Machine Learning applied to Planetary Sciences

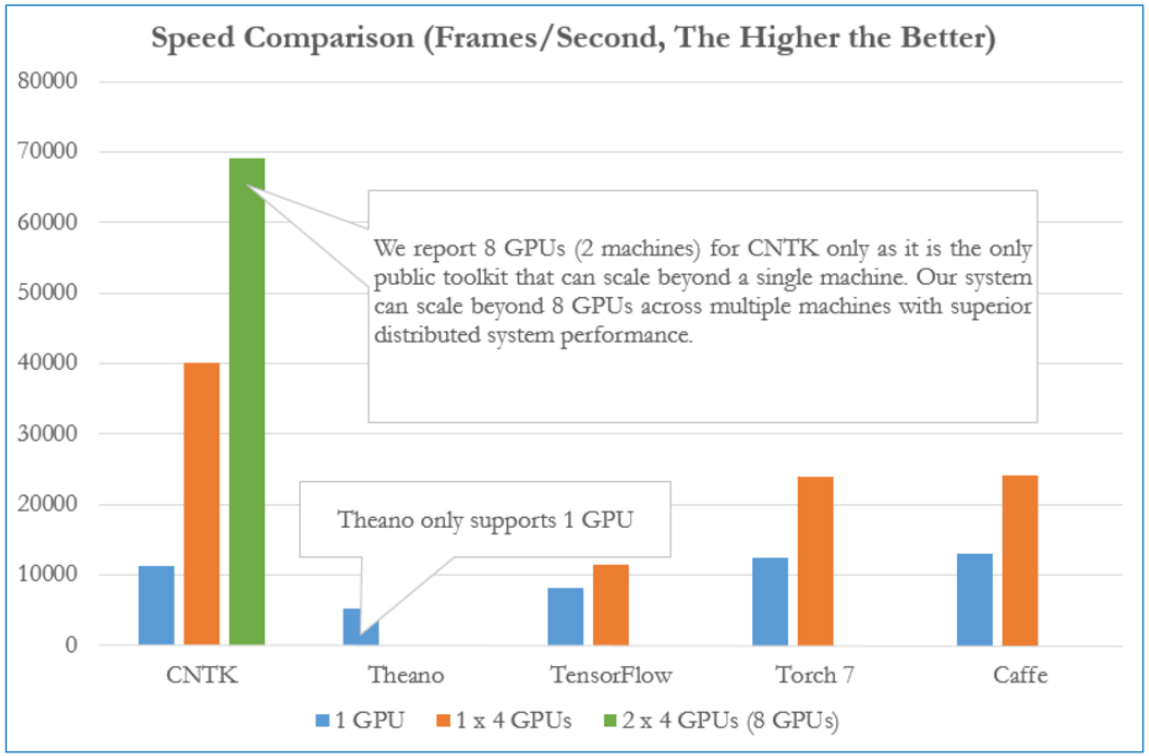
PTYS 595B/495B

Leon Palafox

https://leonpalafox.github.io/MLClass/

Yet one other player

- Microsoft released CNTK



https://github.com/Microsoft/CNTK

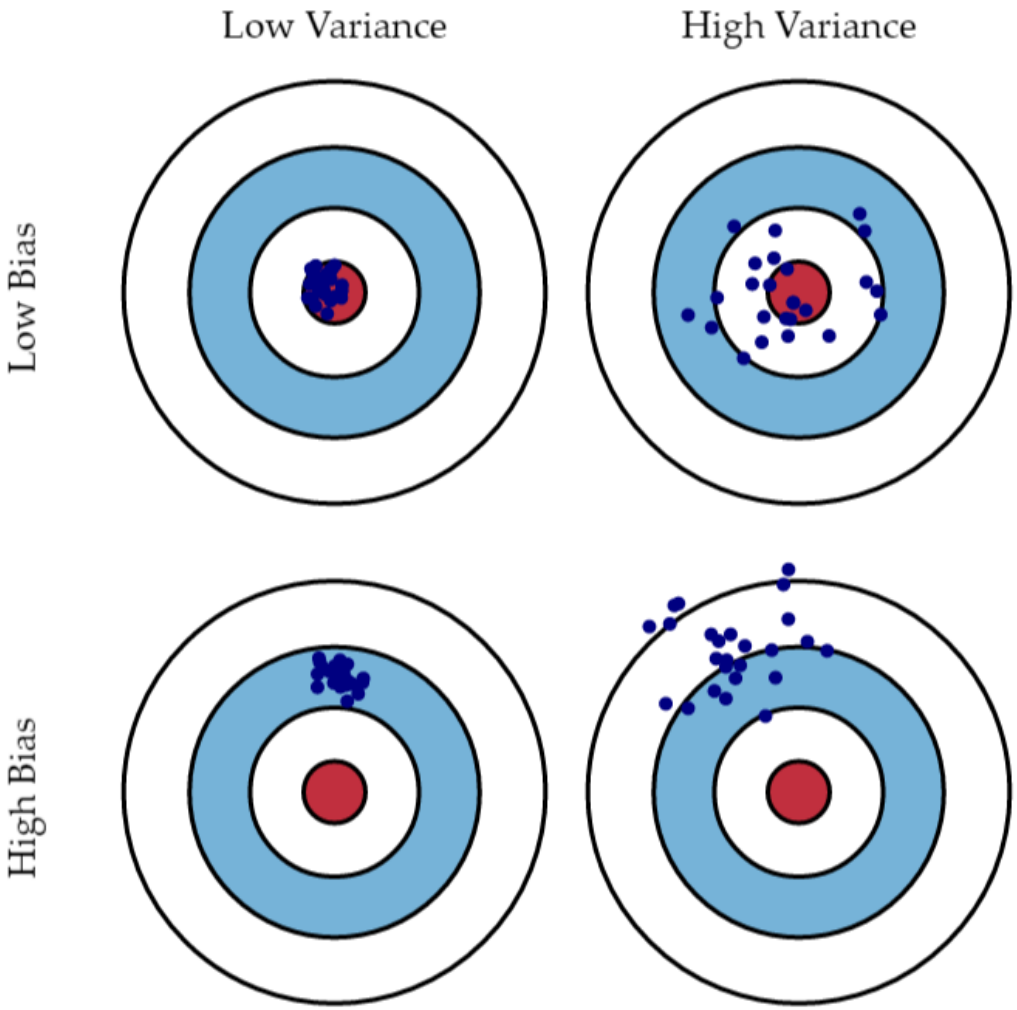
