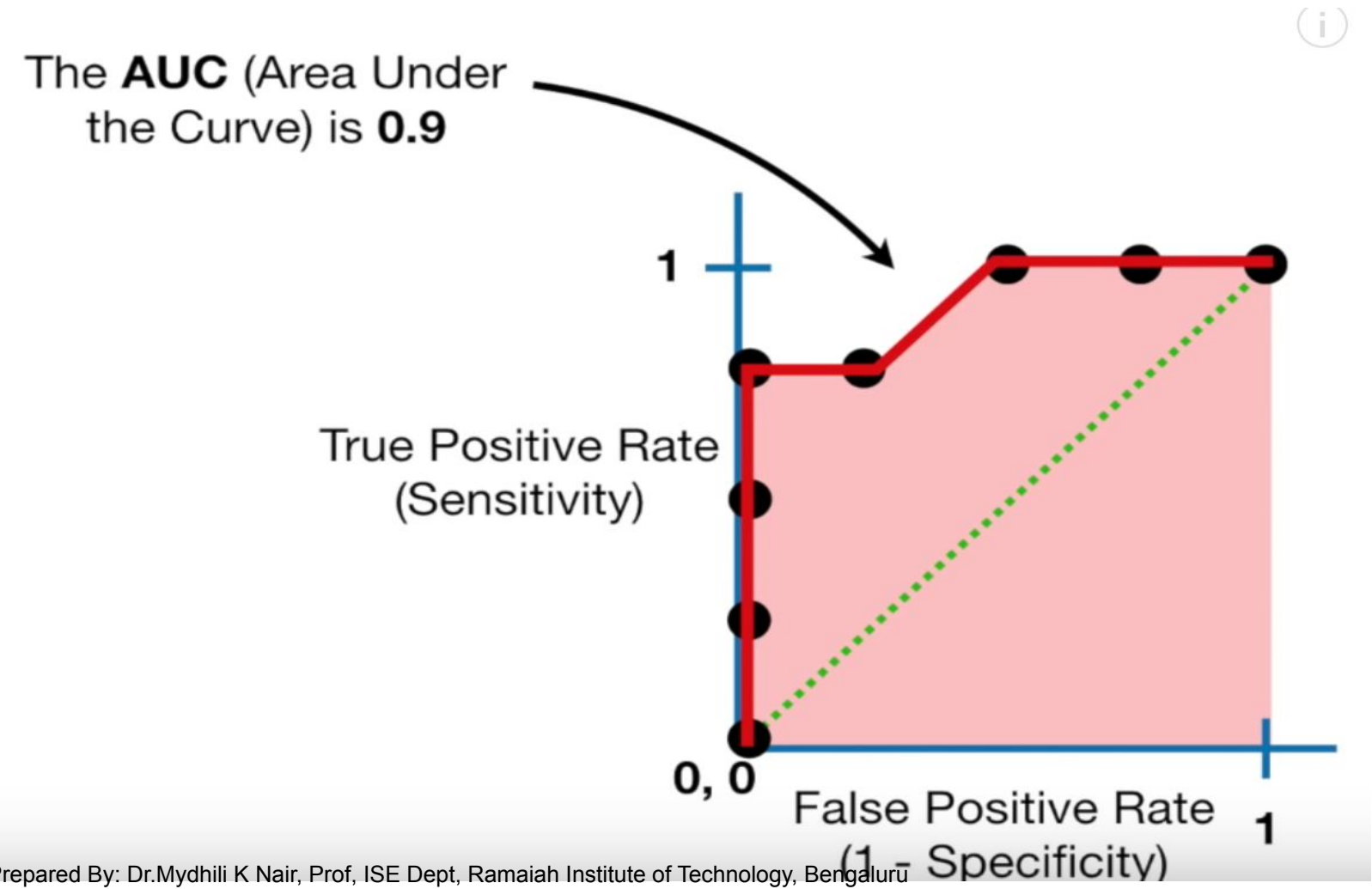
```
      colorize=T,
      main = "ROC Curve",
      ylab = "Sensitivity",
      xlab = "1-Specificity")
abline(a=0, b=1)

# Area Under Curve (AUC)
auc <- performance(pred, "auc")
auc <- unlist(slot(auc, "y.values"))
auc <- round(auc, 4)
legend(.6, .2, auc, title = "AUC")
```

