Ham vs Spam Emails

Project 4 Group 2

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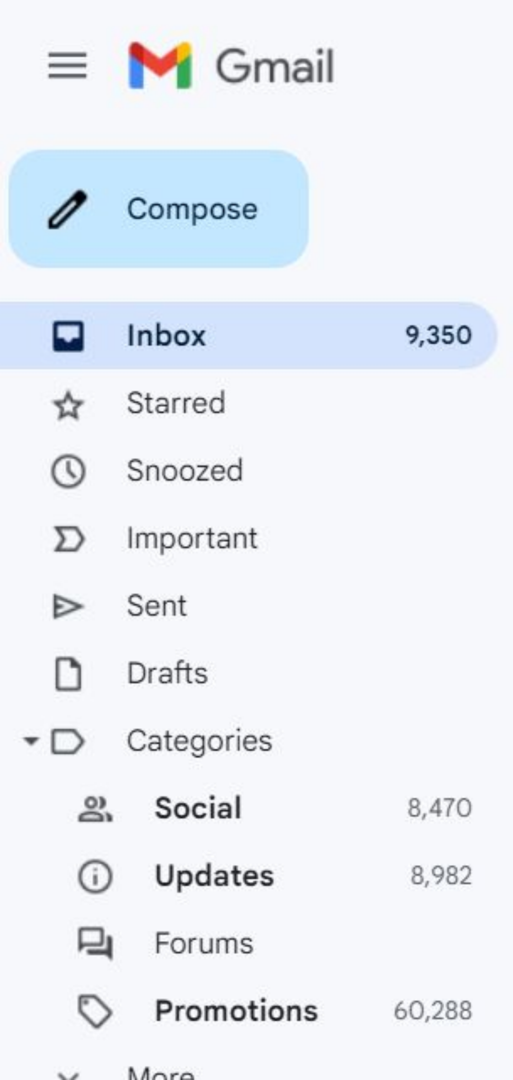


INTRODUCTION

Problem:

- Receiving too many spam emails in your inbox
- Having to find a ham email in your spam/junk folders

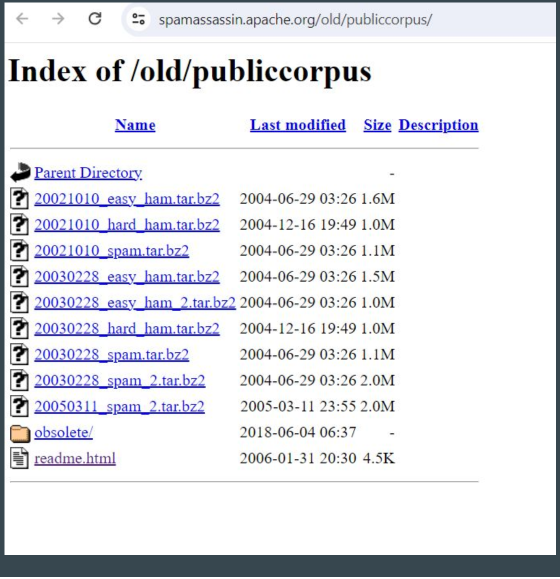
Question: How can we accurately sort spam and ham emails?

What are Spam and Ham emails?:

- **Spam**: unsolicited and unwanted junk email sent out in bulk to an indiscriminate
- **Ham**: non-spam email, “good/wanted” email

Data Source and Explanation of Data

- "Email Spam Dataset (Extended)" from Kaggle containing 9,000 files
- Original dataset came from SpamAssassin's Old Public Corpus which had about 6,000 files
- Altogether, contains 6,951 'ham' and 2,398 'spam' raw email files.
- Includes data between 2002 and 2005.
- Spam emails marked by use of HTML, unusual HTML markup, colored text, and "spammish-sounding" phrases