Validation Methods

Bias–Variance Analysis

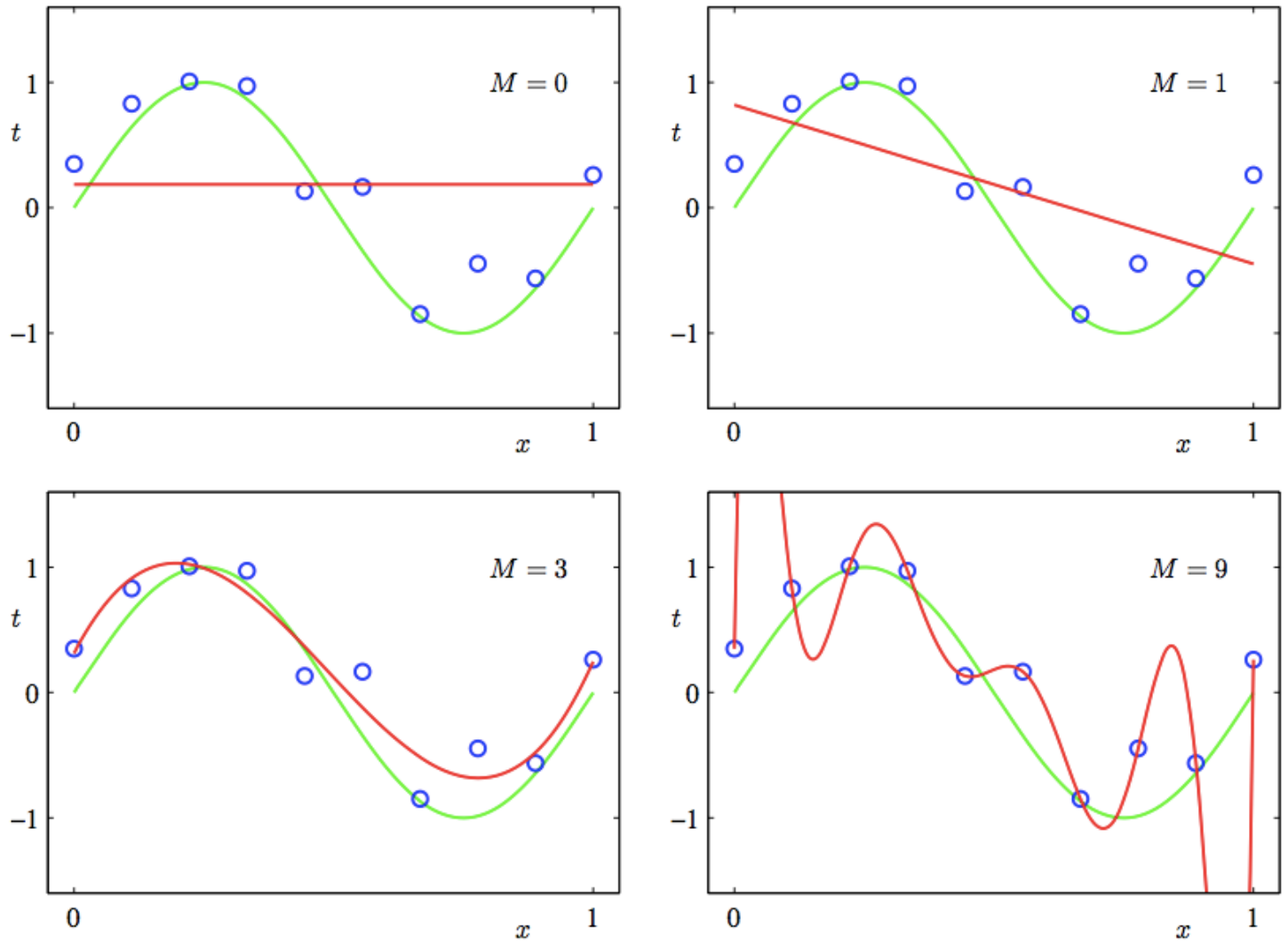
Concepts

- Bias: Measures how far off is our model from the correct set of predictions.
- Variance: It measures how consistent are the predictions of the model.
- Is a trade-off.