47:1 (Top Level) R Script

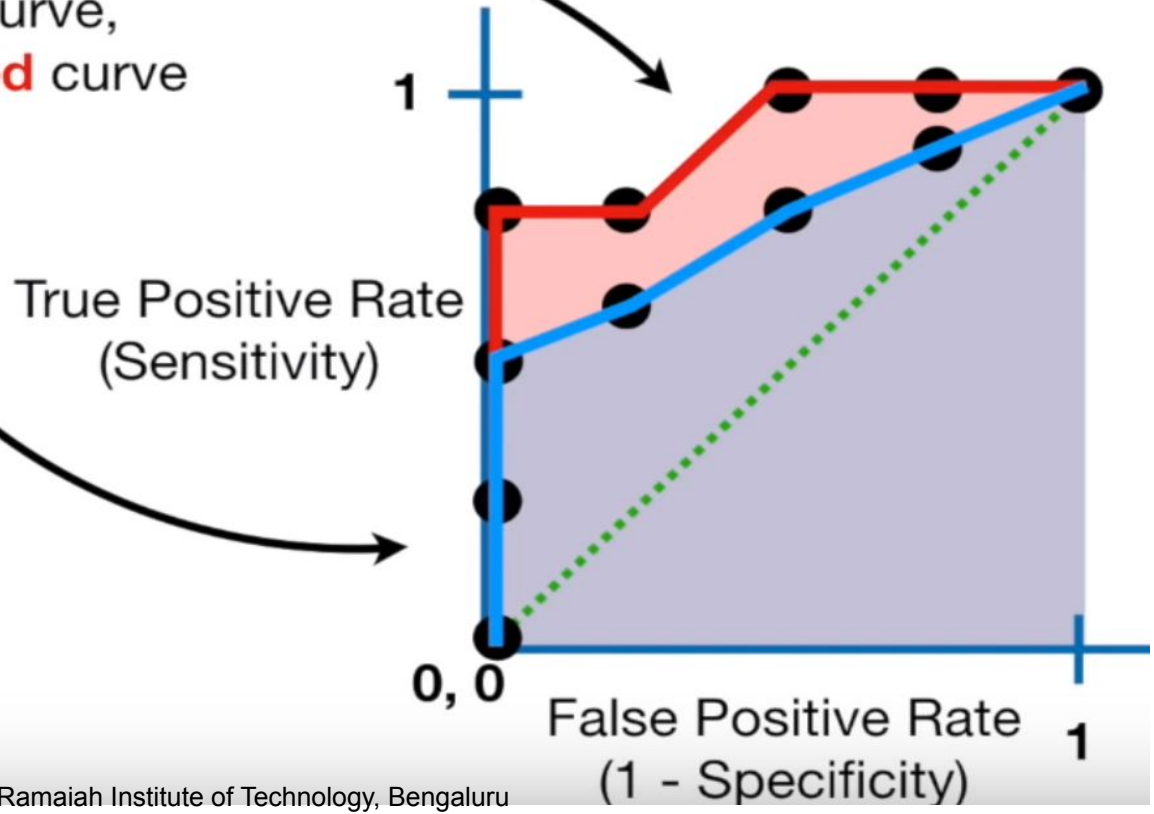
Console ~/Desktop/

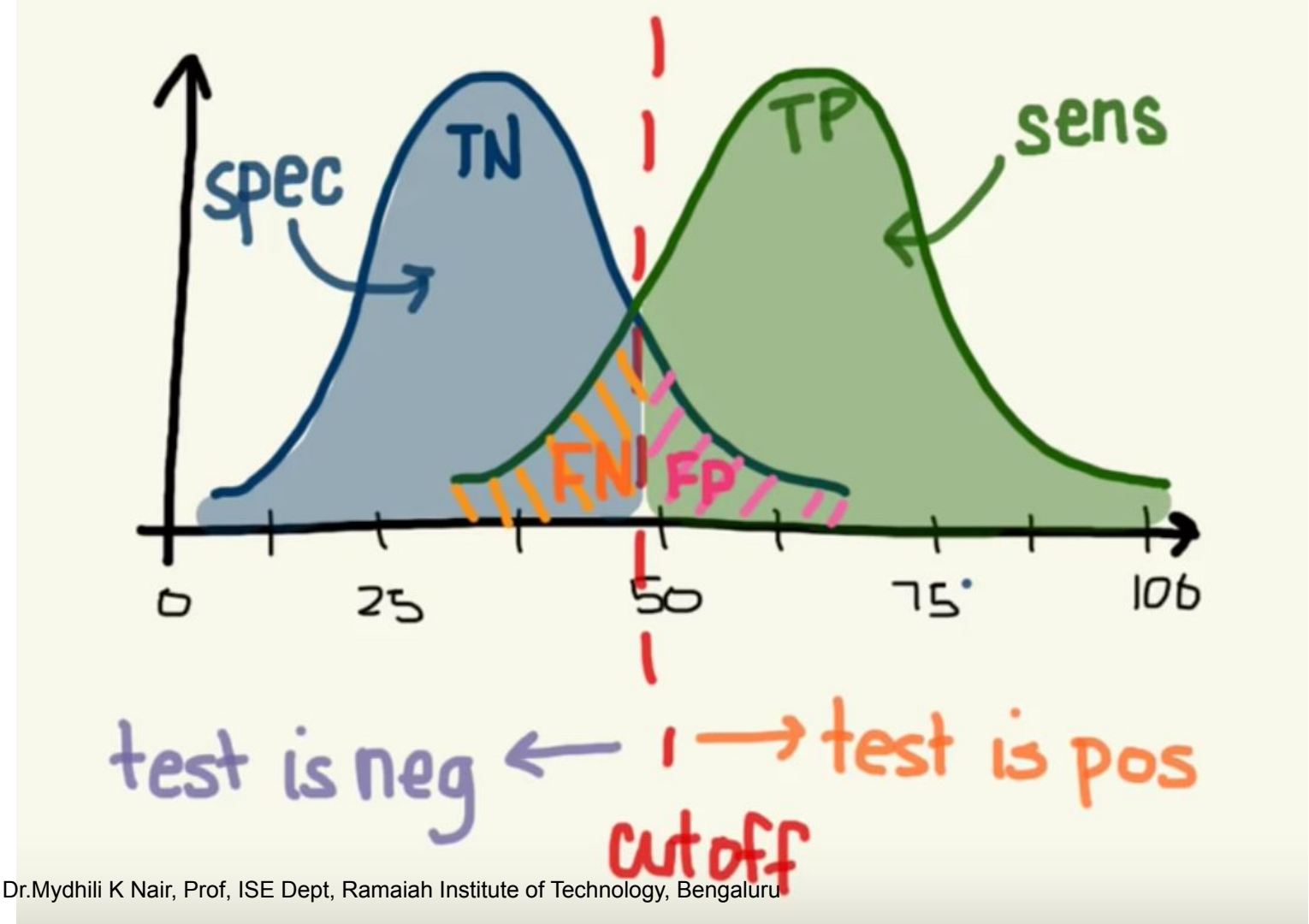
```
      ylab = "Sensitivity",
      xlab = "1-Specificity")
abline(a=0, b=1)
auc <- performance(pred, "auc")
auc <- unlist(slot(auc, "y.values"))
auc
[1] 0.6921202
auc <- round(auc, 4)
auc
[1] 0.6921
```

