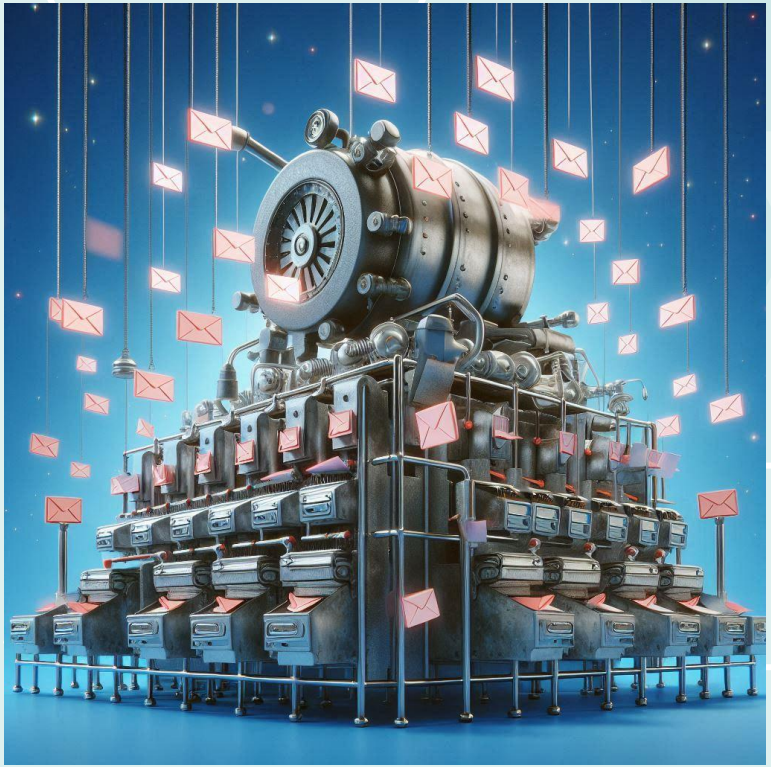
Spam Email Filter Machine Learning Model



Agenda

01 Business Problem

02 Exploratory Data Analysis

03 Predictive Modeling

04 Conclusions

05 Recommendation

06 Next Steps

01 Business Problem

Our telecommunications company wants to break into the email market and needs to implement an effective SPAM filter.

We are charged with:

- Create a model that reliably detects SPAM in a way that will maximize customer satisfaction

02 Data Analysis

Actual emails in the form of individual HTML files were used in the analysis

- 5280 HTML files in total
- Each email was previously labeled as HAM or SPAM and sorted into folders

Source: Index of /old/publiccorpus (apache.org)

Email Importing and Preprocessing

```
From rssfeeds@jmason.org  Tue Oct  8 10:56:10 2002
Return-Path:
Delivered-To: yyyy@localhost.example.com
Received: from localhost (jalapeno [127.0.0.1])
        by jmason.org (Postfix) with ESMTP id EEE0616F03
        for ; Tue,  8 Oct 2002 10:56:09 +0100 (IST)
Received: from jalapeno [127.0.0.1]
        by localhost with IMAP (fetchmail-5.9.0)
        for jm@localhost (single-drop); Tue, 08 Oct 2002 10:56:09 +0100 (IST)
Received: from dogma.slashnull.org (localhost [127.0.0.1]) by
    dogma.slashnull.org (8.11.6/8.11.6) with ESMTP id g9881LK06173 for
    ; Tue, 8 Oct 2002 09:01:21 +0100
Message-Id: <200210080801.g9881LK06173@dogma.slashnull.org>
To: yyyy@example.com
From: newscientist
Subject: Species at risk of extinction growing
Date: Tue, 08 Oct 2002 08:01:21 -0000
Content-Type: text/plain; encoding=utf-8
X-Spam-Status: No, hits=-1014.1 required=5.0
        tests=AWL,T_NONSENSE_FROM_40_50
        version=2.50-cvs
X-Spam-Level:

URL: http://www.newsisfree.com/click/-2,8653742,1440/
Date: Not supplied

The latest "Red List" adds 124 to the 11,000 endangered species around the
globe - but also includes a stick insect revival
```

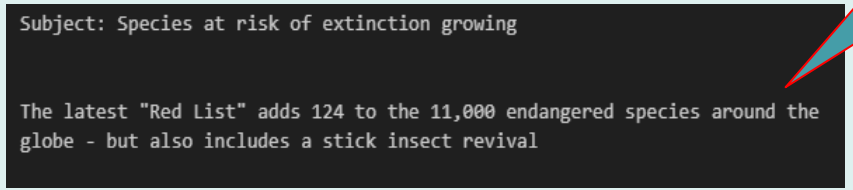
```
Subject: Species at risk of extinction growing


The latest "Red List" adds 124 to the 11,000 endangered species around the
globe - but also includes a stick insect revival
```

