A Hybrid Approach to Email Spam Detection-Random Forest and Sentiment Analysis

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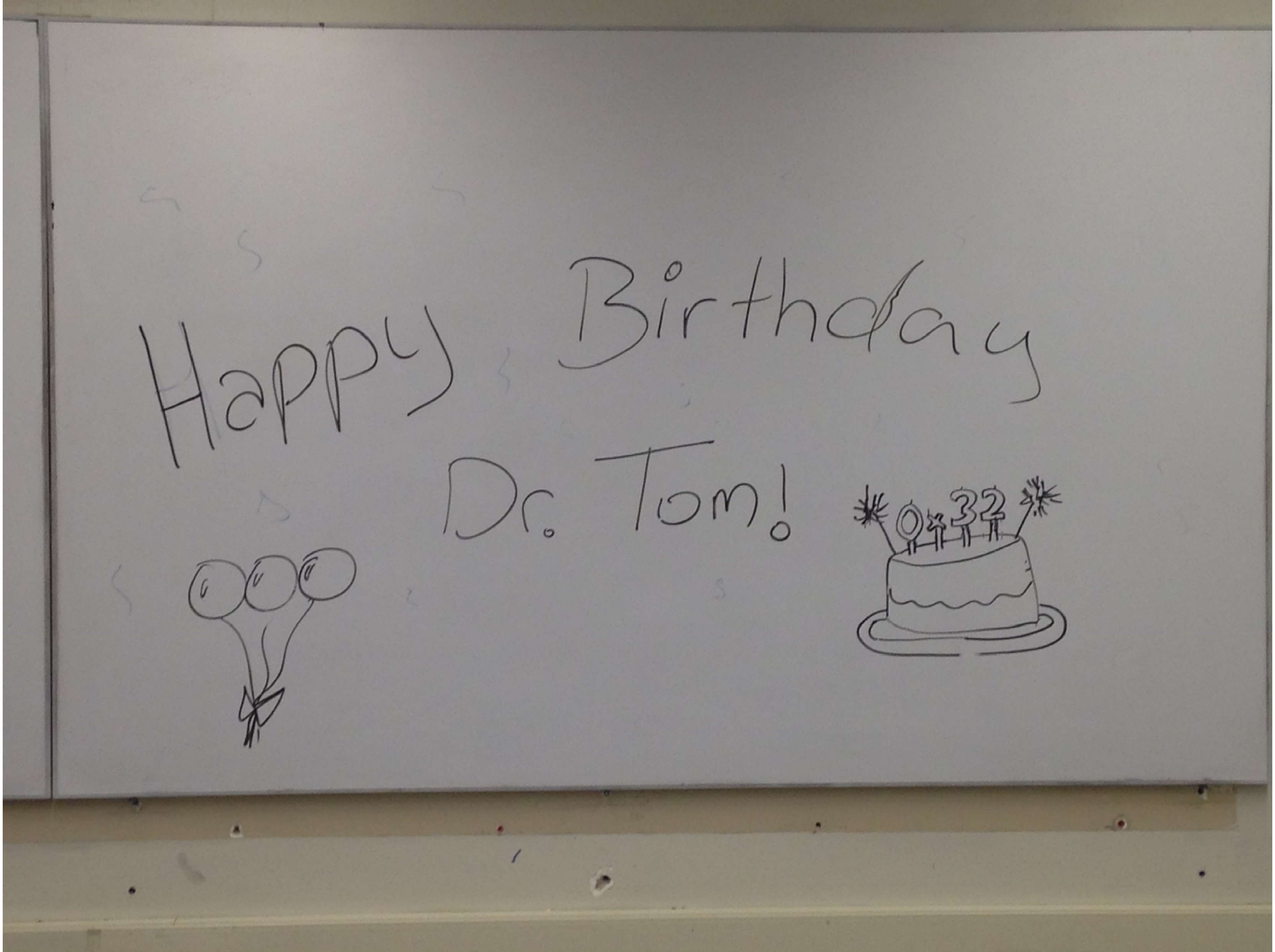
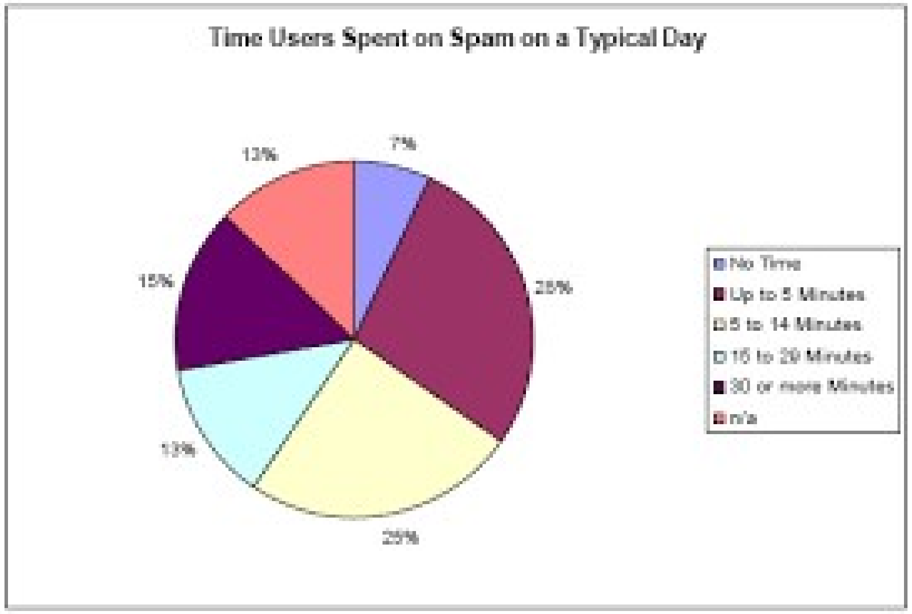
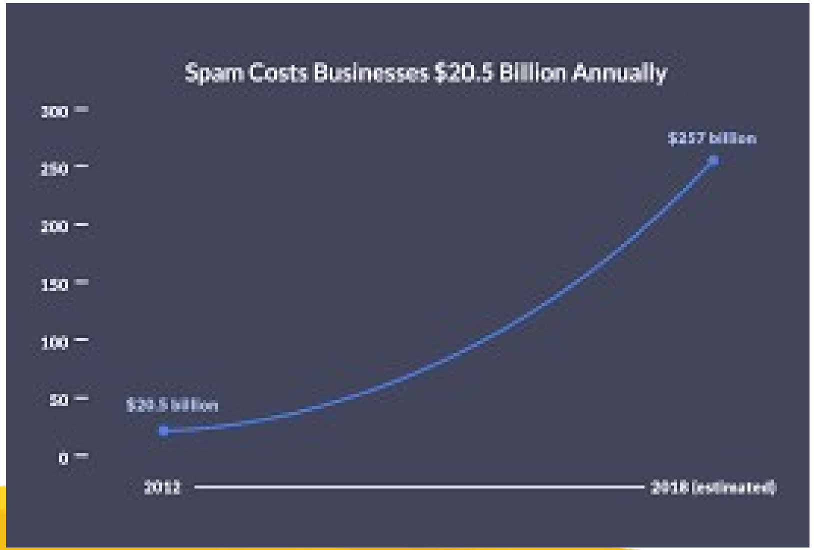