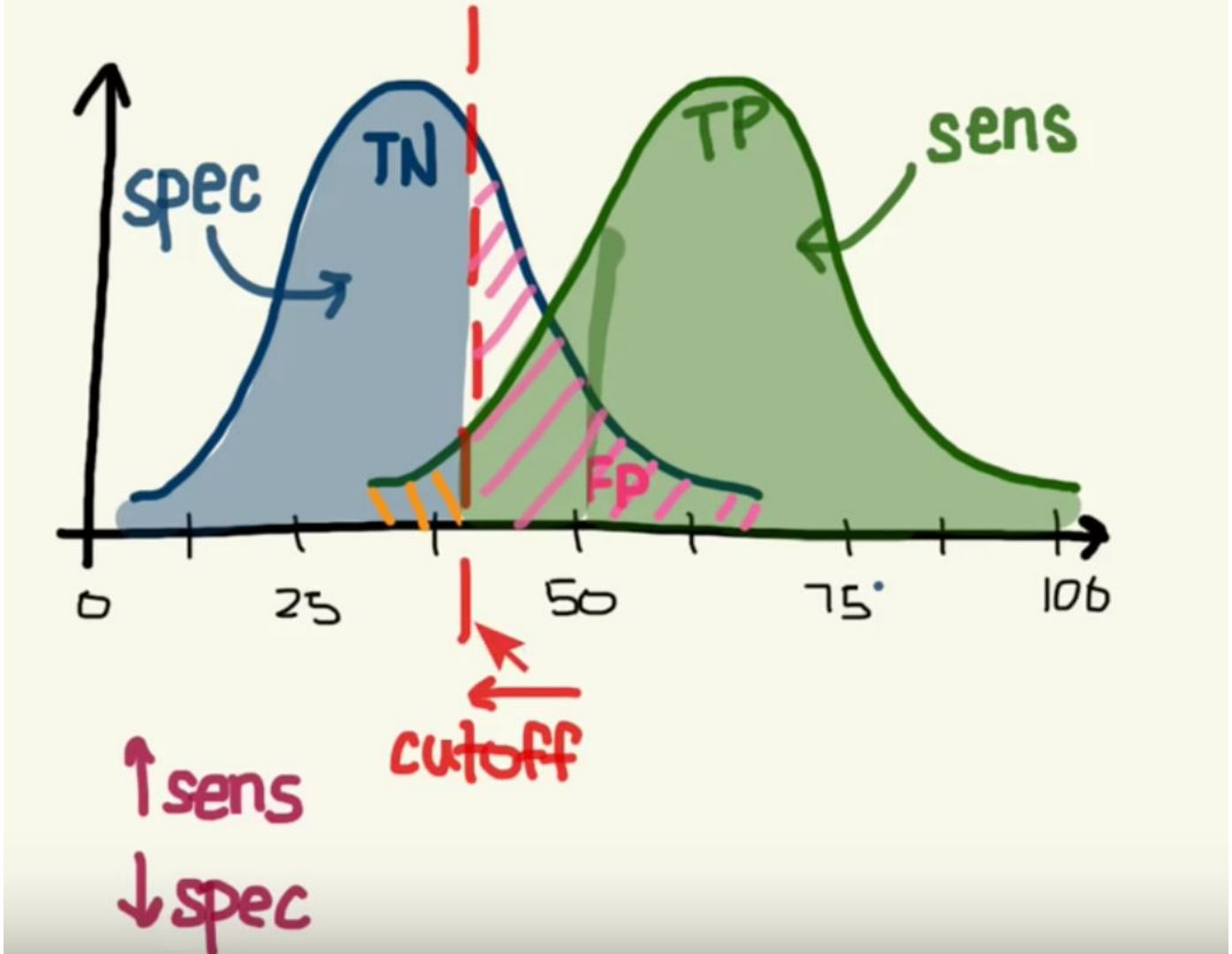


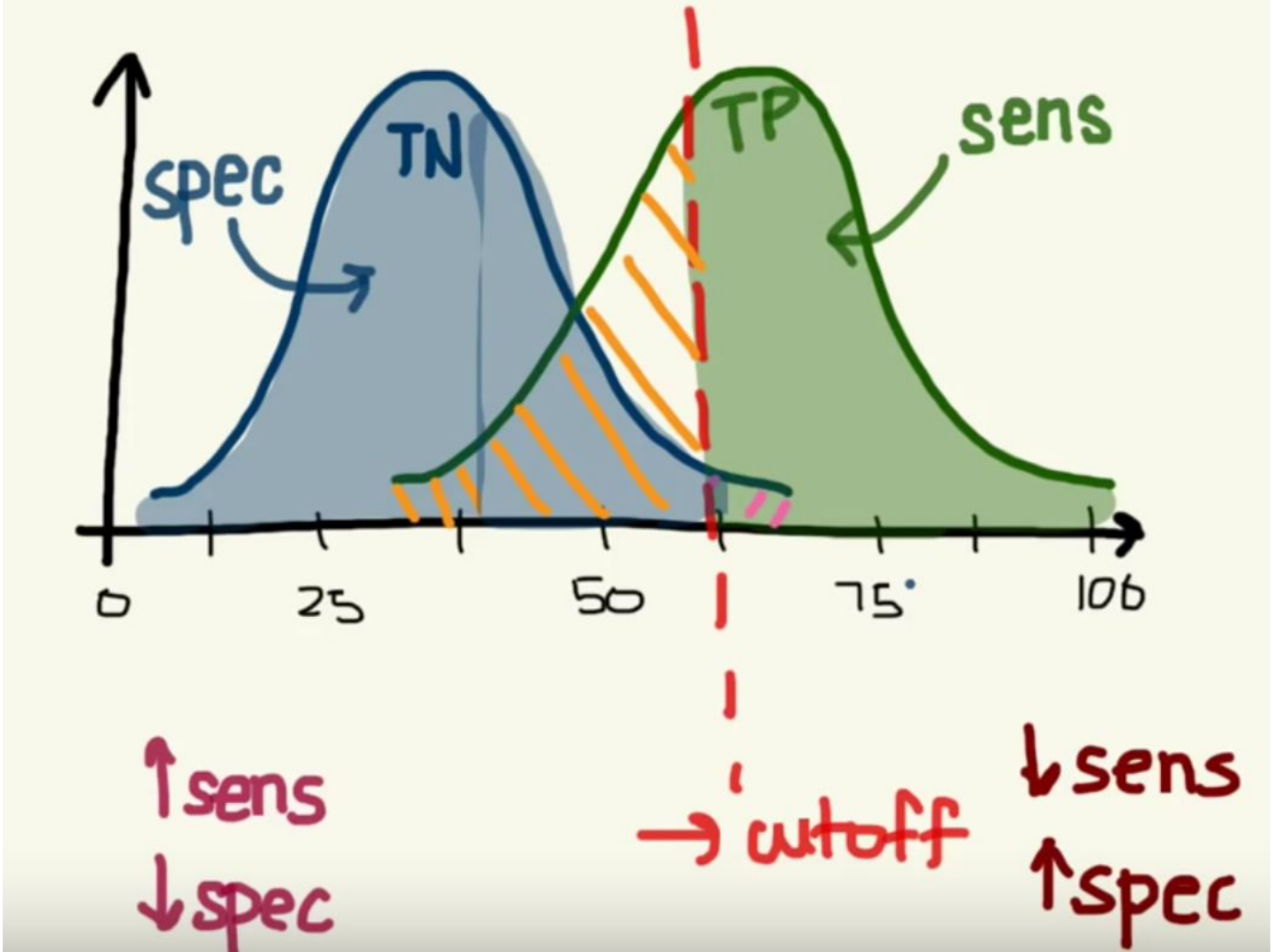

The AUC (Area Under the Curve) is 0.9
1
True Positive Rate (Sensitivity)
0, 0
False Positive Rate (1 - Specificity)