Subject Line vs Email Body

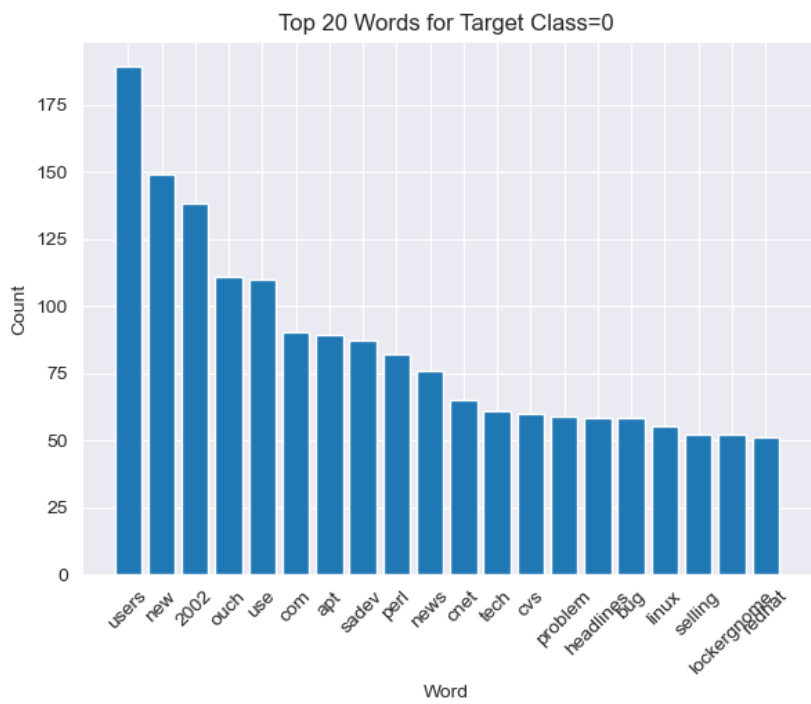
Subject Line:
- We expect ‘dense’ information about the nature of the email

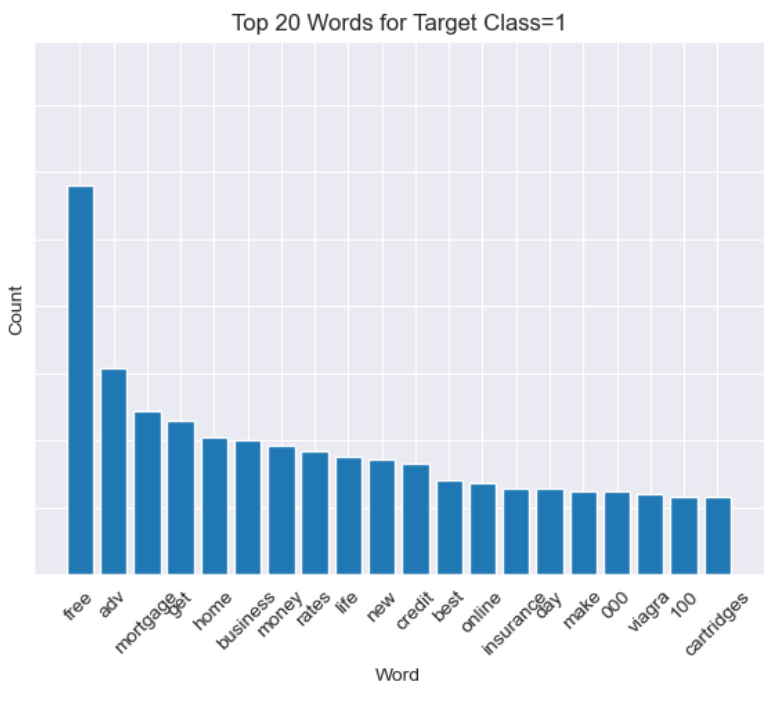
Email Body:
- More information about the nature of the email, more verbose



- Modeling the Subject and Body separately…

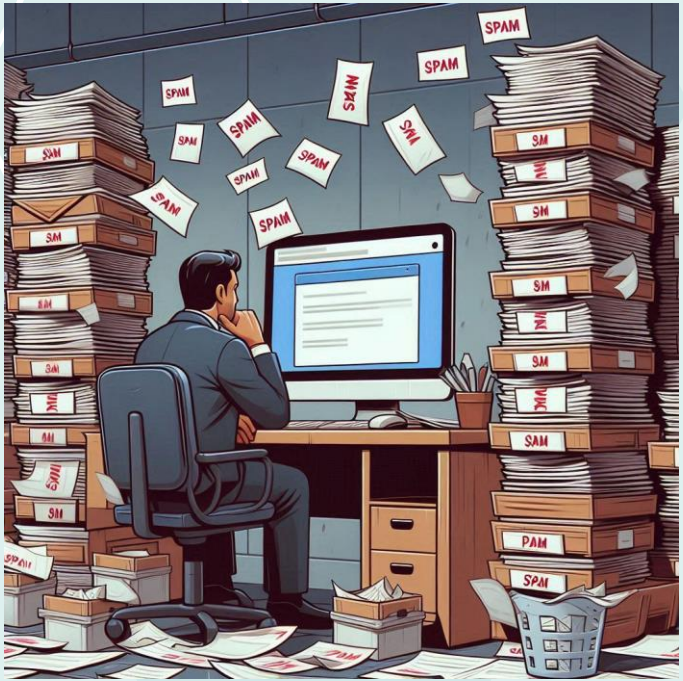
Subject Line Word Count by Target Class





Note: Models are built on company internal email data, will need to adjust models trained on anonymized customer emails data after deployment