Happy Birthday
Dr. Tom!
0x32

Agenda

- Spam Detection
- Types of Errors
- Pattern Recognition
- Classifiers
- Sentiment Analysis
- Building the model
- Results
- Future Directions

The Spam Problem





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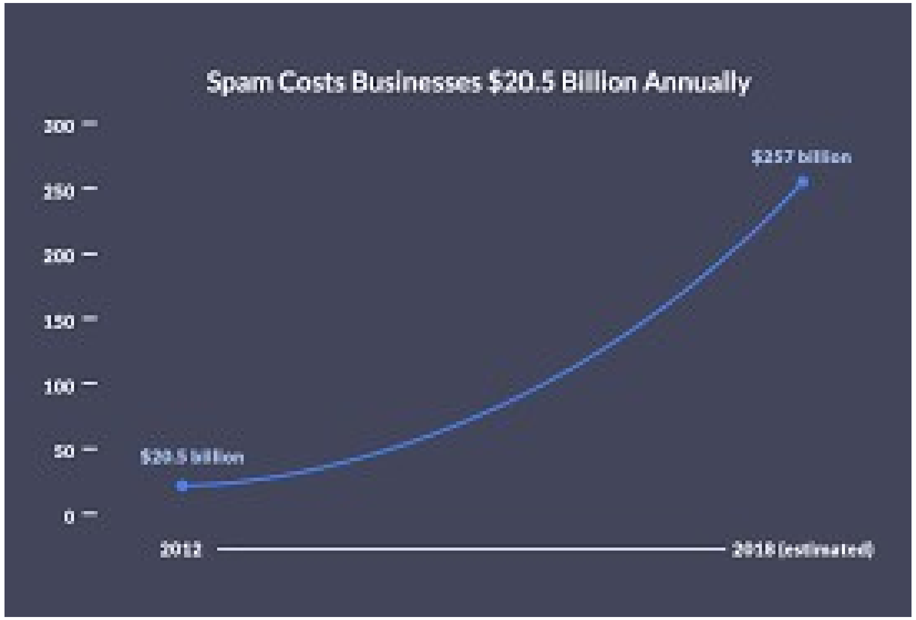
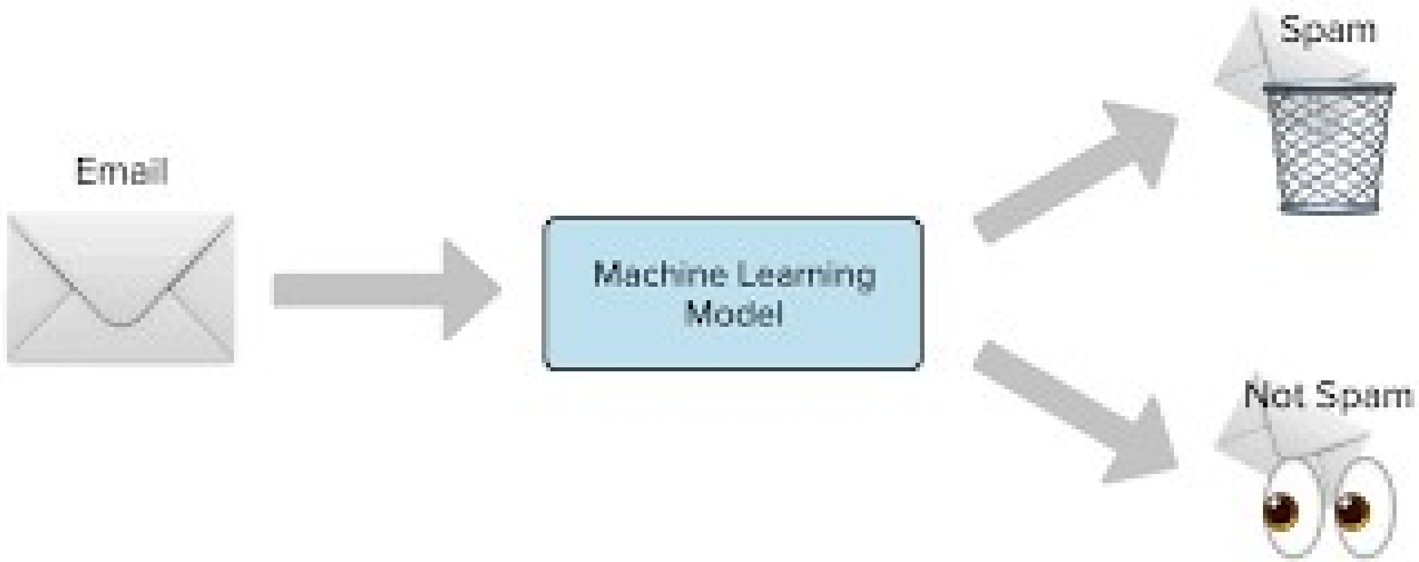
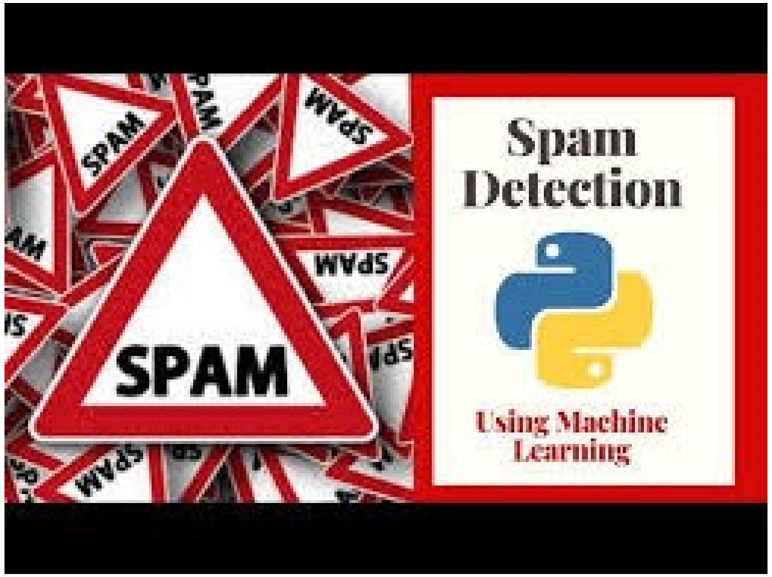


