Coin Year Classification

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ELEN 520: Spring 2019

Problem Statement

- We will attempt to identify coin years from images of U.S. pennies
- H_0: Image pixel values are not correlated with the year of the coin
- H_1: Image pixel values are correlated with the year of the coin

Background

- Worth of coin is determined by year and condition
- Everyone has loose change. Could be valuable
- Ongoing debate about phasing out pennies

Ultra-Rare Penny Sells for $204,000 at Auction

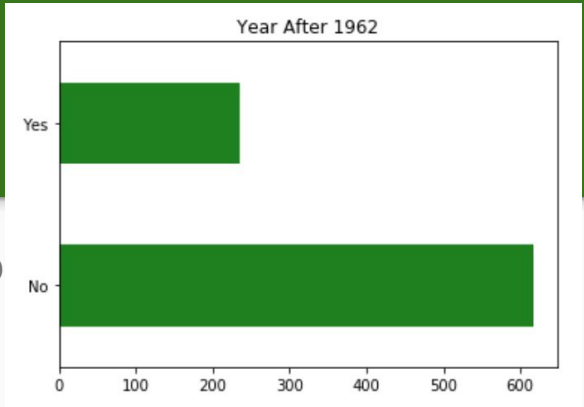
FORTUNE

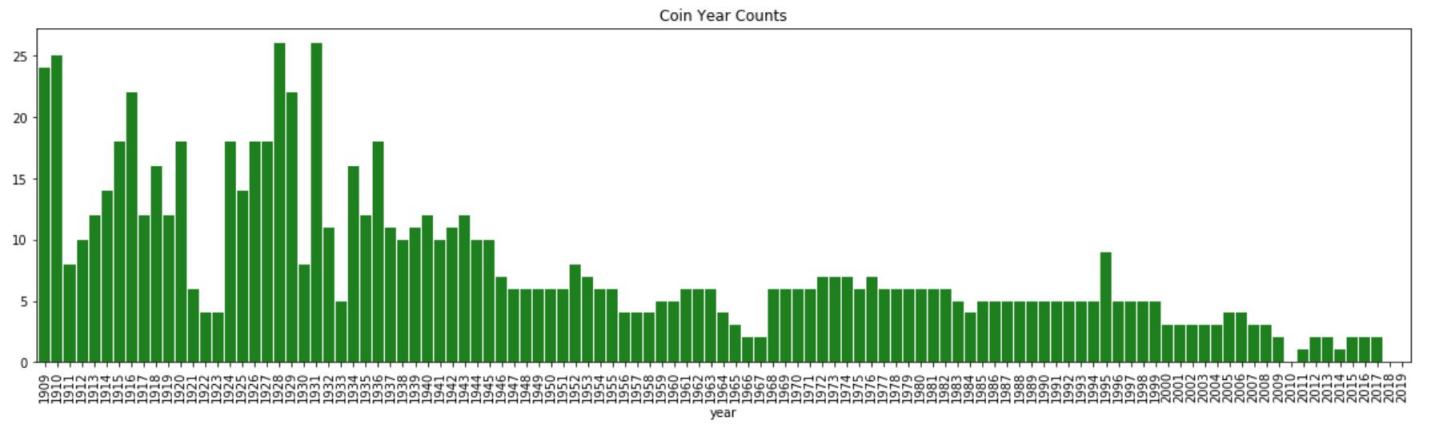
Chris Morris

Fortune January 11, 2019, 6:21 PM UTC

Target Variable

- We chose to predict whether a coin is made befo or after 1963.
- The alternative is a target with 111 classes