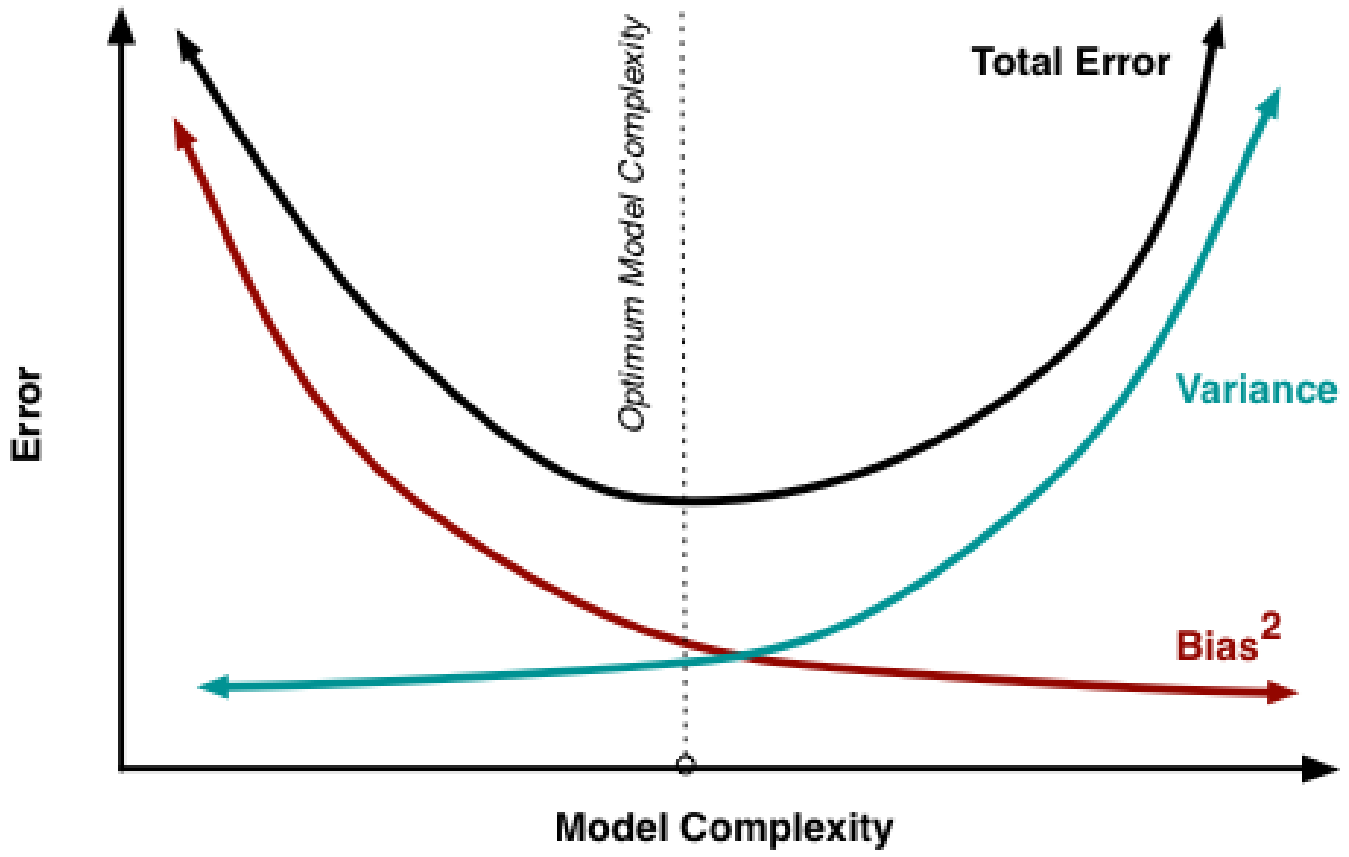
An example



Smallest training error



Bias-Variance Plot



Notes

- Is best used as a stop point when running CV.
- You can use it without CV, and you can still have very good results.
- Bias and Variance are defined differently for different algorithms. Thus, it adds an extra layer of complexity in implementation.