03 Predictive Modeling

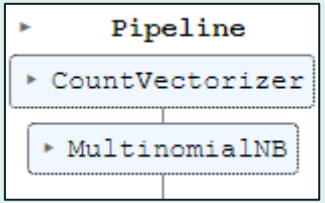


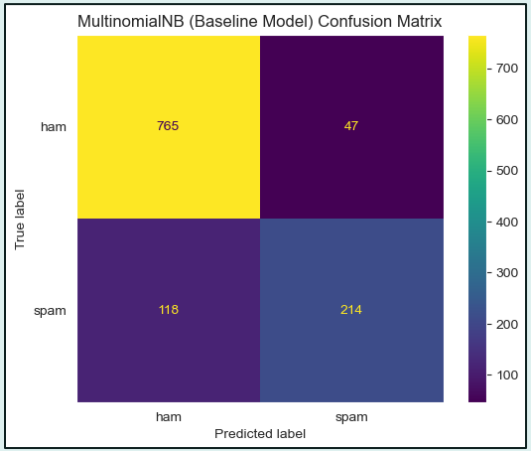
BUSINESS REQUIREMENT: Less than 1% of customers HAM emails are allowed to go to the SPAM classification

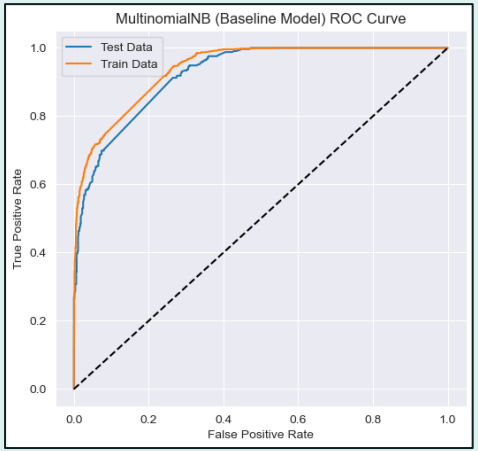
- Getting SPAM irritates our customers, but missing HAM because we classified it as SPAM will really anger them!

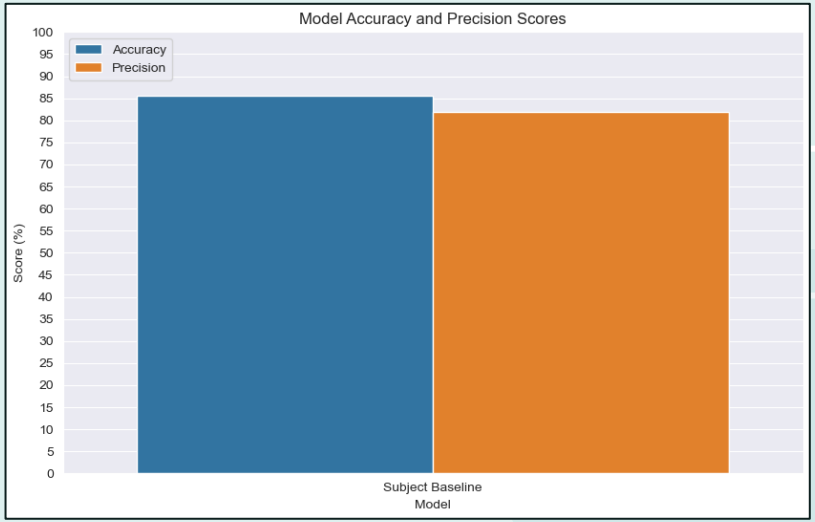
- Optimizing models on Precision, then Accuracy