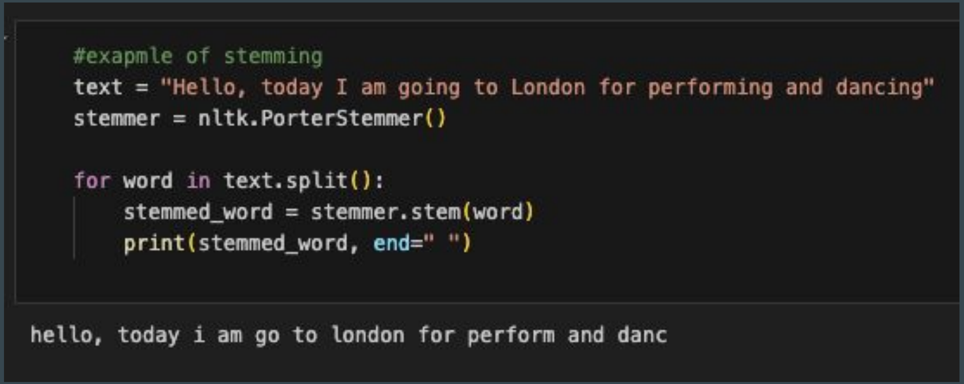
spamassassin.apache.org/old/publiccorpus/

Index of /old/publiccorpus

Name	Last modified	Size	Description
Parent Directory		-	
20021010_easy_ham.tar.bz2	2004-06-29 03:26	1.6M	
20021010_hard_ham.tar.bz2	2004-12-16 19:49	1.0M	
20021010_spam.tar.bz2	2004-06-29 03:26	1.1M	
20030228_easy_ham.tar.bz2	2004-06-29 03:26	1.5M	
20030228_easy_ham_2.tar.bz2	2004-06-29 03:26	1.0M	
20030228_hard_ham.tar.bz2	2004-12-16 19:49	1.0M	
20030228_spam.tar.bz2	2004-06-29 03:26	1.1M	
20030228_spam_2.tar.bz2	2004-06-29 03:26	2.0M	
20050311_spam_2.tar.bz2	2005-03-11 23:55	2.0M	
obsolete/	2018-06-04 06:37	-	
readme.html	2006-01-31 20:30	4.5K	

Data Cleaning and Preprocessing

1. Parse emails to just their text
2. BeautifulSoup to convert raw email files to plain text
3. Normalize text
    a. Lowercasing
    b. Removing punctuation
    c. Stemming
4. Create a vector of word counts



```
#exapmle of stemming
text = "Hello, today I am going to London for performing and dancing"
stemmer = nltk.PorterStemmer()

for word in text.split():
    stemmed_word = stemmer.stem(word)
    print(stemmed_word, end=" ")
```

```
hello, today i am go to london for perform and danc
```

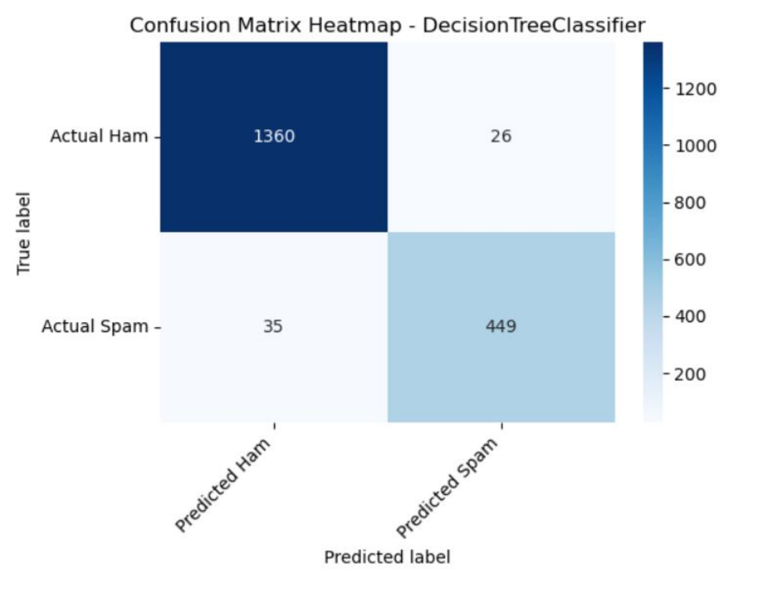
Models Used During Optimization Process

- Random Forest
- Decision Tree
- Logistic Regression

Decision Tree

"Tree-like model with nodes representing features and leaves representing outcomes. Used for both classification and regression."