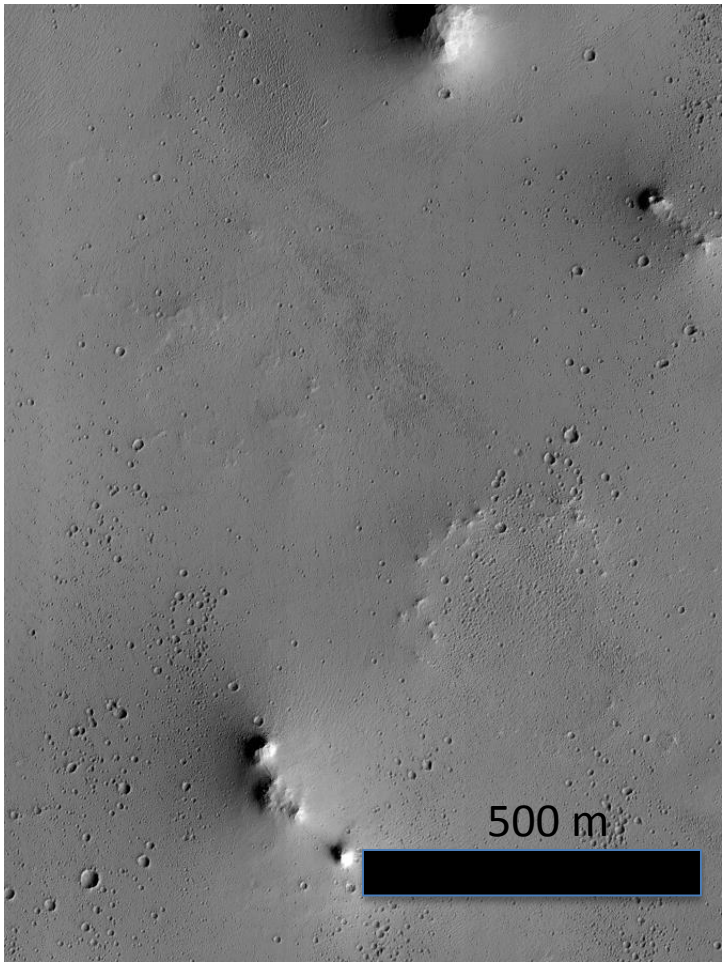
Metrics for classifiers

Terminology

- True Positive: Correct detection of a positive example.
- True Negative: Correct detection of a negative(null) example.
- False Positive: False detection of a positive example
- False Negative: False detection of a negative example.