Proof of Identity

Email Spam Detection



Email Spam Detection: ML problem



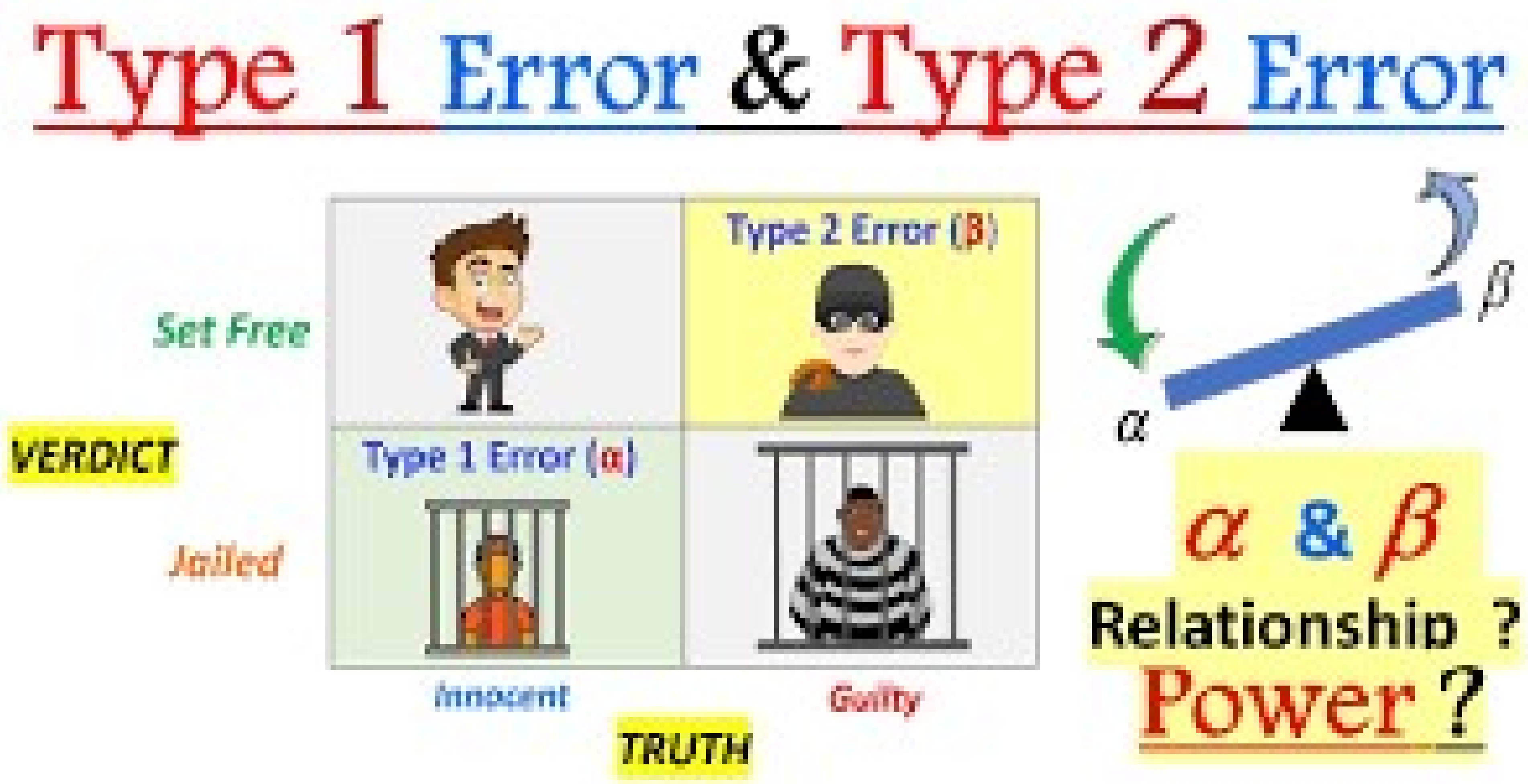
PGP


HOW TO USE PGP TO VERIFY THAT AN EMAIL IS AUTHENTIC:
LOOK FOR THIS TEXT AT THE TOP:
REPLY
-----BEGIN PGP SIGNED MESSAGE-----
HASH: SHA256
HEY,
IF IT'S THERE, THE EMAIL IS PROBABLY FINE.