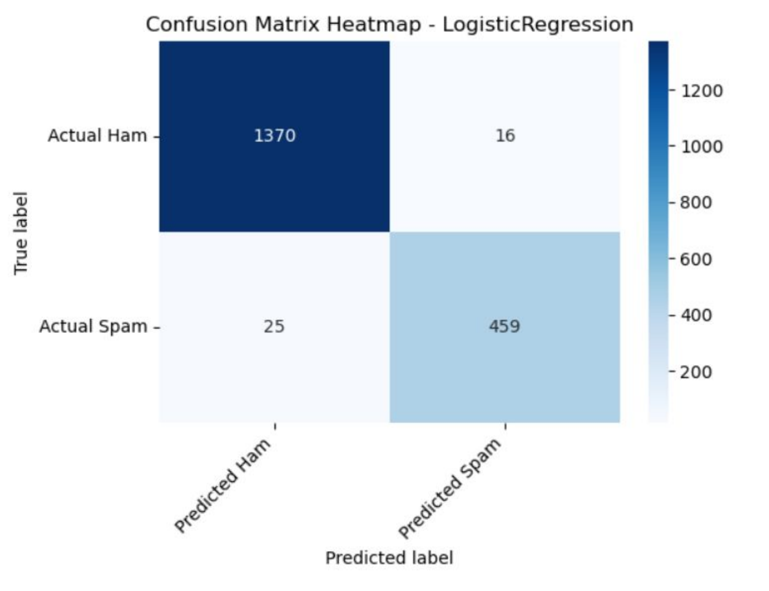
- 97% Accuracy
  - True Positive - 449
  - True Negative - 1360
  - False Positive (Spam) - 26
  - False Negative (Ham) - 35



Logistic Regression

"Linear model predicting probabilities for binary classification. Extends to multinomial logistic regression for multiple classes."

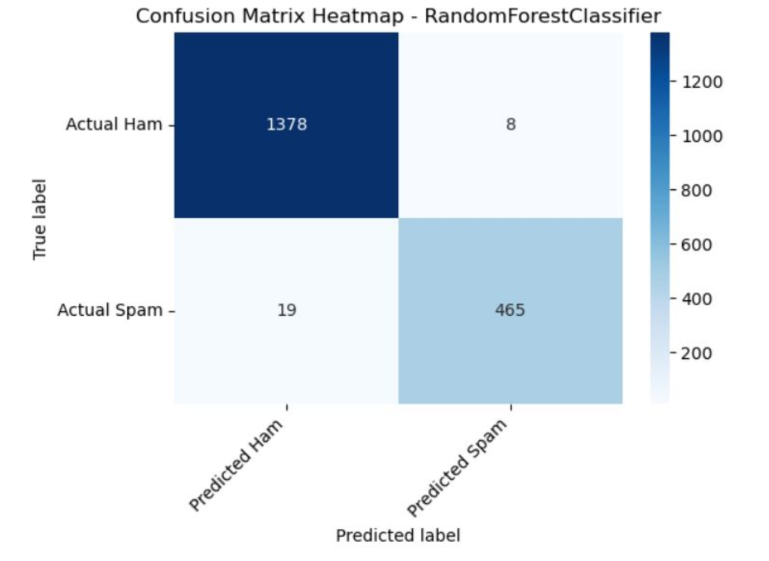
- Accuracy 98%
  - True Positive - 459
  - True Negative - 1370
  - False Positive (Spam) - 16
  - False Negative (Ham) - 25