Crater Detection

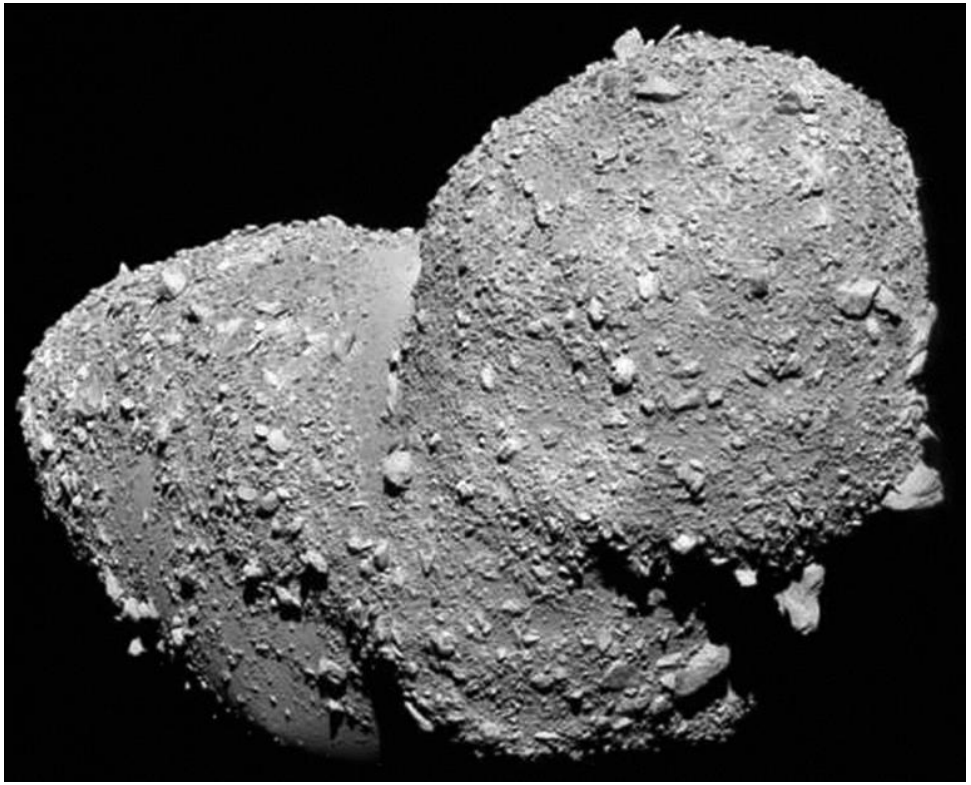
In this example false negatives are not very important, but false positives are important.



HiRISE image ESP_045481_1845

Boulder Detection

In this example false negatives are crucial, while false positives are not as essential.



Itokawa asteroid

Accuracy

- Is a measure of the statistical bias.
- Is one of the most widely used metrics.
- Out of all your classifications, which ones did you get right.

$$\text{Accuracy} = \frac{tp + tn}{tp + tn + fp + fn}$$

Precision

- Out of all your positive detections, which ones are correct.
- Gives you a good sense of how good is the classifier at detecting your positive examples.

$$\text{Precision} = \frac{tp}{tp + fp}$$

Recall

- Along with accuracy, helps us to score unbalanced datasets.
- Is the ability to detect the positive cases.