1

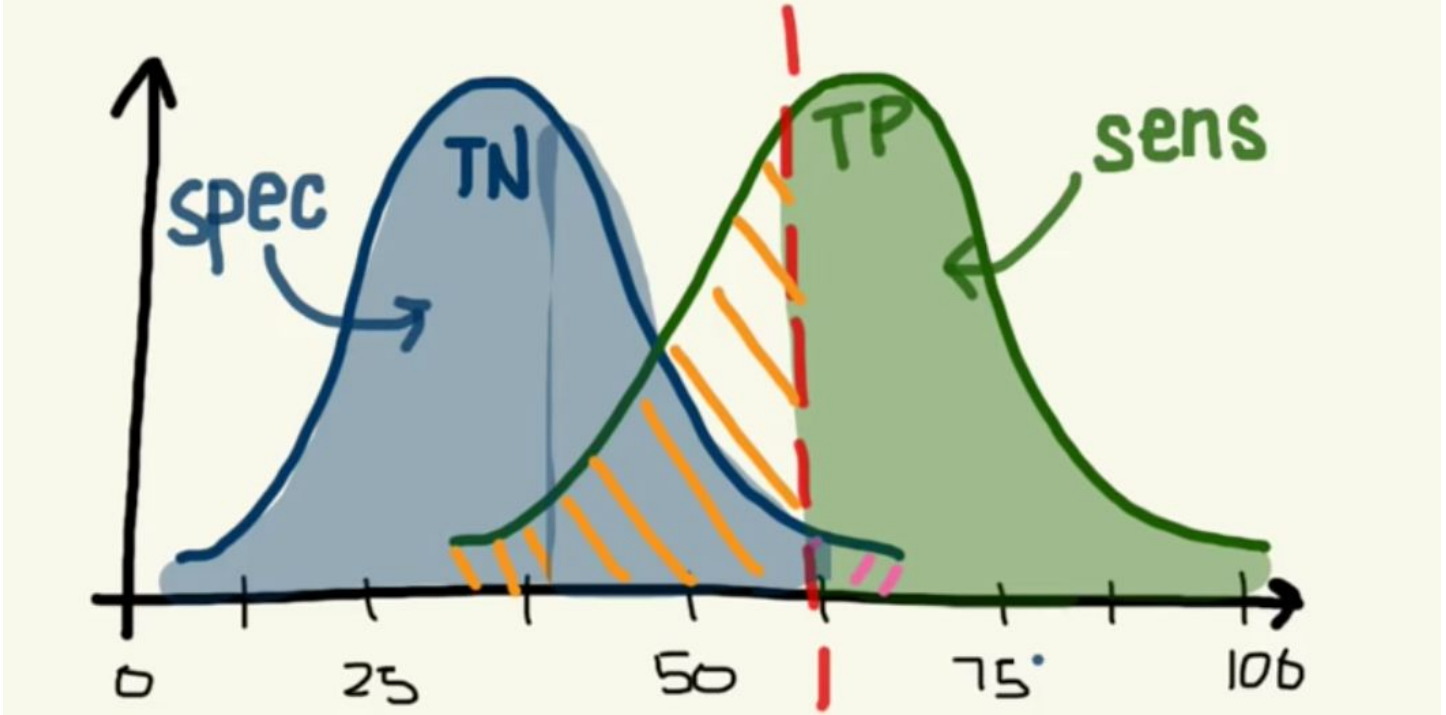
The **AUC** for the **red ROC** curve is greater than the **AUC** for the **blue ROC** curve, suggesting that the **red** curve is better.




