



COMP 6721

Project Assignment - 2 **Spam Detector**

Submitted to
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FL-G08

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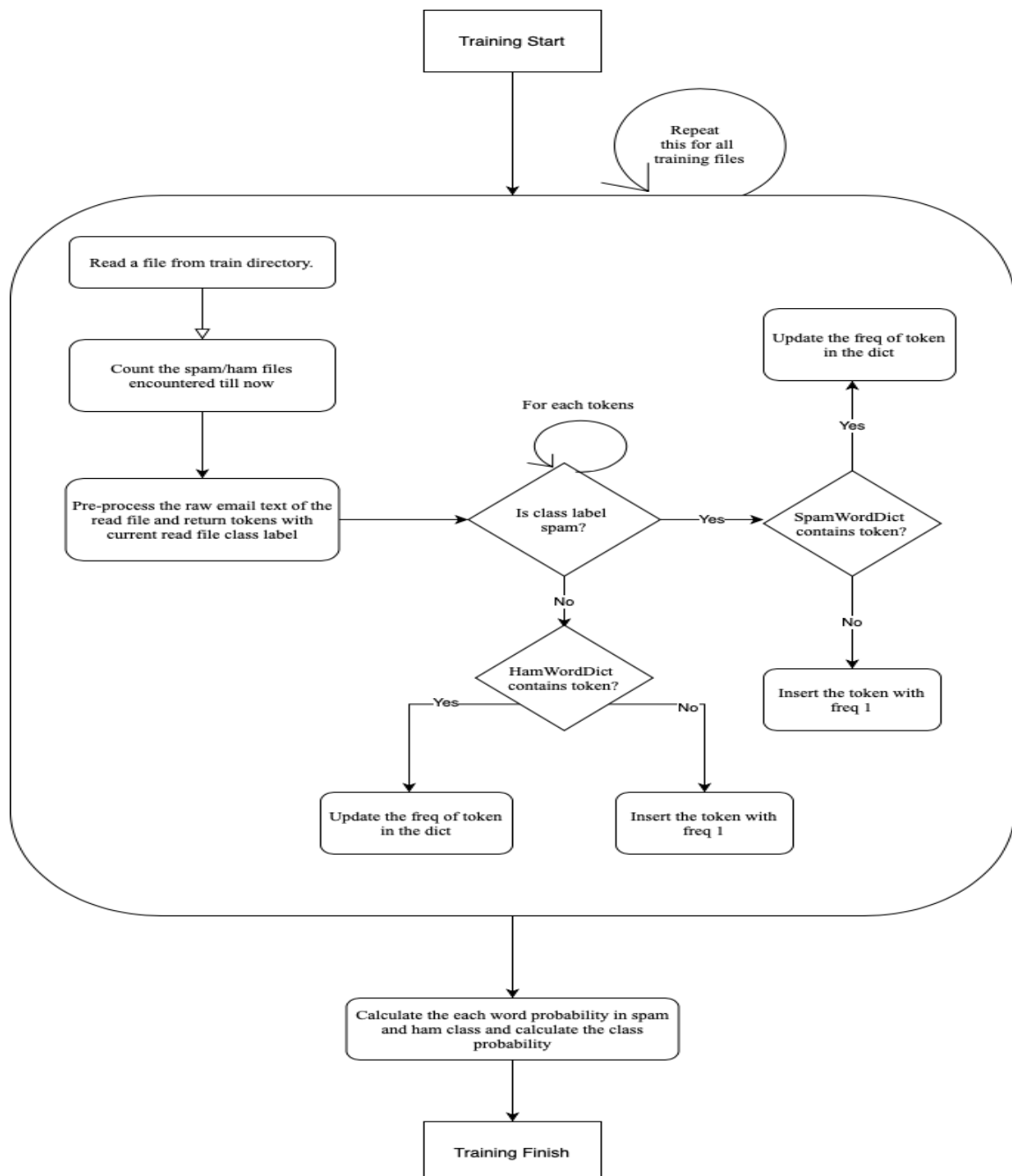
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Analysis