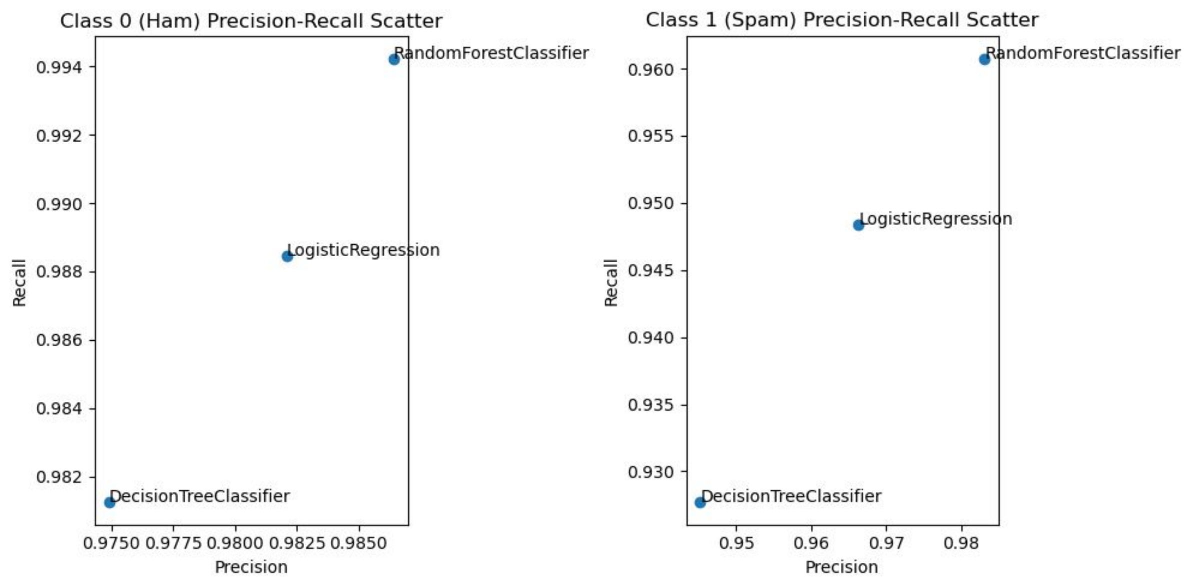
Random Forest Model

"Ensemble of decision trees. Each tree is built with randomness to improve generalization and reduce overfitting. Used for both classification and regression."

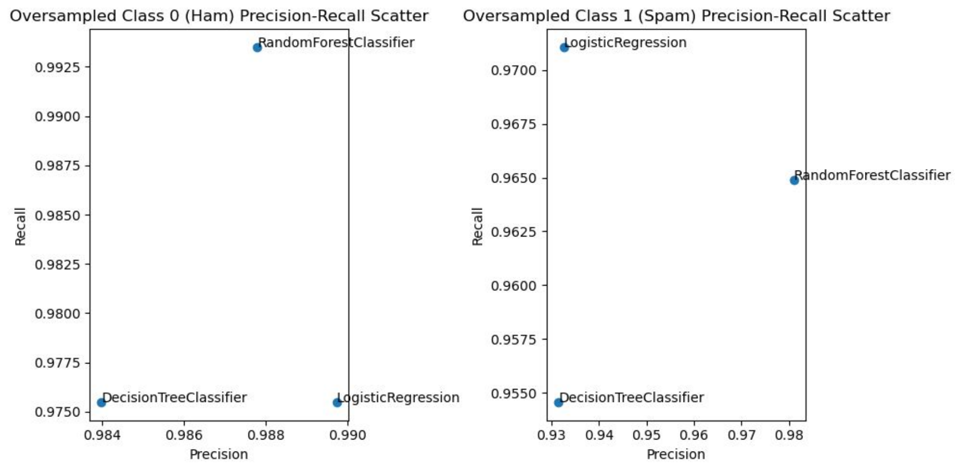
- Optimization - reducing false positives and false negatives.
- 99% Accuracy
  - True Positives - 465
  - True Negatives - 1378
  - False Positives (Spam) - 8
  - False Negatives (Ham) - 19

