

# Classification Continued

CAC 350



# Last Class

- \* Trained a binary classification model (Stochastic Gradient Descent) on classifying whether or not an image was of a five
- \* Measured the accuracy and got good results - maybe accuracy isn't the best judge
- \* Confusion matrix:  $\begin{bmatrix} 53875 & 704 \\ 1484 & 3937 \end{bmatrix}$ 
  - \* 53,875 true negatives
  - \* 704 false positives
  - \* 1,484 false negatives
  - \* 3,937 true positive



# Precision

- \* Confusion matrix provides good information, but it's not concise
- \* Precision: accuracy of the positive predictions

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

- \* TP = number of true positives
- \* FP = number of false positives



# Recall (sensitivity)

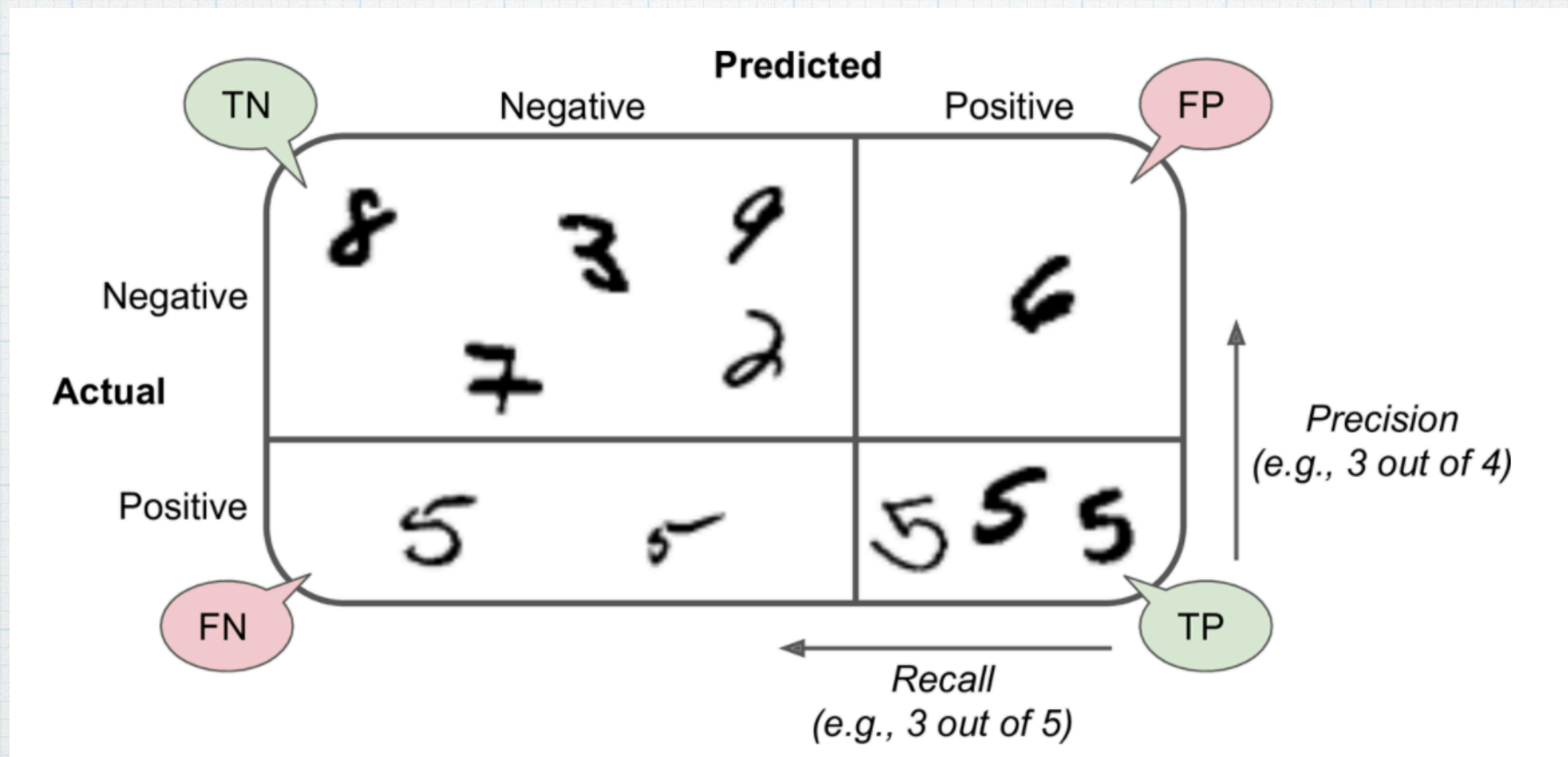
- \* Used in conjunction with precision
- \* Ratio of positive instances that are correctly detected by the classifier