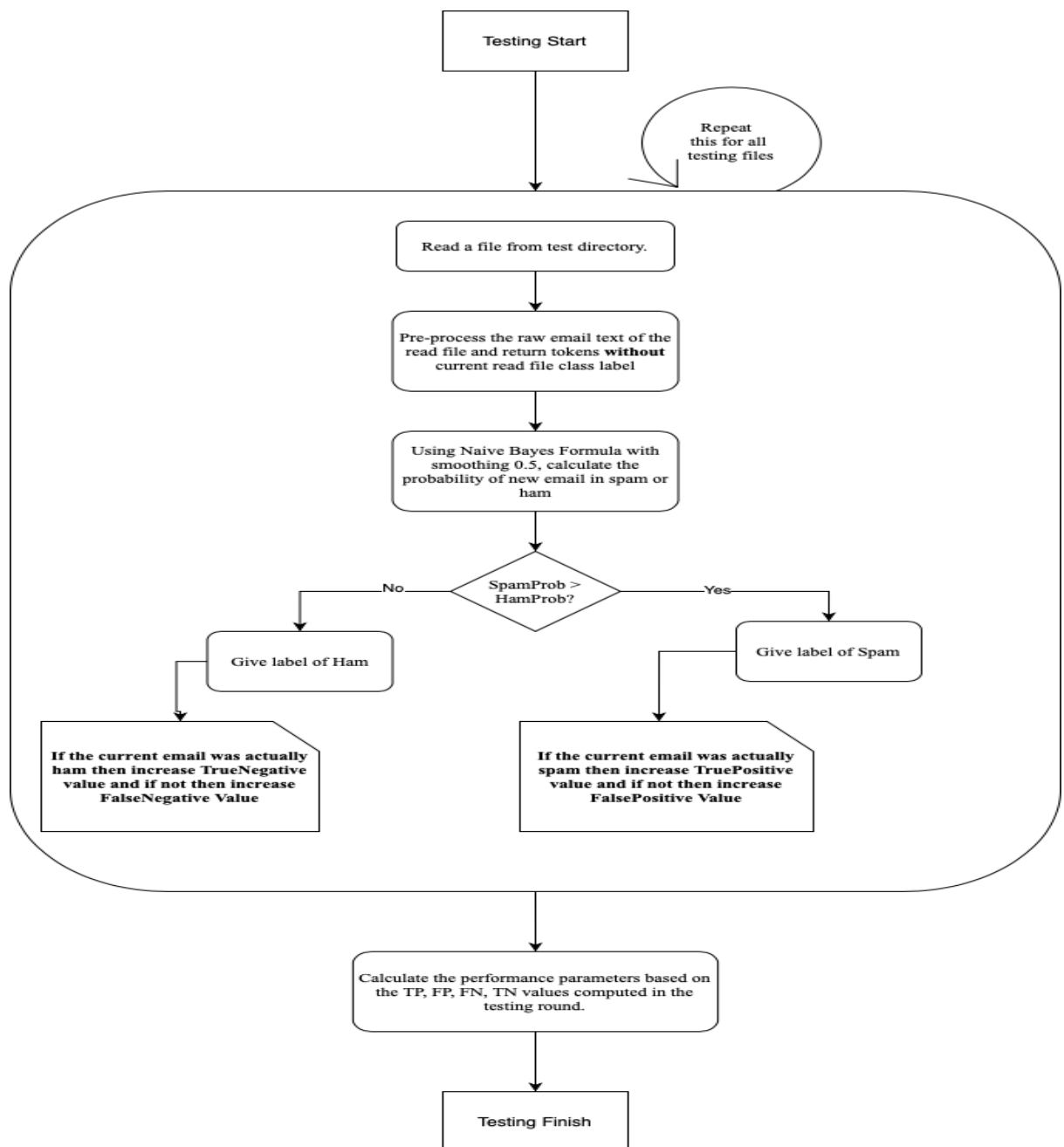
- **Flow Diagrams:** For **Evaluating** our Spam Classifier we tried both the **Unigram approach** (with 2 different REGEX explained below) and a **Bigram approach**.

Finally it was the **Unigram Approach with Regex-2** which gave us better results compared to other options.