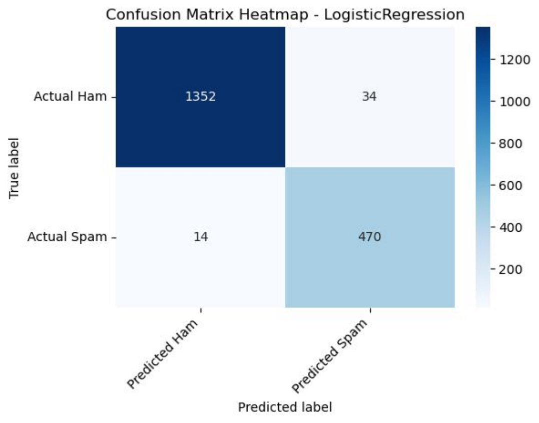


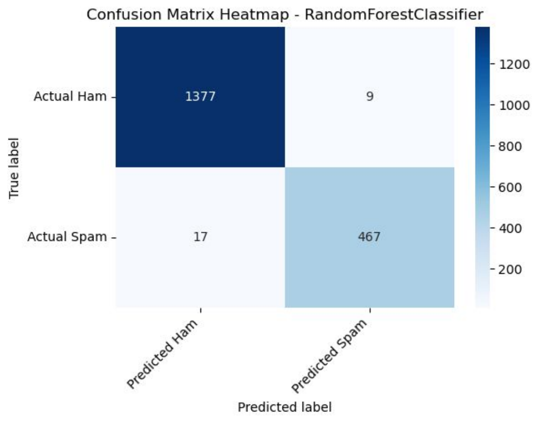
Comparison

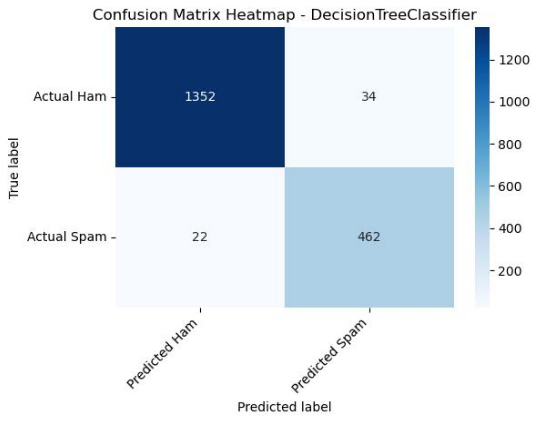

Class 0 (Ham) Precision-Recall Scatter
Recall
0.994
0.992
0.990
0.988
0.986
0.984
0.982
Precision
0.9750
0.9775
0.9800
0.9825
0.9850
RandomForestClassifier
LogisticRegression
DecisionTreeClassifier
Class 1 (Spam) Precision-Recall Scatter
Recall
0.960
0.955
0.950
0.945
0.940
0.935
0.930
Precision
0.95
0.96
0.97
0.98
RandomForestClassifier
LogisticRegression
DecisionTreeClassifier