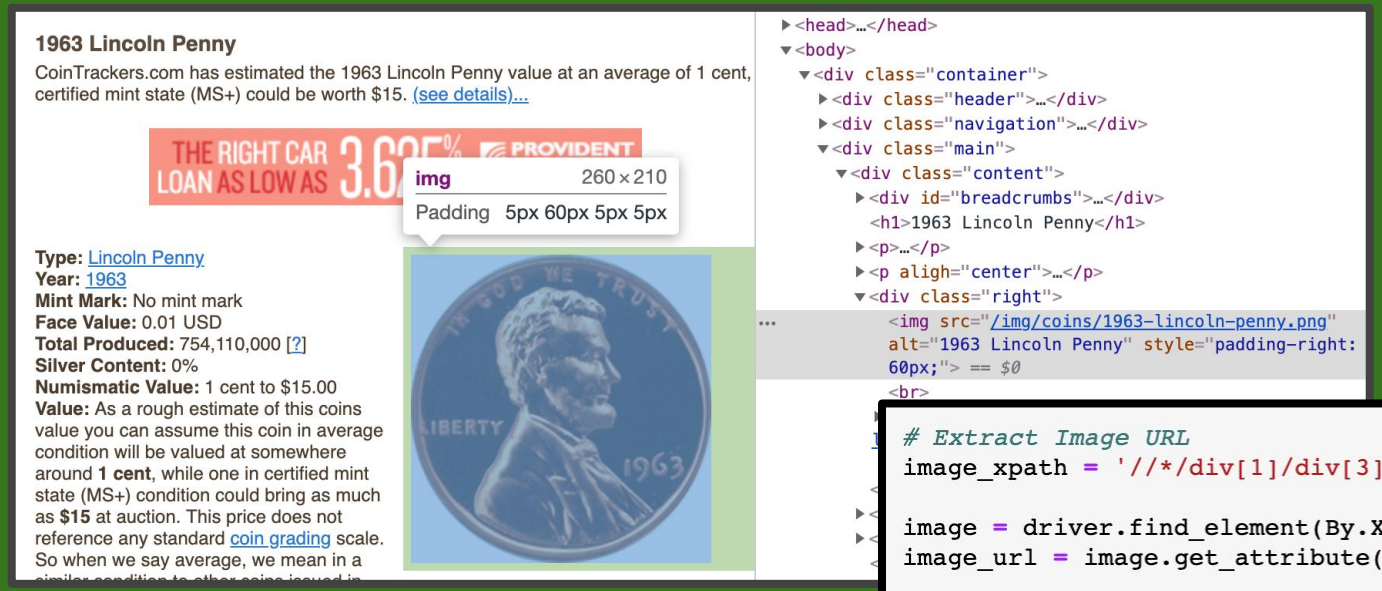




Data

- Training data: We found 845 labeled penny images online
- Training data was scraped with the Selenium python package
  - Image
  - Year
- Test data was collected with camera connected to PYNQ board

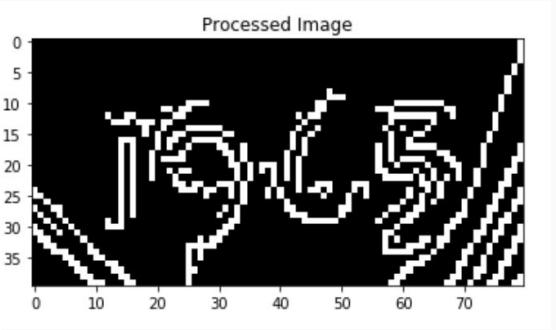
Scraping Images with Python




```python
# Extract Image URL
image_xpath = '//*/div[1]/div[3]/div[1]/div[2]/img'

image = driver.find_element(By.XPATH,image_xpath)
image_url = image.get_attribute("src")

# Save Image
destination = 'ct/' + name + '.png'

try:
    urllib.request.urlretrieve(image_url, destination)
except:
    pass
```

Image Preprocessing

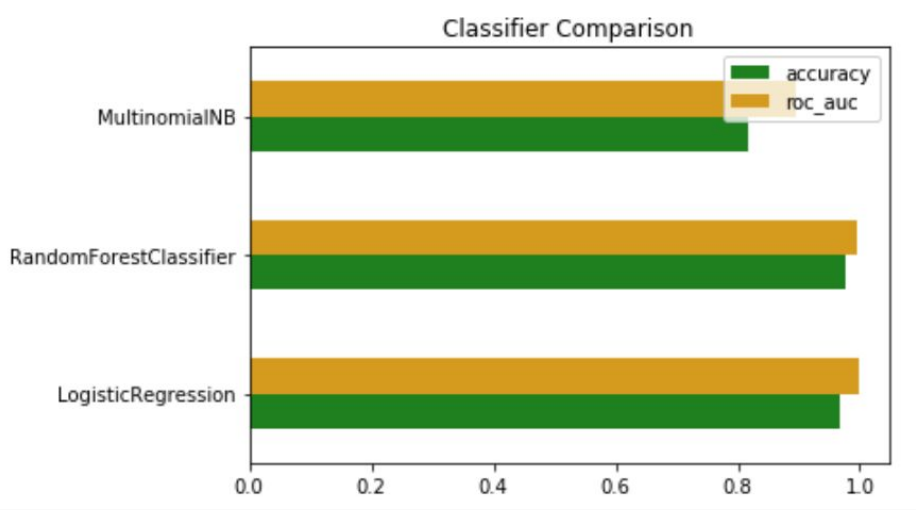
- All operations performed by OpenCV
  - Apply gaussian blur
  - Canny edge detection
  - Slice matrix to include year location
- OpenCV is an open source package that allows complex image processing operations with only a few lines of code
- Size reduced from 50 x 150 to 40 x 80