Subject Line Baseline Model

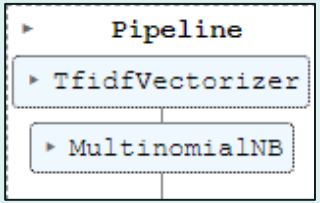


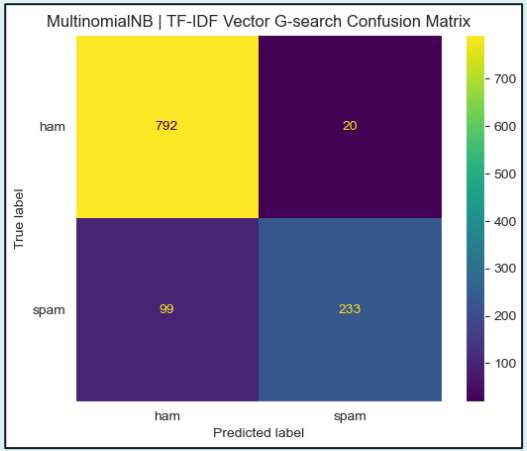


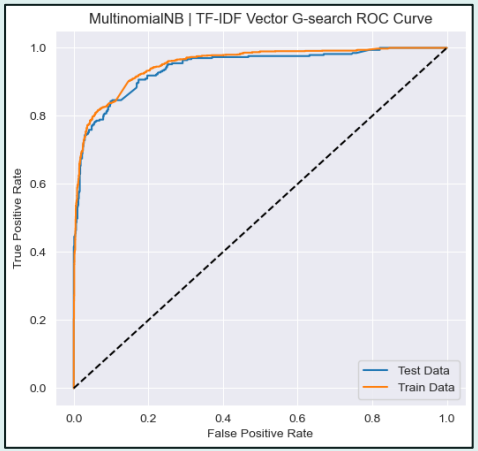


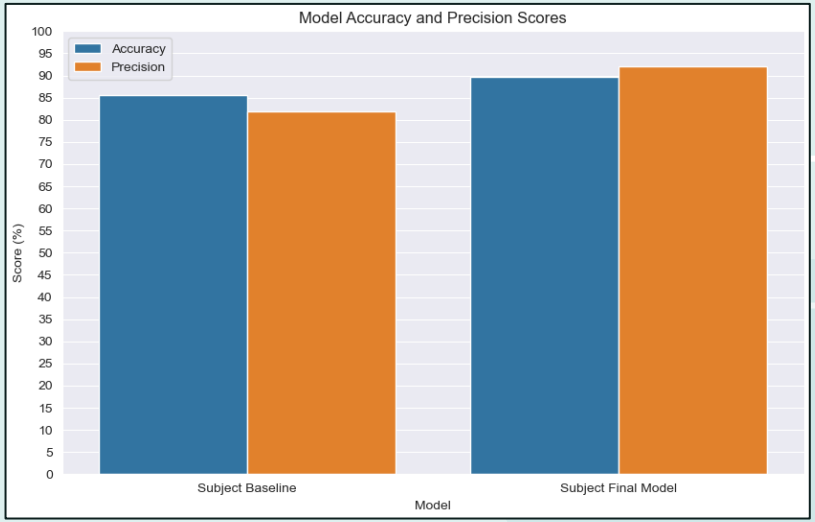


Subject Line Final Model

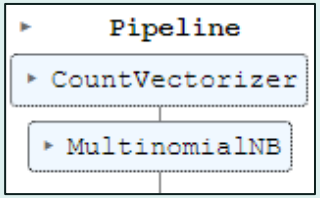


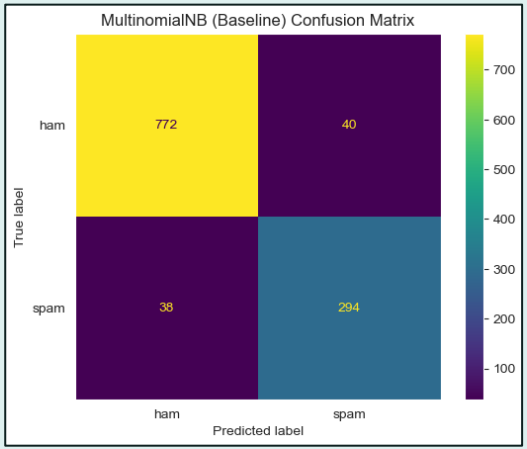


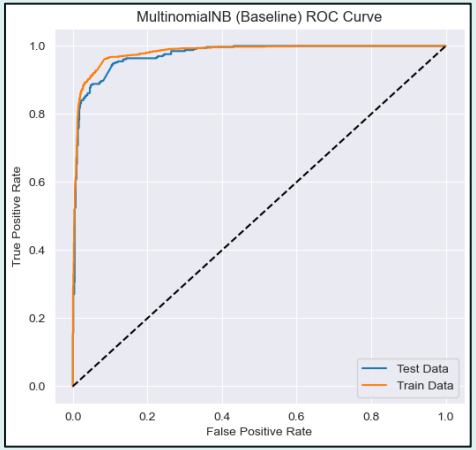


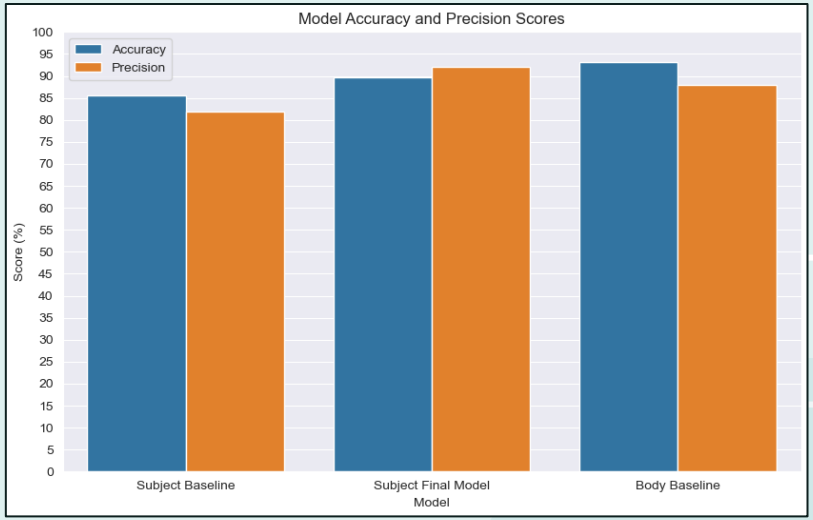


Email Body Baseline Model

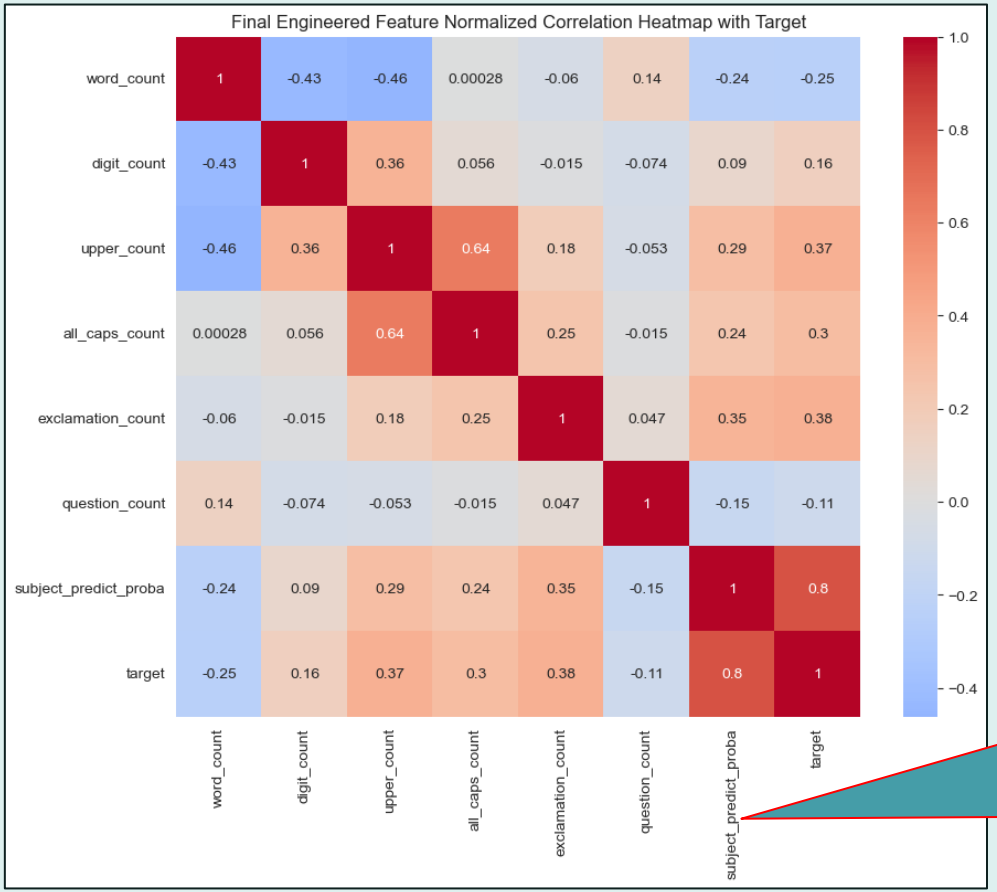