Type 1 and Type 2 Errors

	Null Hypothesis is TRUE	Null Hypothesis is FALSE
Reject null hypothesis	Type I Error (False positive)	Correct Outcome! (True positive)
Fail to reject null hypothesis	Correct Outcome! (True negative)	Type II Error (False negative)

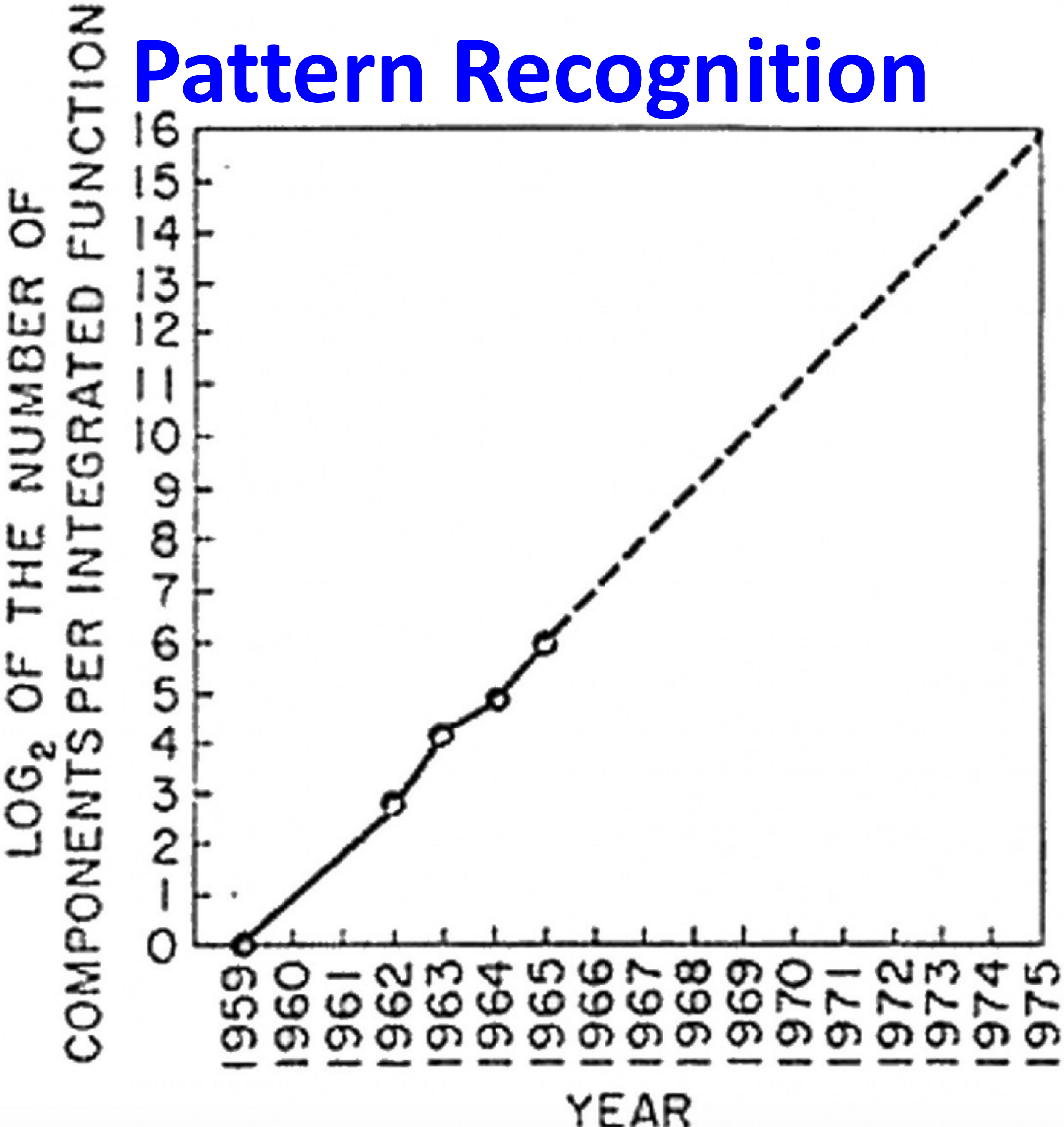
Type 1 and Type 2 Errors



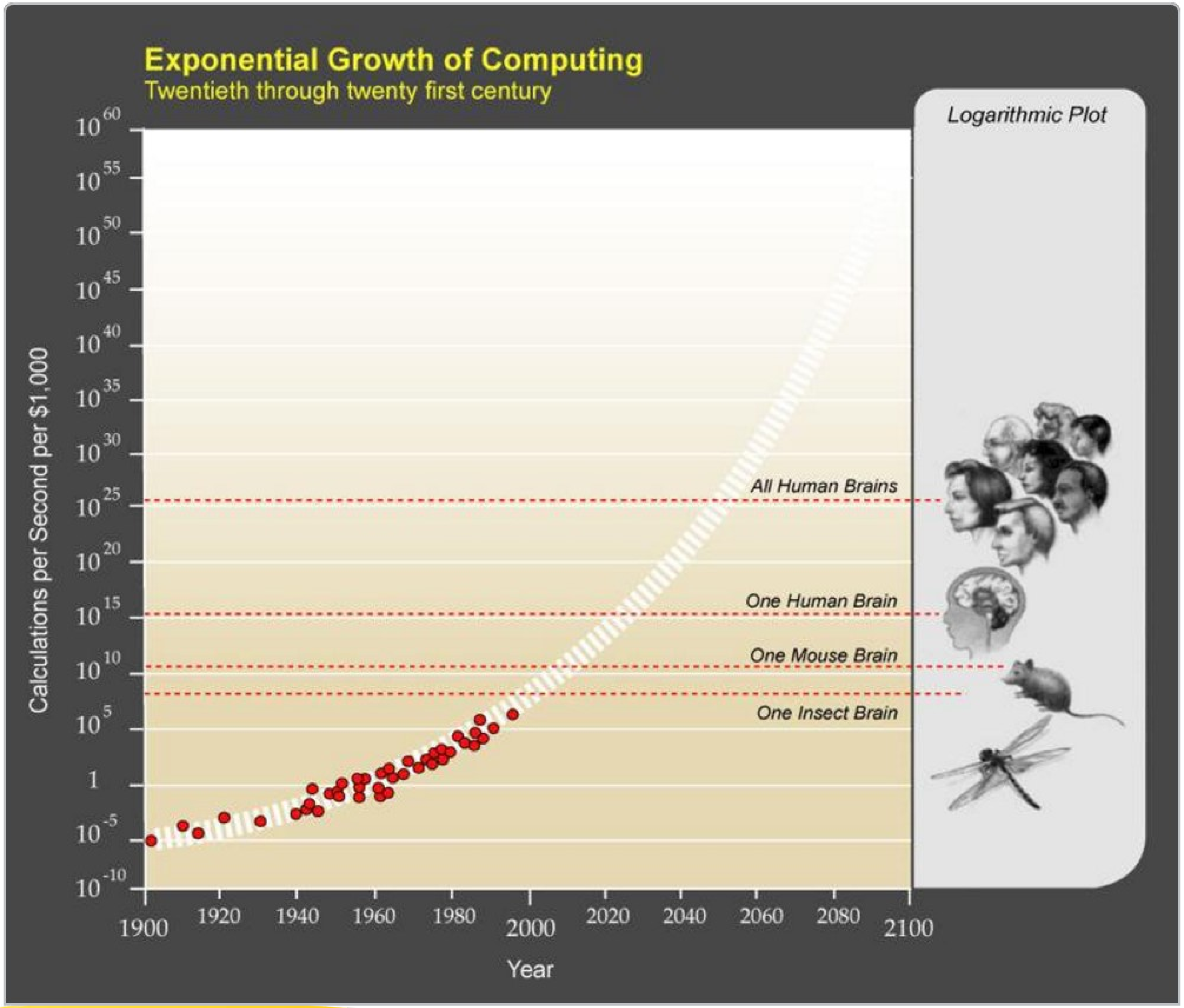
Type 1 and Type 2 Errors, Spam Detection

	Null Hypothesis (H_0)	
Machine Learning Classifier	Actual Spam Email	Actual Not-Spam Email
Predicted Spam (Action: Delete)	222 (True Negative)	32 (False Negative) TYPE II ERROR
Predicted Not-Spam (Action: Keep)	22 (False Positive) TYPE I ERROR	39 (True Positive)
Sum	244	71

Pattern Recognition



Is the Pattern Clearer now?



Naïve classification?