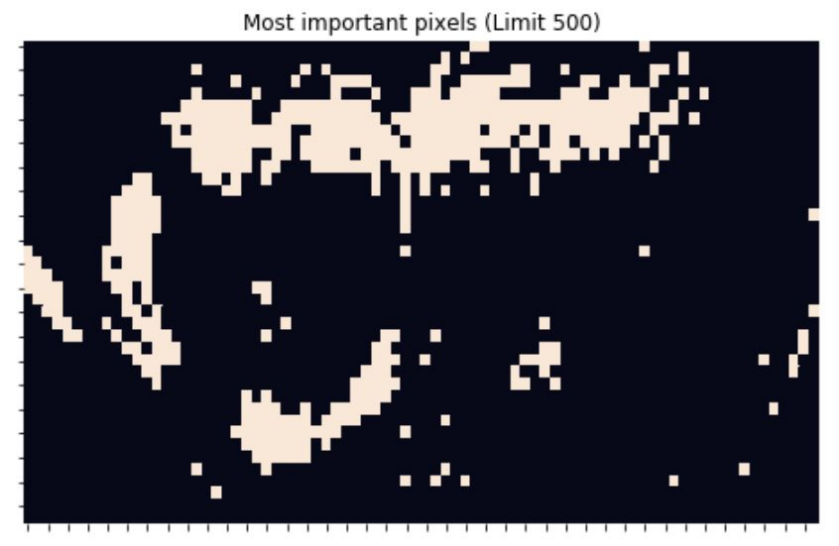
Classifier Comparison - Training Data

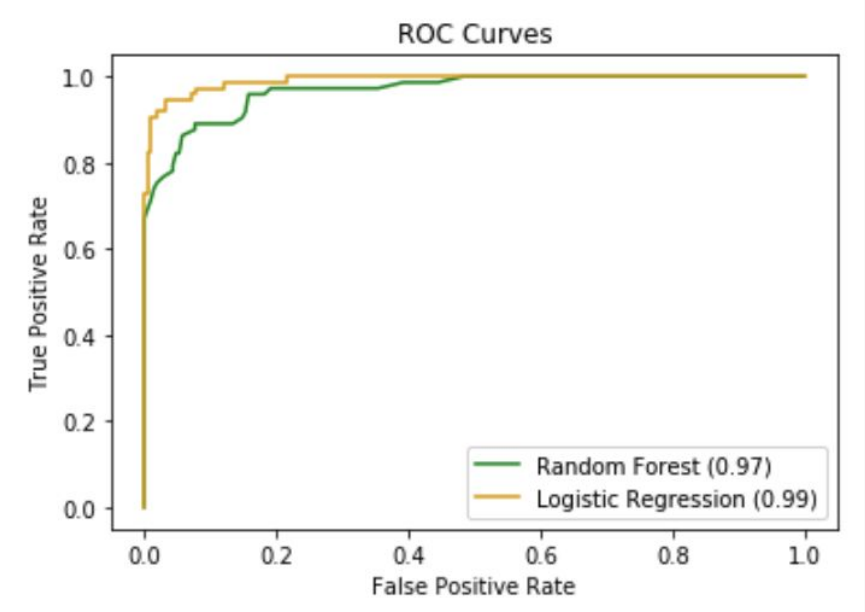
- Oversampled minority class to balance our target variable
- Classifiers generally performed well on training set
- Logistic regression showed the best accuracy and area under ROC
- Expected ensemble methods to perform better

name	accuracy	roc_auc
LogisticRegression	0.967071	0.997560
RandomForestClassifier	0.976761	0.996773
MultinomialNB	0.821548	0.898377