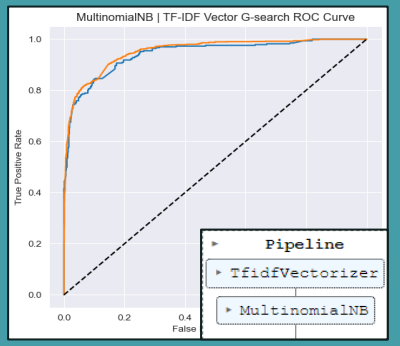




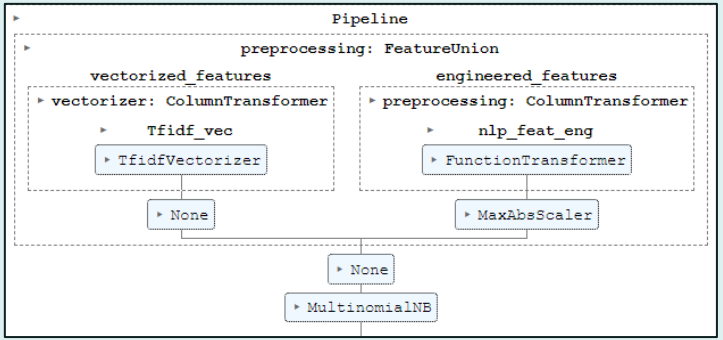
Email Body Feature Engineering

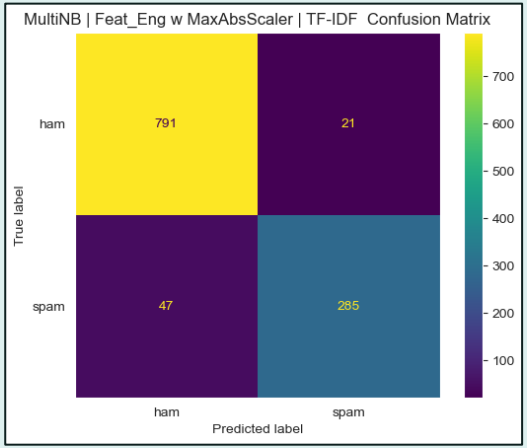


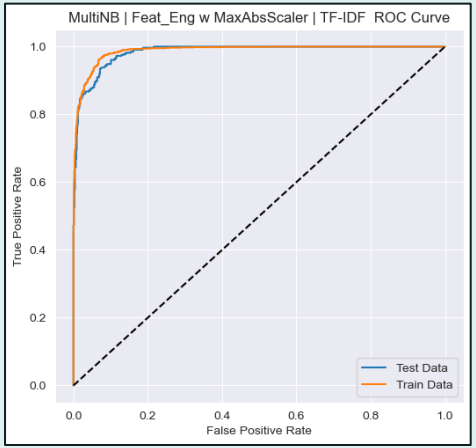
SUBJECT LINE PREDICTIONS

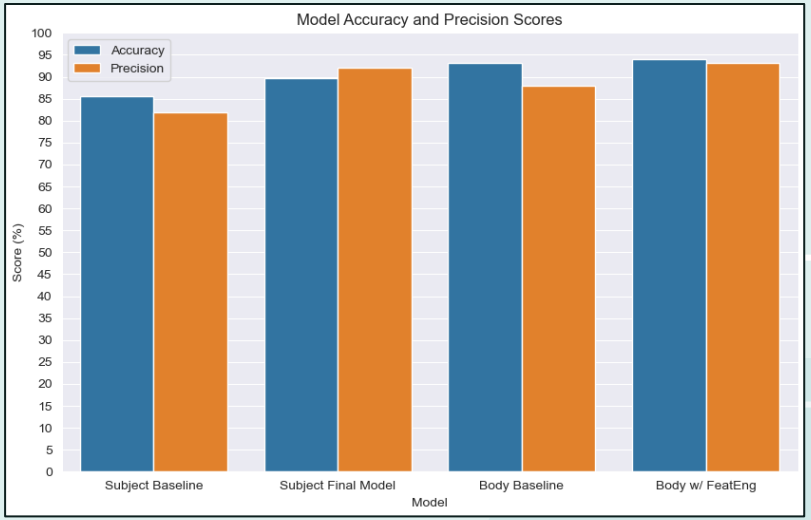


Email Body With Feature Engineering

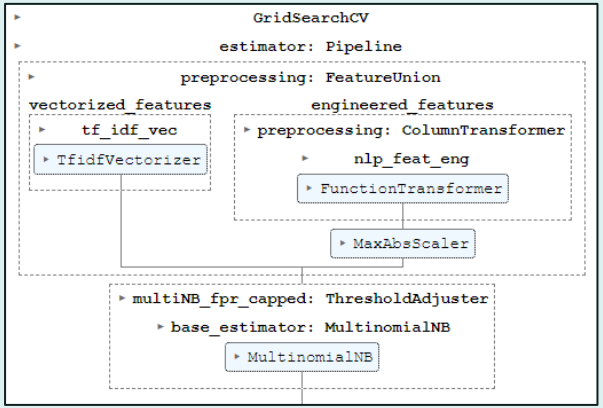


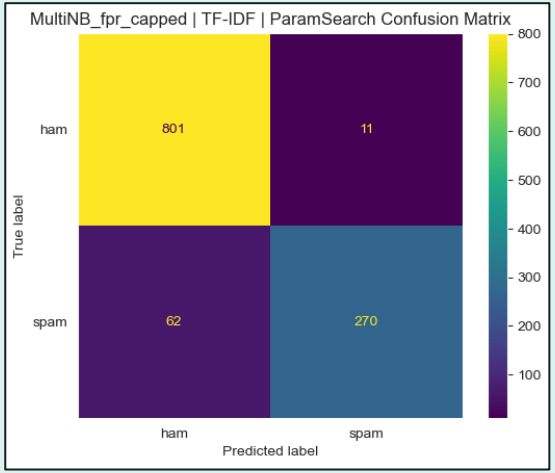


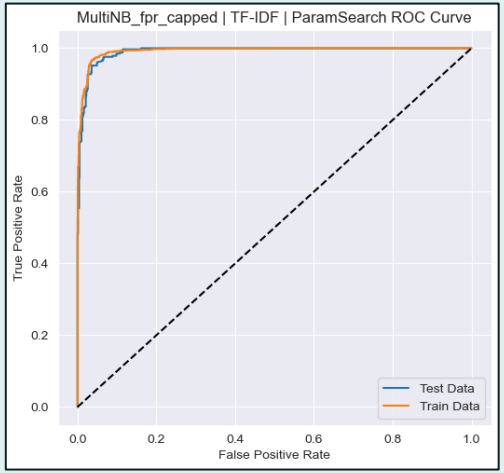