Oversampling

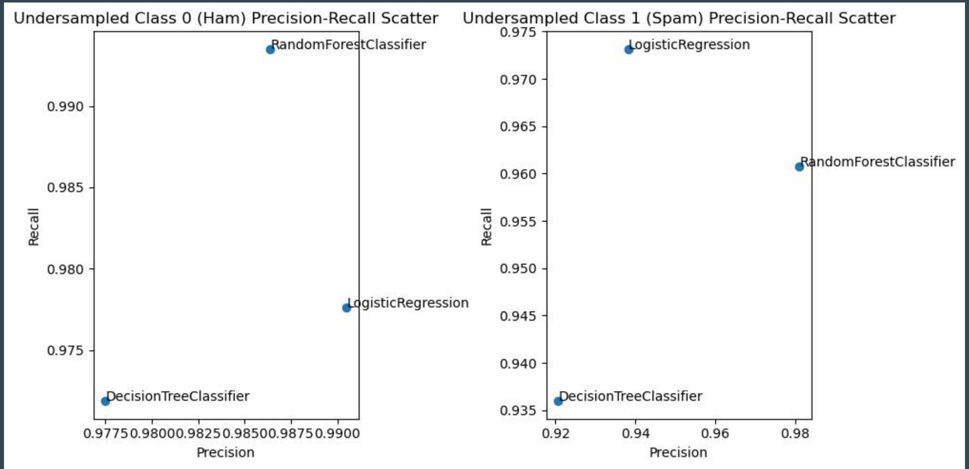


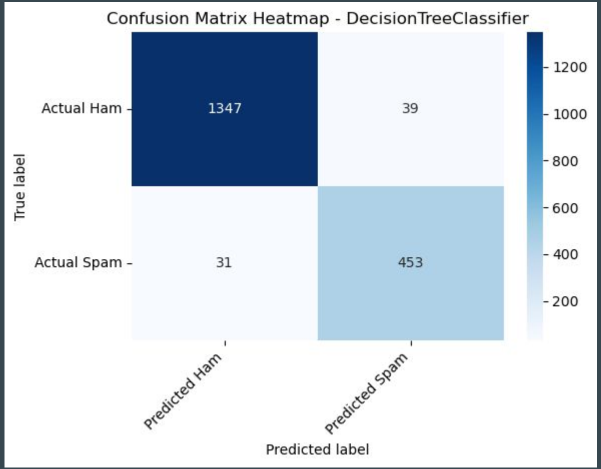


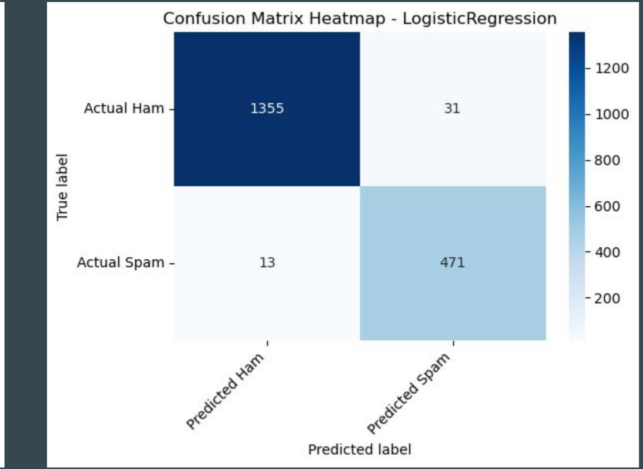


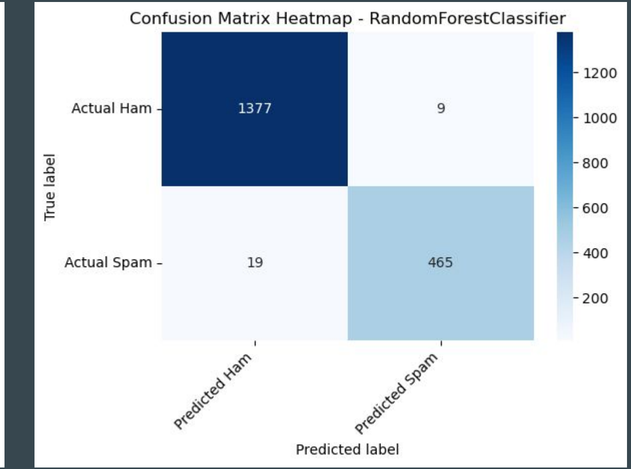


Undersampling

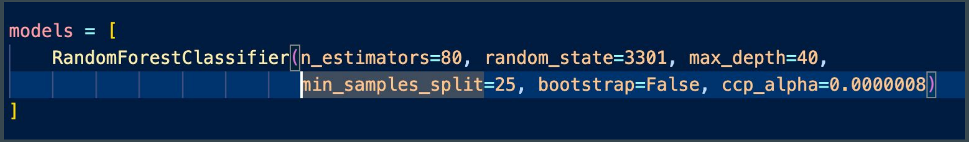




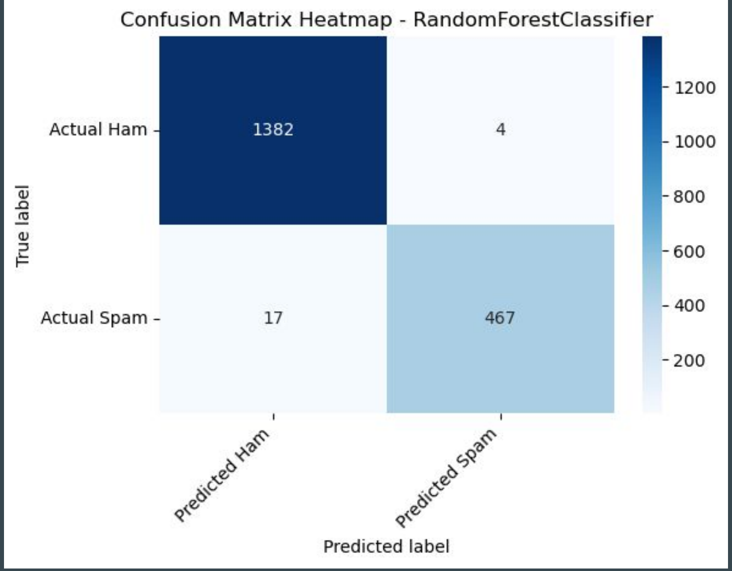




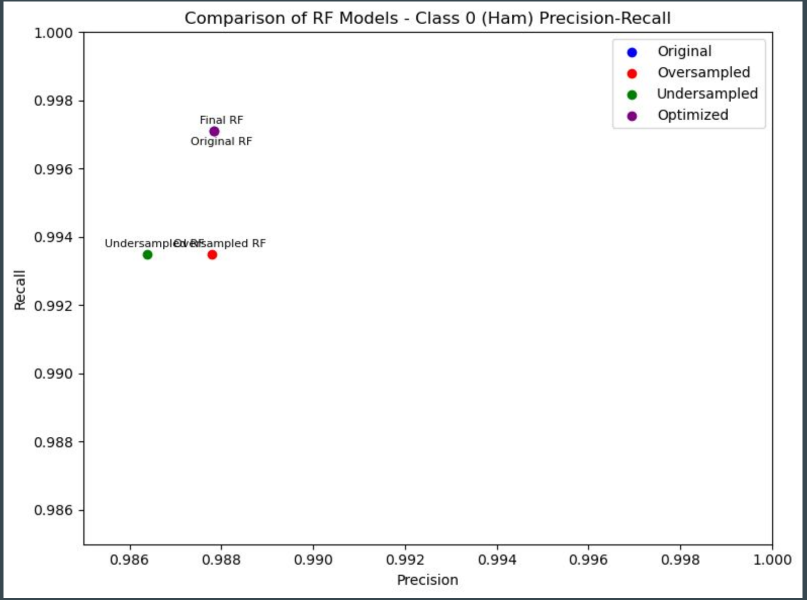
Hyperparameter Tuning



```
models = [
    RandomForestClassifier(n_estimators=80, random_state=3301, max_depth=40,
                           min_samples_split=25, bootstrap=False, ccp_alpha=0.0000008)
]
```



Comparison of Random Forest Models



Possible Future Steps

- Compare the accuracy of the computer model we created for this data set to a dataset containing more recent emails to see how the accuracy changes.
- Increase the number of most commonly used words in the word vector.
- Add any words that we believe could be important in distinguishing ‘ham’ vs ‘spam’ emails.

Resources:

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Thank you!

Special thanks to Hunter, Sam, and Randy. Questions?