Naïve Bayes

$$P(c \mid x) = \frac{P(x \mid c)P(c)}{P(x)} \qquad (1)$$

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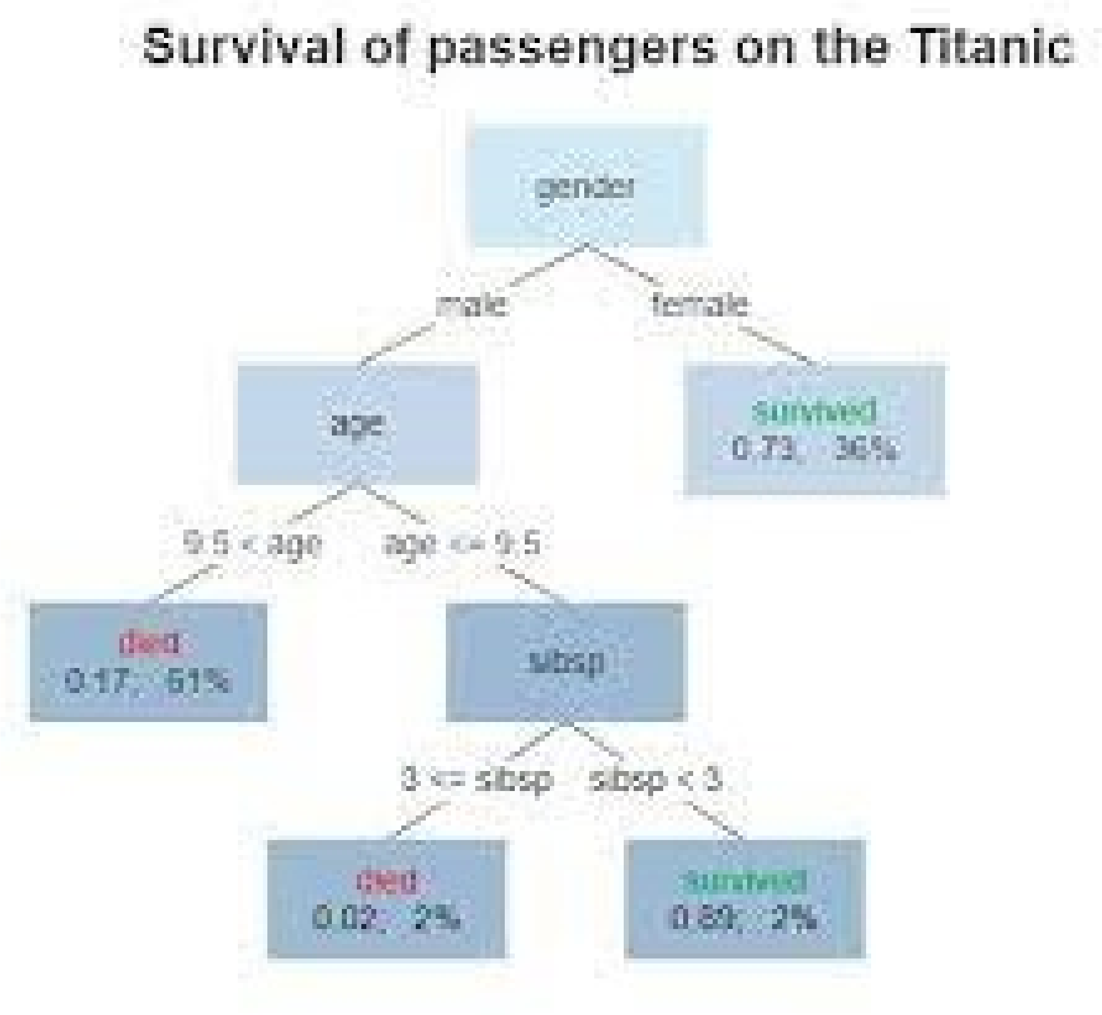
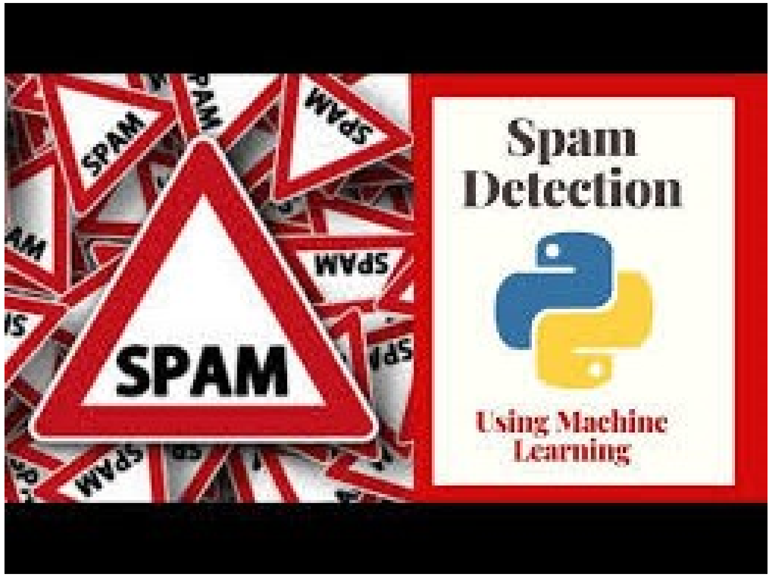
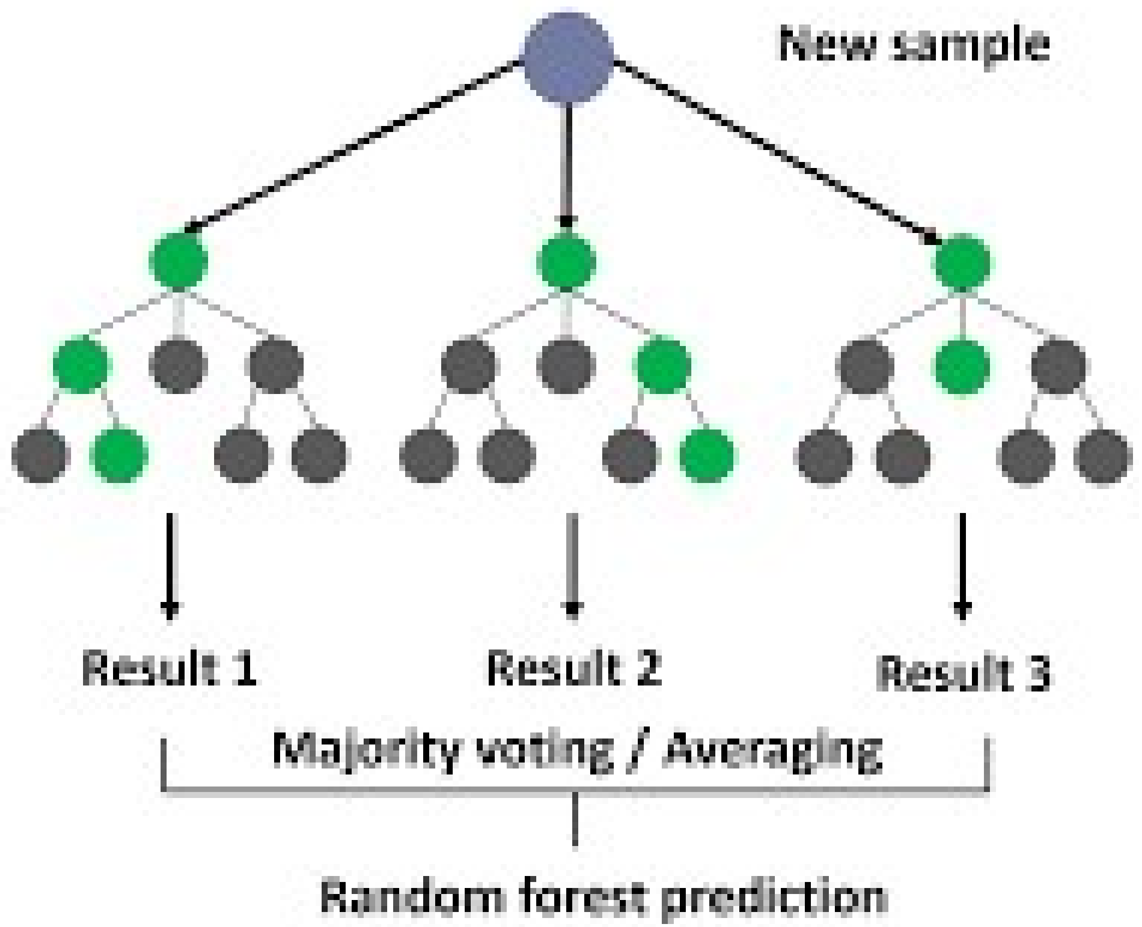
Titanic Decision Tree