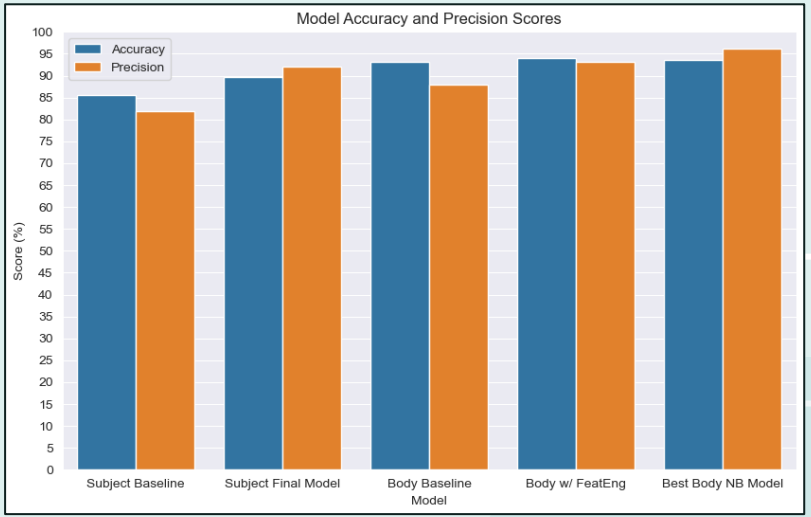


Email Body – Best Naive Bayes Model

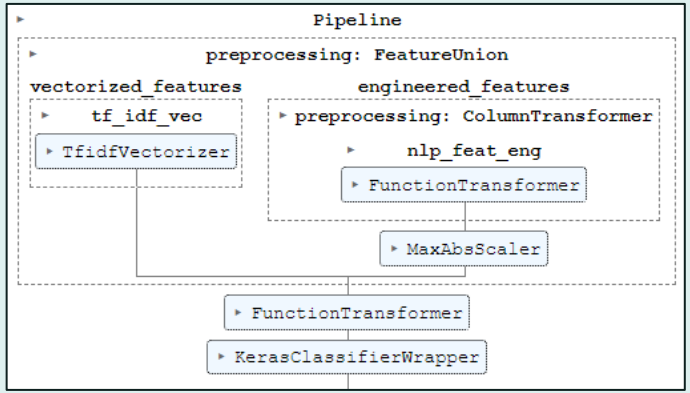




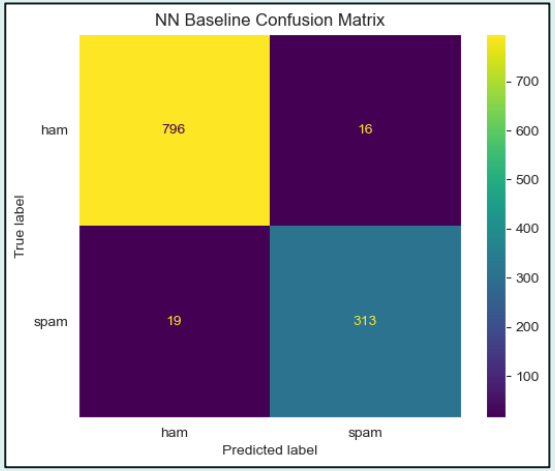


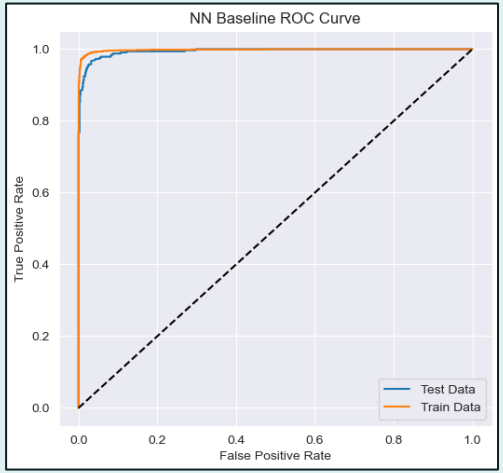


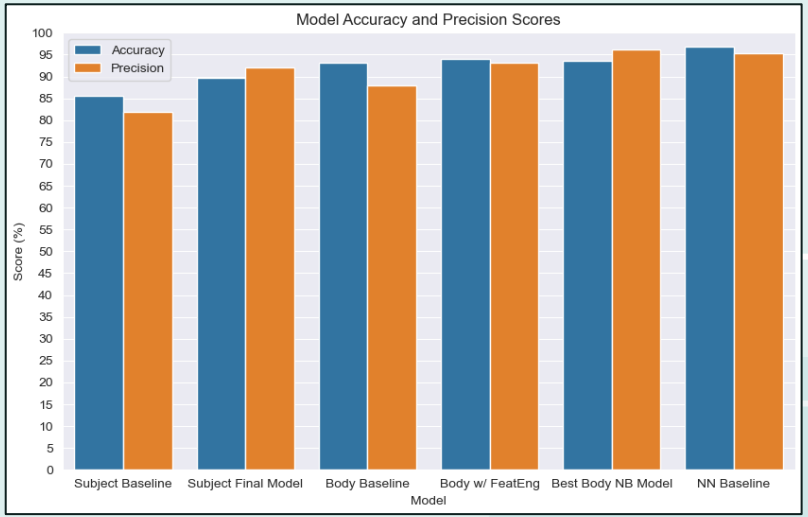
Email Body – Neural Network Baseline



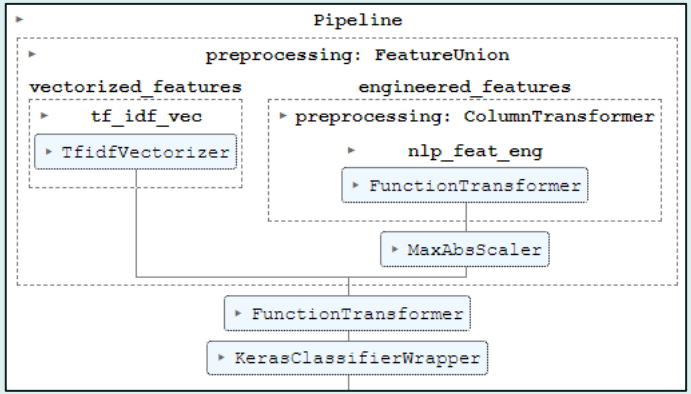
- One hidden layer



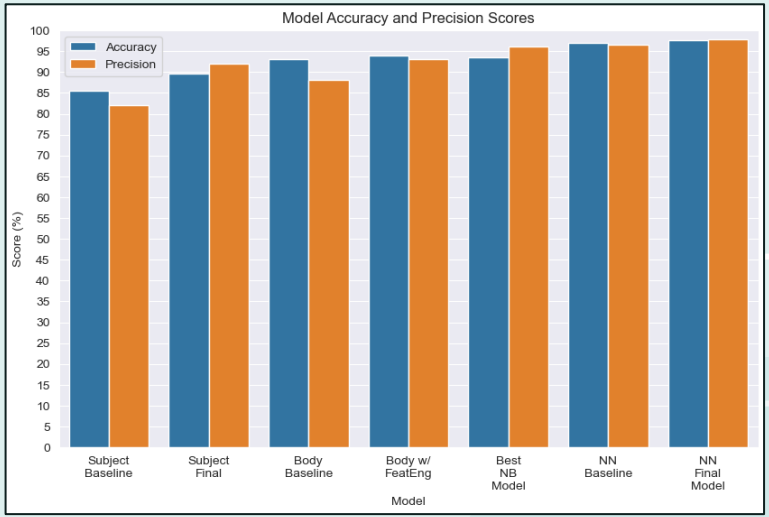


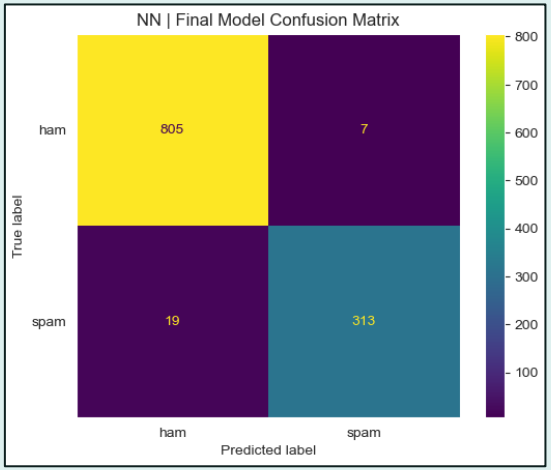