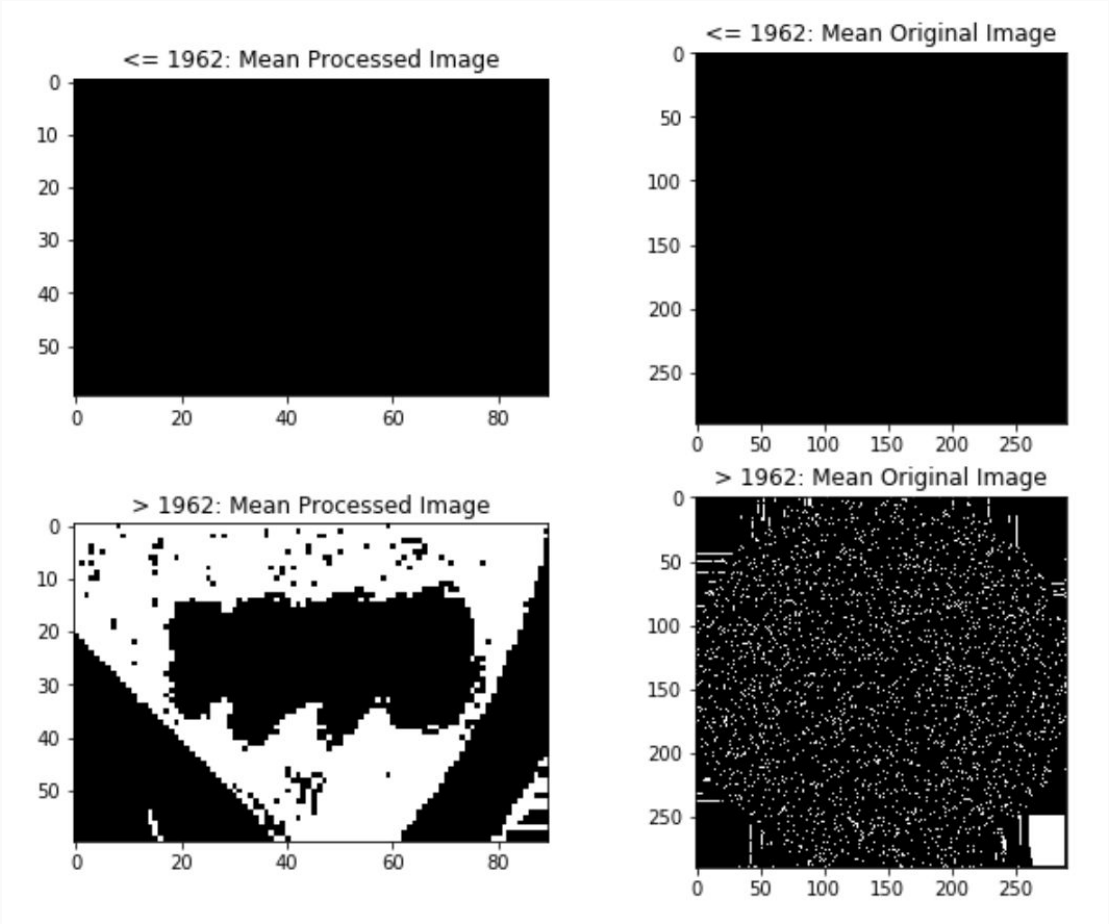
Classifier Comparison - Training Data





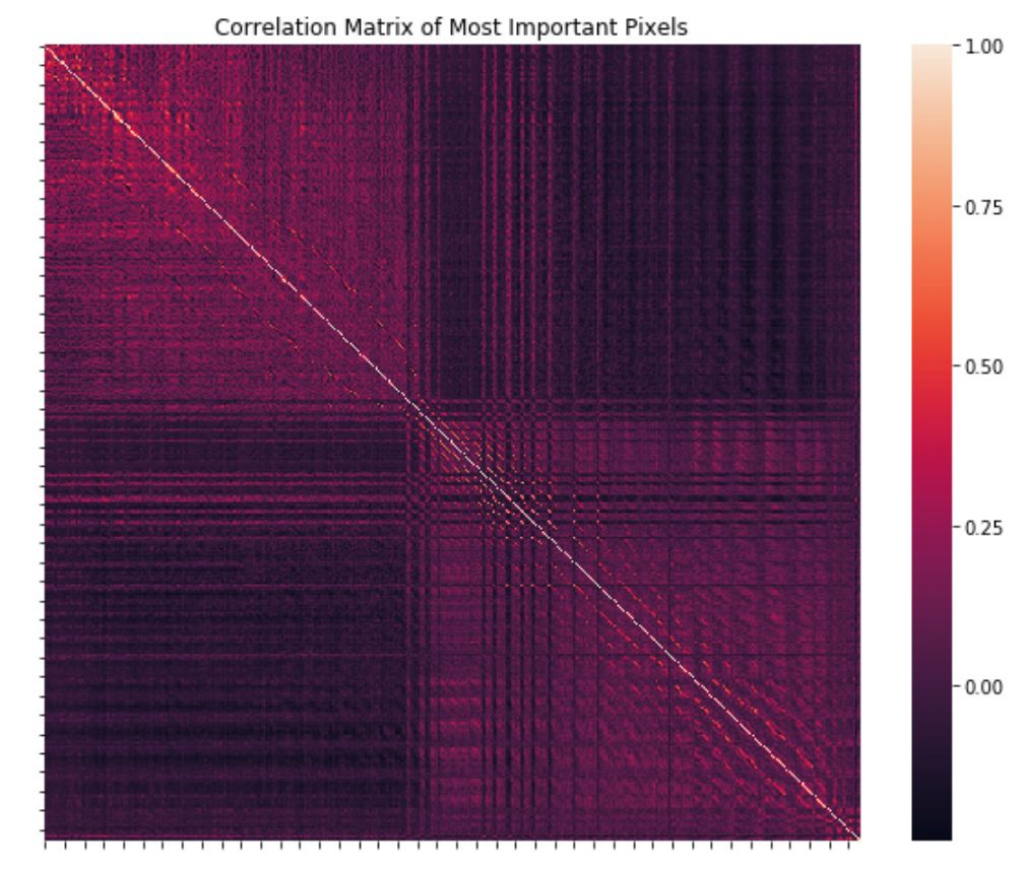
Target Variable

- Coin years after 1962 are brighter than before 1962
- This effect is preserved through preprocessing



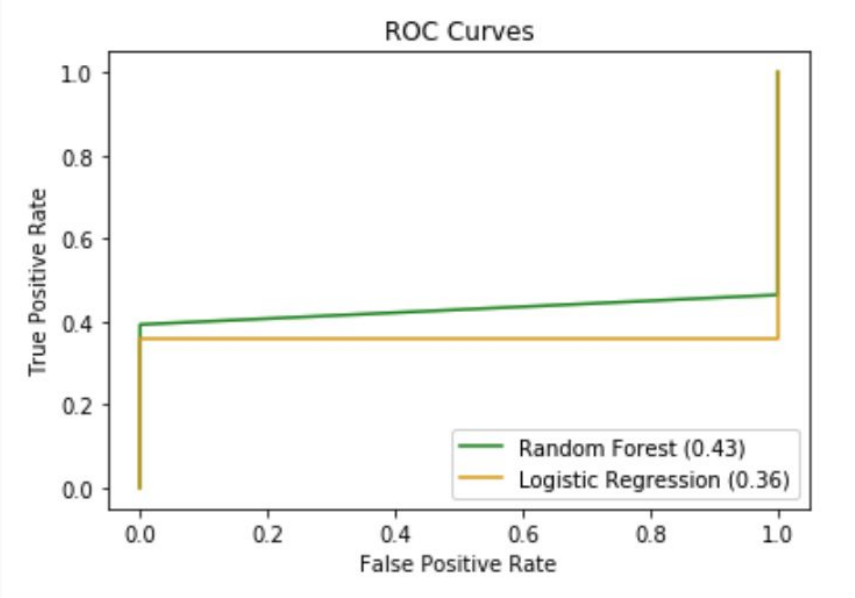
Collinearity

- Looking at the 500 most important pixels, we see some patterns.
- Most of the important pixels are on the border of the year on the coin



Classifier Comparison - Test Data

- Significant drop in performance when applying to test data
- Suspected causes:
  - Small amount of test data
  - Image preprocessing could be more robust



Next Steps

- Look at individual digits
- Better image preprocessing
- Collect more data and attempt to classify all years
- Predict coin condition (good, fair, excellent, etc.)
- Explore Deep Learning algorithms