Email Spam Detection: ML problem

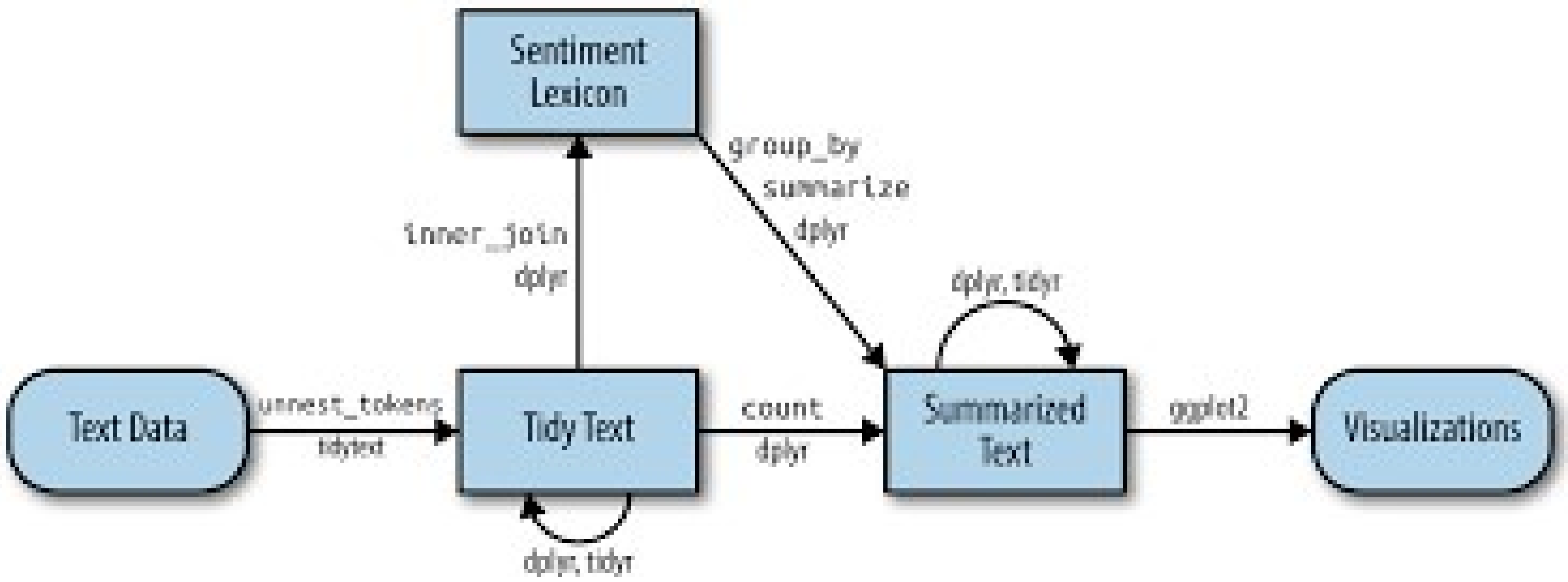


Random Forest as ML?



Sentiment Analysis

Sentiment Analyzer



Model Build Flow Chart

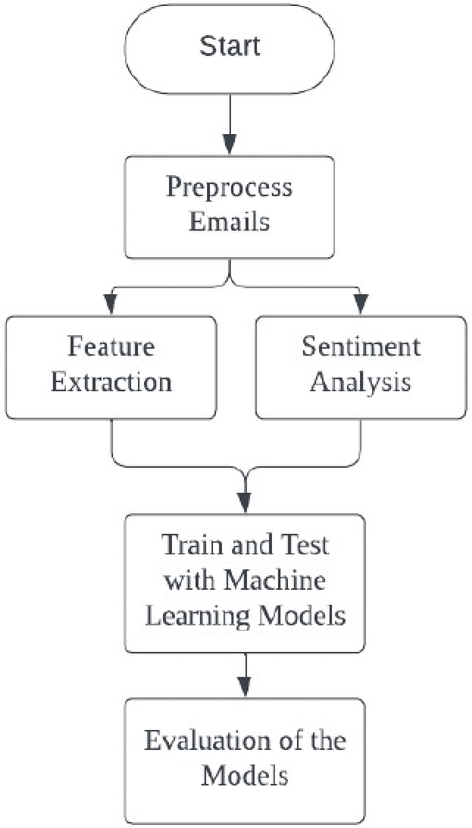
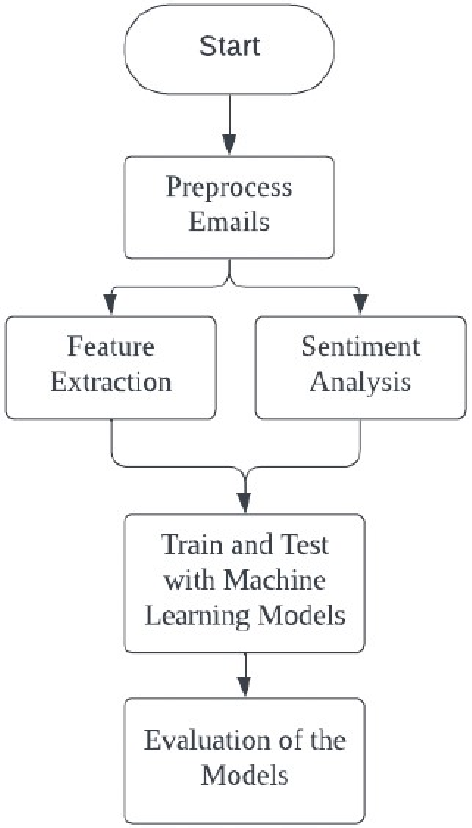