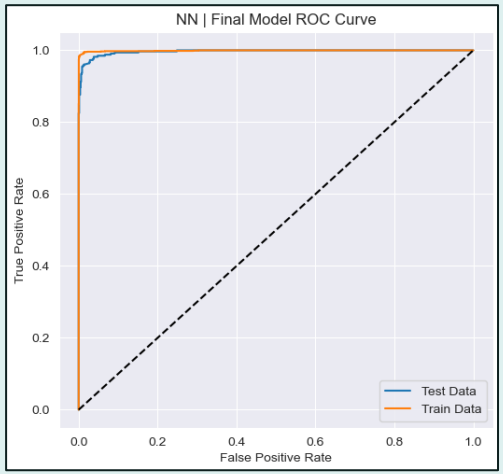
Email Body – Neural Network Final



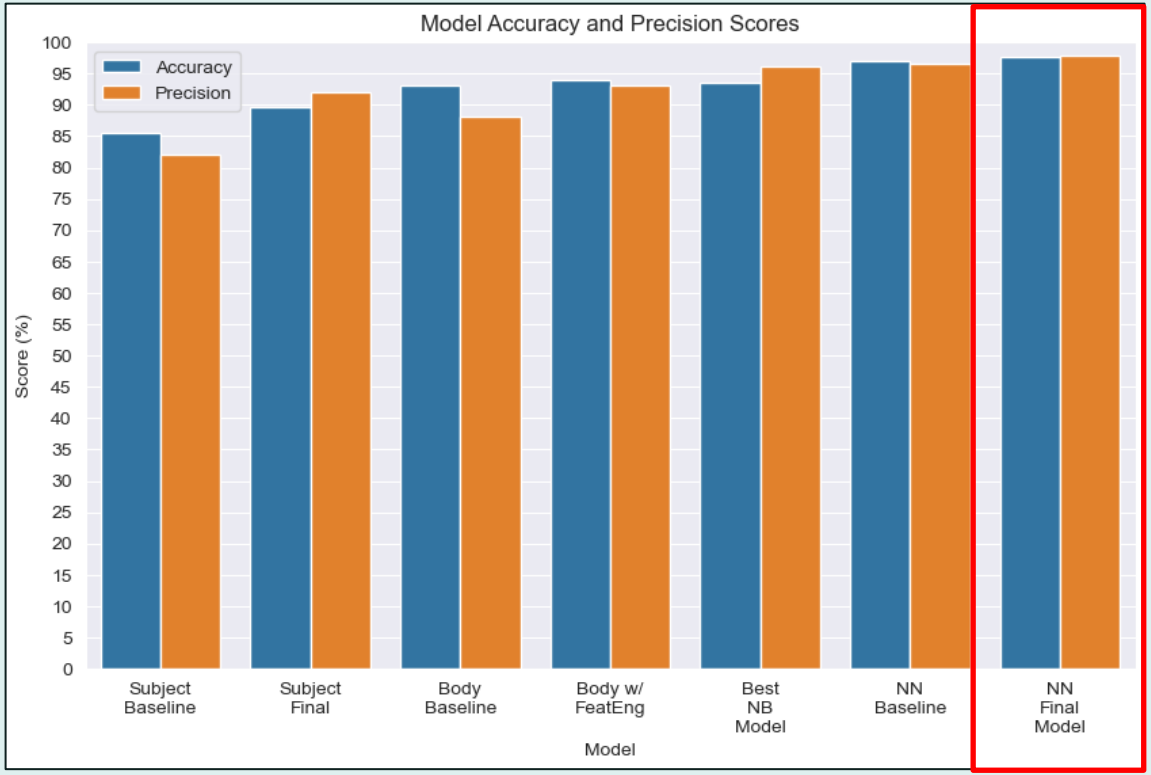
- 5 hidden layers
- 2 dropout layers
- Gridsearch using Hyperband()







04 Conclusion



Final Model Test Metrics:

- Precision: **97.7%**
- Accuracy: **97.8%**

Final Business Metrics:

- False Pos Rate (HAM going to SPAM): **0.9%**
- False Neg Rate (SPAM going to HAM): **6%**

05 Recommendation

1. Implement the best Neural Network model during initial Email service rollout

2. Continue to retrain and retune the models on new anonymized customer data

3. Investigate other potential model architectures (RandomForest, XGBoost)

06 Next Steps

1. Acquire larger data sets of up-to-date, real emails

2. Investigate SPAM detection models for calls and texts

Thanks!

Do you have any questions?

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daledeford@gmail.com