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

- \* FN = false negatives



# Confusion Matrix





# F-Measure

- \*  $F_1$  Score
- \* Combines precision and recall into one metric
- \* Harmonic mean of precision and recall
- \* Arithmetic mean is the average of all numbers, but the harmonic mean gives more weight to smaller numbers and reduces the impact of larger numbers
- \* As a result, a high F-Measure only occurs if both the precision and recall are high

$$F_1 = \frac{2}{\frac{1}{\text{precision}} + \frac{1}{\text{recall}}} = 2 \times \frac{\text{precision} \times \text{recall}}{\text{precision} + \text{recall}} = \frac{TP}{TP + \frac{FN + FP}{2}}$$

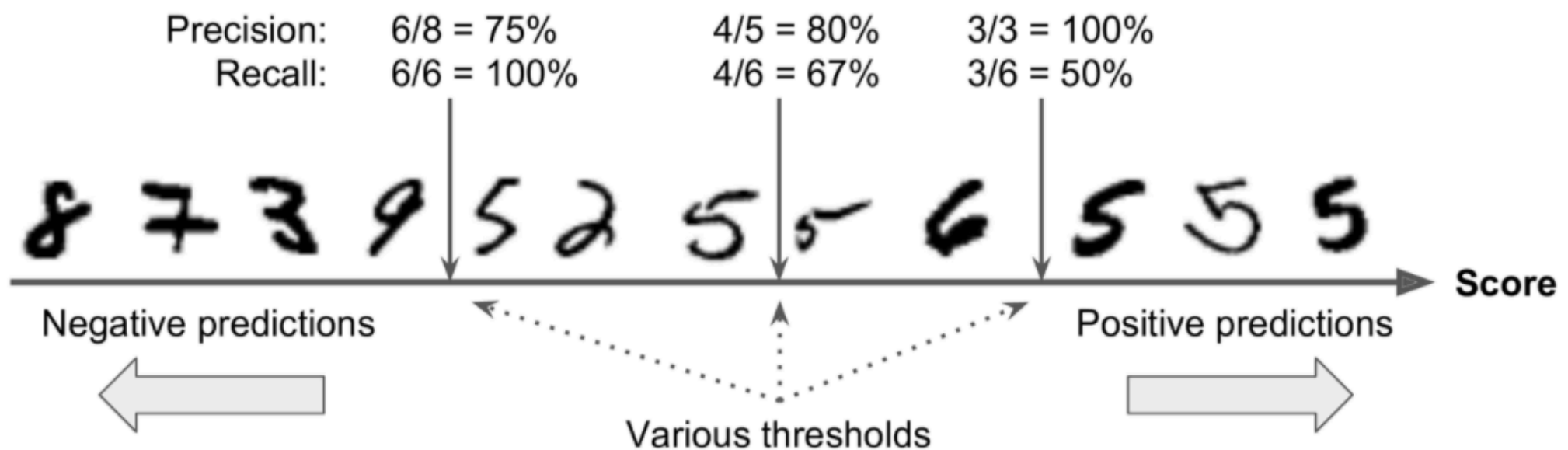


# Precision/Recall Trade-off

- \* Increasing precision reduces recall and vice versa
- \* What you want depends on what you're analyzing...
  - \* Videos safe for kids: reject some good ones (low recall), keeps only safe ones (high precision)
  - \* Shoplifters: low precision, high recall



# Precision/Recall Trade-off





# Next Class...

- \* Assignment, choose one:
  - \* Cars - predicting if a vehicle is fuel efficient
  - \* Spam Filter - don't look at the solution
- \* We'll go through Chapter Four: Training Models