spec
TN
TP
sens
FN
FP
0
25
50
75
106
test is neg
test is pos
cutoff

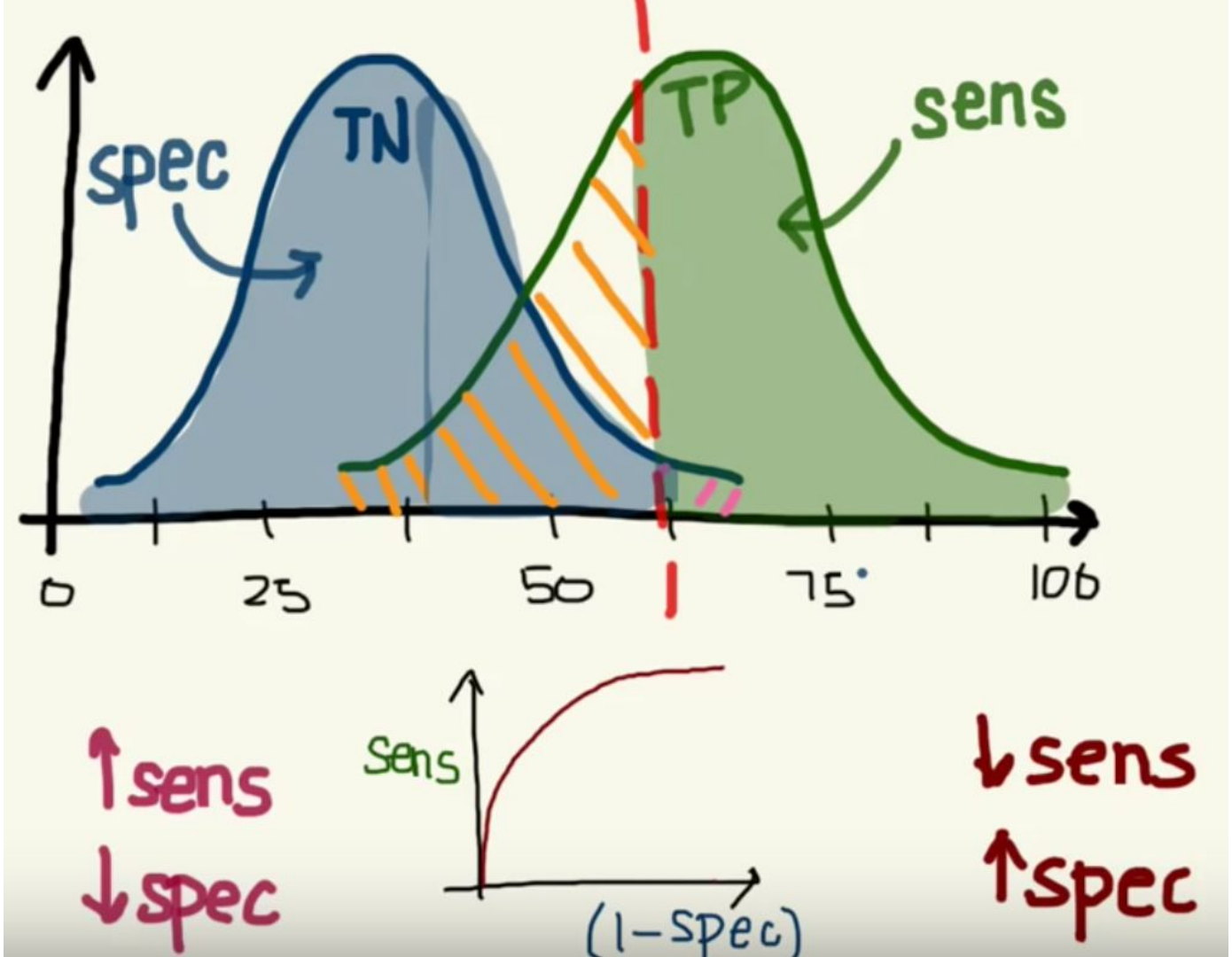

spec
TN
TP
sens
FP
0
25
50
75
106
cutoff
↑sens
↓spec

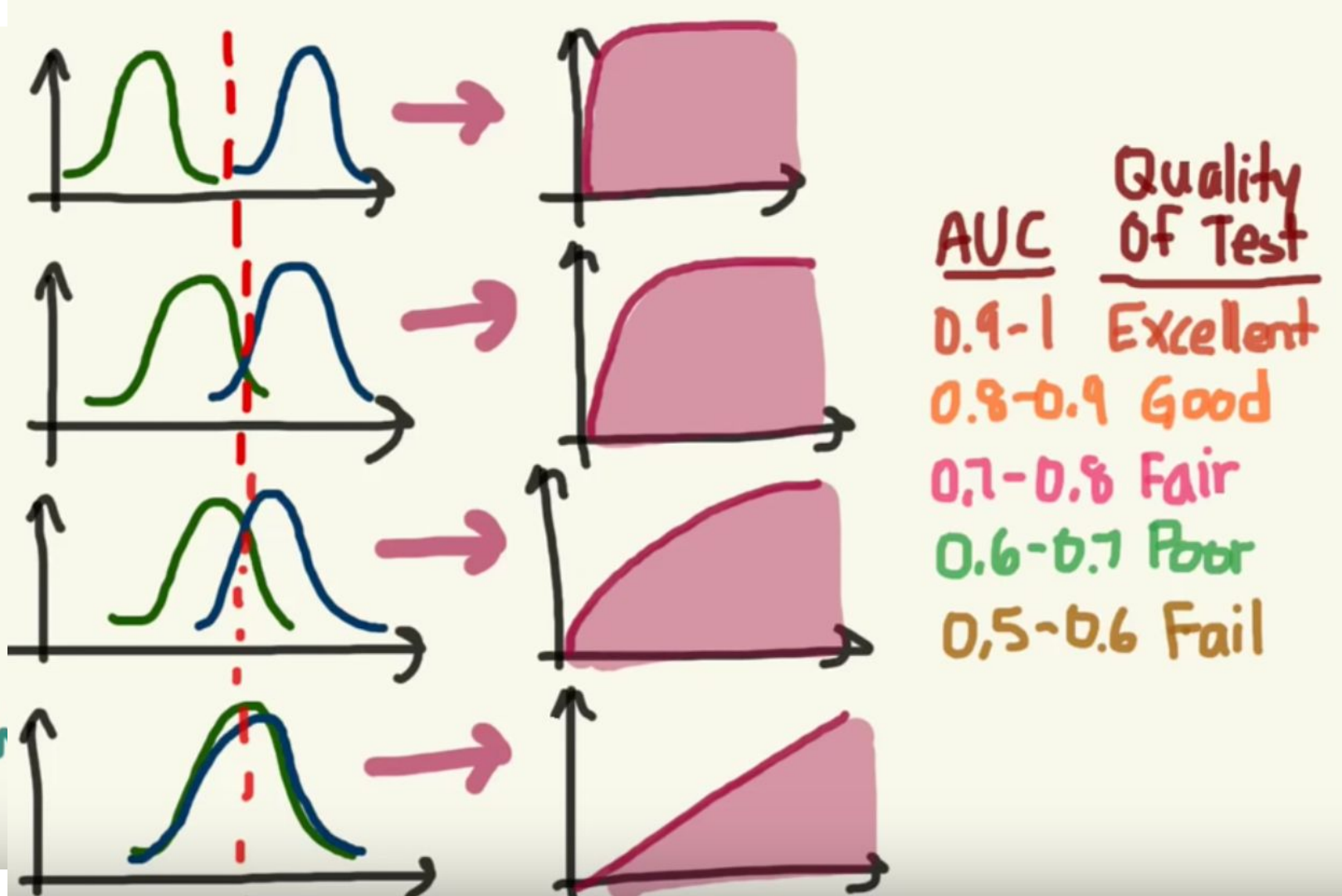

spec
TN
TP
sens
0
25
50
75
106
↑sens
↓spec
→ cutoff
↓sens
↑spec

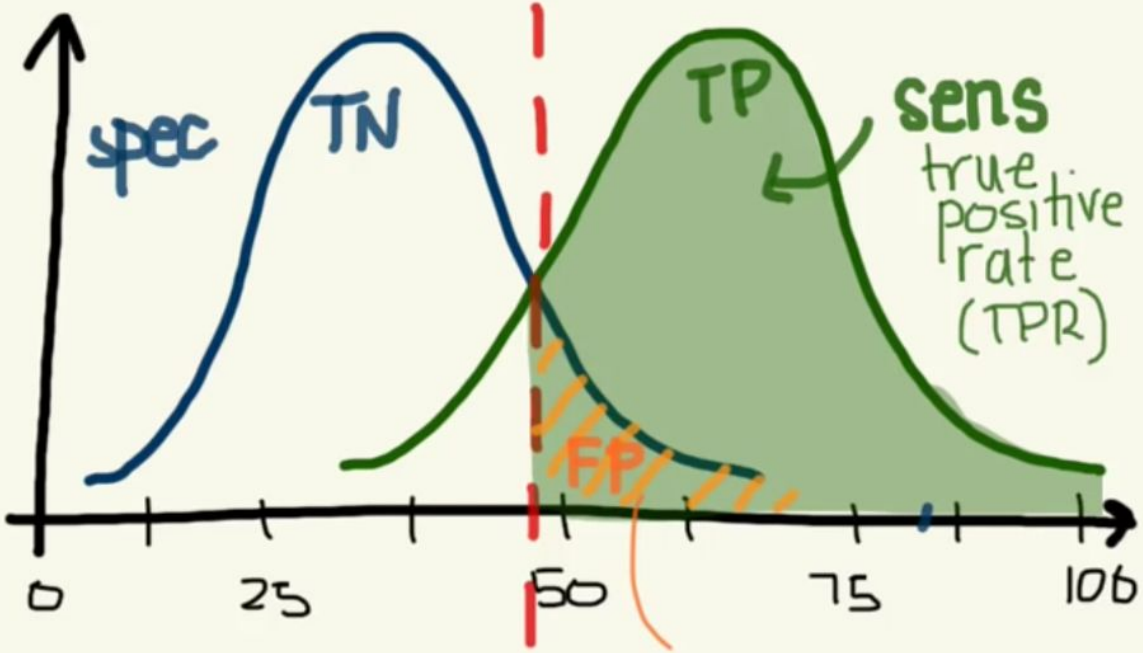


↑sens
↓spec

↓sens
↑spec


spec
TN
TP
sens
0
25
50
75
106
↑sens
↓spec
Sens
(1-spec)
↓sens
↑spec


AUC
Quality Of Test
0.9-1 Excellent
0.8-0.9 Good
0.7-0.8 Fair
0.6-0.7 Poor
0.5-0.6 Fail


spec
TN
TP
sens
true positive rate (TPR)
FP
0
25
50
75
106
(1-spec)
false positive rate

"Why (1-spec)?"

Source:

1. **ROC History:** https://www.youtube.com/watch?v=21Igj5Pr6u4
2. **ROC-AUC Textbook Style**: https://www.youtube.com/watch?v=GQsFFs-XyJ0
3. **ROC-AUC-Obsese Mice-Rare Disease:** https://www.youtube.com/watch?v=xugjARegisk
4. **R-Program Screenshot of ROC-AUC**: https://www.youtube.com/watch?v=ypO1DPEKYFo