Training Flow:



Testing Flow:



- **Problem formulation for training the Naïve Bayes Classifier:** Every single file provided within Training dataset (**1000 HAM and 997 SPAM**), was passed through a regular expression to split the file string and arrive a vocabulary of unique words. For splitting the file string we started our development with the regex provided in the problem statement, '**[^a-zA-Z]**' i.e. **split at every non-alphabet character**. However, we also tried checking if we could arrive at better results by slightly tweaking the regex to '**\W**' which is equivalent to '**[^a-zA-Z0-9_]**' i.e. **split at every non-alphanumeric character (except underscore)**. We would be showing results for both.

➤ **REGEX-1: [^a-zA-Z]**

- **Vocabulary Size: 59251 Unique Words**
- **Confusion Matrix over Test Dataset:** Considering **SPAM** as a positive class and **HAM** as the negative class.

<i>Test Files = 800</i>	Predicted (Spam)	Predicted (Ham)	
Actual (Spam)	TP=364	FN=36	<i>400</i>
Actual (Ham)	FP=7	TN=393	<i>400</i>
	<i>371</i>	<i>429</i>	

- **Evaluation Metrics:** Based on the above confusion matrix values following evaluation metrics were calculated.

Accuracy: $TP + TN / (TP + TN + FP + FN)$

Recall: $TP / (TP + FN)$

Precision: $TP / (TP + FP)$

F1-Score: $2 * Recall * Precision / (Recall + Precision)$

Evaluation Metric	Value
Accuracy	94.625
Precision	98.113
Recall	91.0
F1-Score	94.423

➤ **REGEX-2: [^a-zA-Z0-9_] with unigram approach**

- **Vocabulary Size: 63480 Unique Words**
- **Confusion Matrix over Test Dataset:**

<i>Test Files = 800</i>	Predicted (Spam)	Predicted (Ham)	
Actual (Spam)	TP=366	FN=34	<i>400</i>
Actual (Ham)	FP=5	TN=395	<i>400</i>
	<i>371</i>	<i>429</i>	

- **Evaluation Metrics:**

Evaluation Metric	Value
Accuracy	95.125
Precision	98.652
Recall	91.5
F1-Score	94.942

- **REGEX-2: [^a-zA-Z0-9_] With Bigram Approach:**

***Note:** Code for this has not been committed to the master branch and can be seen in a different branch – ‘bigram’ - <https://github.com/apoorvsemwal/IntroToAI-SpamDetector/tree/bigram>.

- **Evaluation Metrics:**

Evaluation Metric	Value
Accuracy	14.375
Precision	0
Recall	0
F1-Score	NA

We obtained **best accuracy for Unigram Approach with Regex-2 - [^a-zA-Z0-9_] - 95.125%**

For unigram with Regex-2 we also tried **removing the stop words** (frequently occurring words like this, the etc.) to check if it results in any improvement. However it resulted in a decrease in **accuracy – 84.75%. Code can be checked in branch ‘stop_words’** - https://github.com/apoorvsemwal/IntroToAI-SpamDetector/tree/stop_words

Overall in general the Unigram with Regex-2 model was able to show very high Precision signifying that there is very high possibility of a mail being SPAM if our model predicts it to be a SPAM. This is desirable as we do not want our model to predict SPAM for a genuine mail.

However a slightly lower Recall signifies that in some 9% of the cases model might not classify a mail as SPAM at all while the mail was actually a SPAM.

References

1. <https://stackoverflow.com/questions/28931224/adding-value-labels-on-a-matplotlib-bar-chart>
2. <https://stackoverflow.com/questions/265960/best-way-to-strip-punctuation-from-a-string>

Instructions to run the project:

- Download/Clone the Project Repo to your local machine –
[IntroToAI-SpamDetector](<https://github.com/apoorvsemwal/IntroToAI-SpamDetector.git>)
or access it from Google drive –
(<https://drive.google.com/open?id=1hFeO5xocprJfMTZcDSfcwEt-uOsAlrHS>)
- Navigate to '**\IntroToAI-SpamDetector\src**' in your terminal
- Run CMD:
python launcher.py
- Check results folder '**\IntroToAI-SpamDetector\results**'