$$\text{Recall} = \frac{tp}{tp + fn}$$

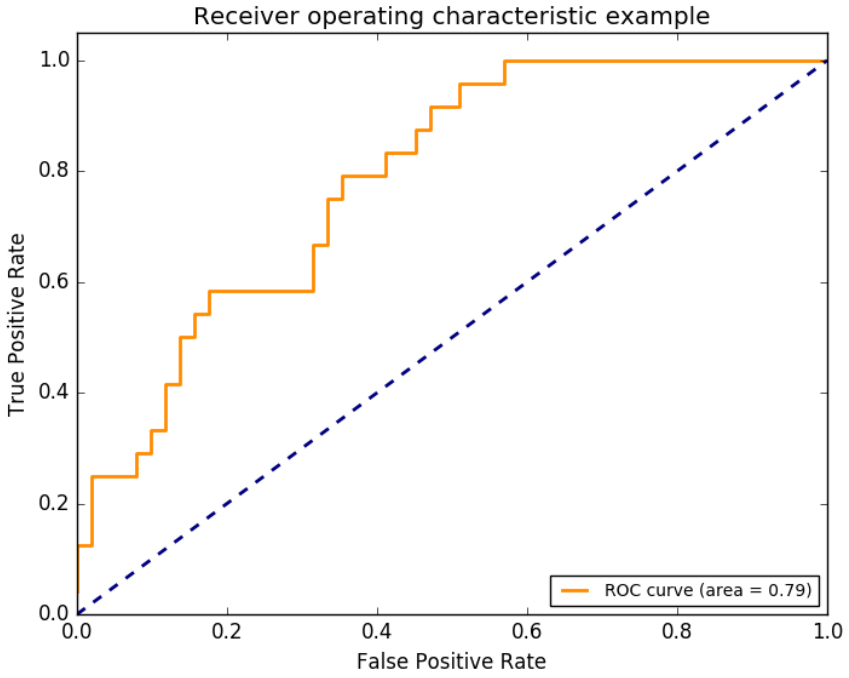
F1-Score

- Is a mixture of precision and recall
- Works to have a single number that indicates how good is the classification doing.

$$F_1 = 2 \cdot \frac{\mathrm{precision} \cdot \mathrm{recall}}{\mathrm{precision} + \mathrm{recall}}.$$

ROC Plot

- Receiver operating characteristic
- Is a plot that shows, in a single shot, many of the metrics we've been talking about.

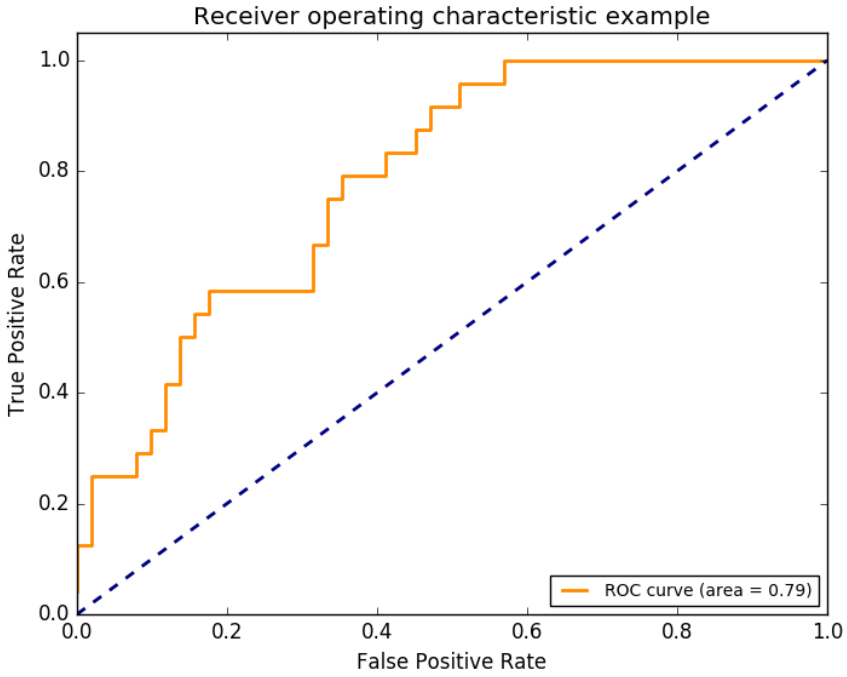


ROC Plot

- Classifiers generally give us a number between 0 and 1.
- Generally we use a threshold of 0.5
- By changing the threshold, we can become more or less sensitive to TP or FP.

ROC Plot

- Train classifier
  - Set threshold to 0.1
    - Obtain TPR and FPR
    - Set a point
  - Set threshold to 0.2
    - Repeat
  - ……..



Area under the curve (AUC)

- As the name implies it, is the area under the ROC curve.

- Is intuitive to see that you want an area as large as possible.