Fig. 1. Model Build Flow Chart

Model Build Flow Chart



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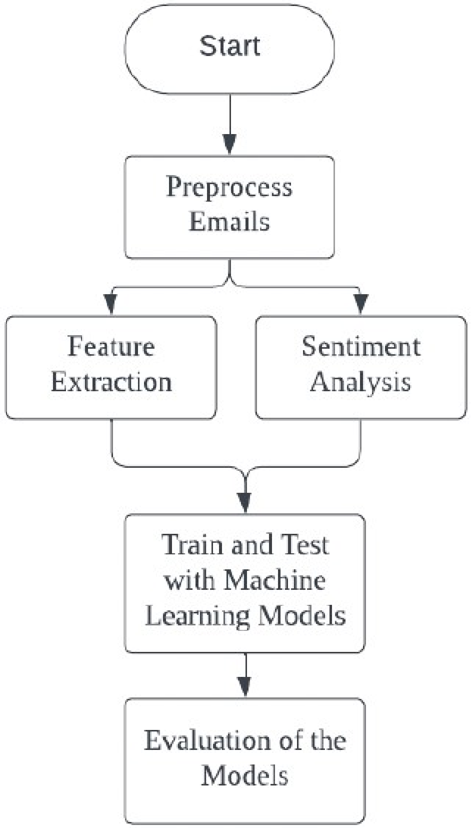

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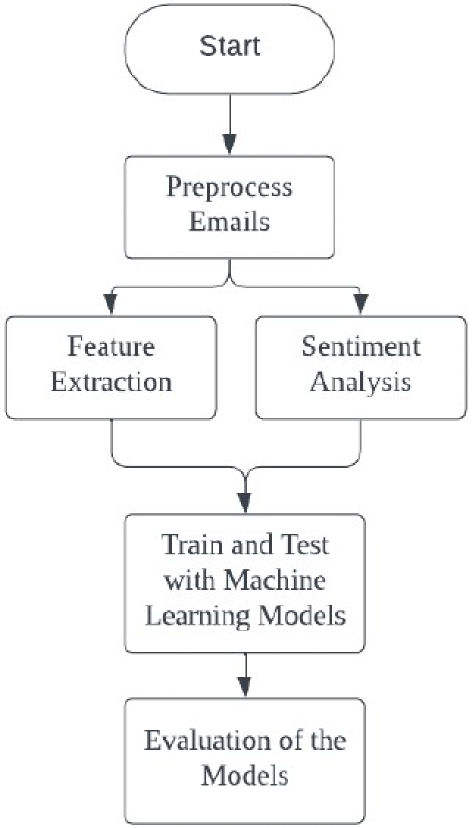

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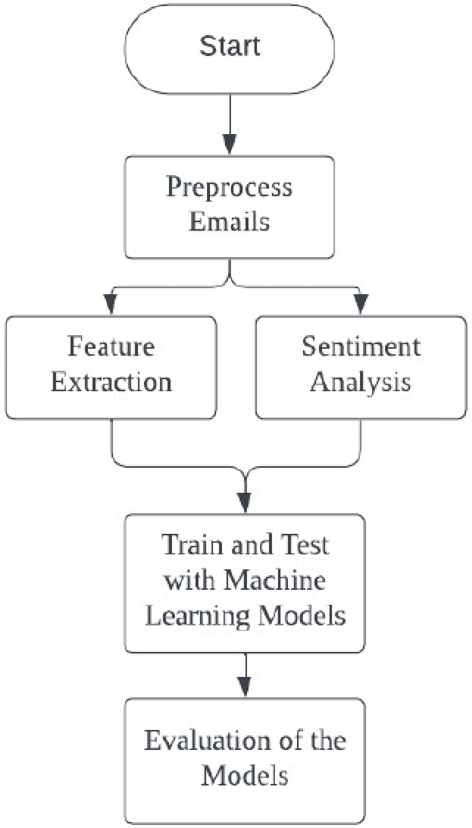

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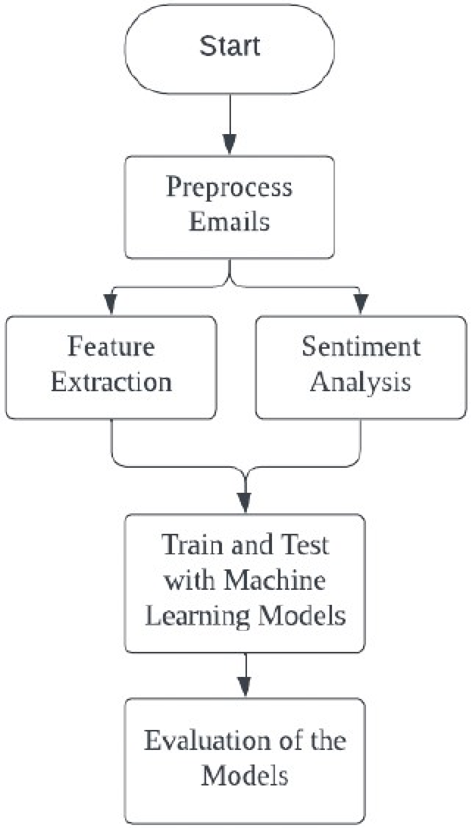

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Throw that all into our ML Blender

Classification Results for Proposed Models

TABLE I
CLASSFICATION RESULT FOR PROPOSED MODELS

Model	FP-Rate	FN-Rate	Accuracy	Precision	Recall
NB	26.25%	38.91%	66.67%	68.10%	66.67%
RF	15.23%	10.67%	87.32%	87.31%	87.32%
NB-SA	23.55%	21.24%	77.80%	78.10%	77.80%
RF-SA	7.59%	3.69%	94.54%	94.56%	94.54%

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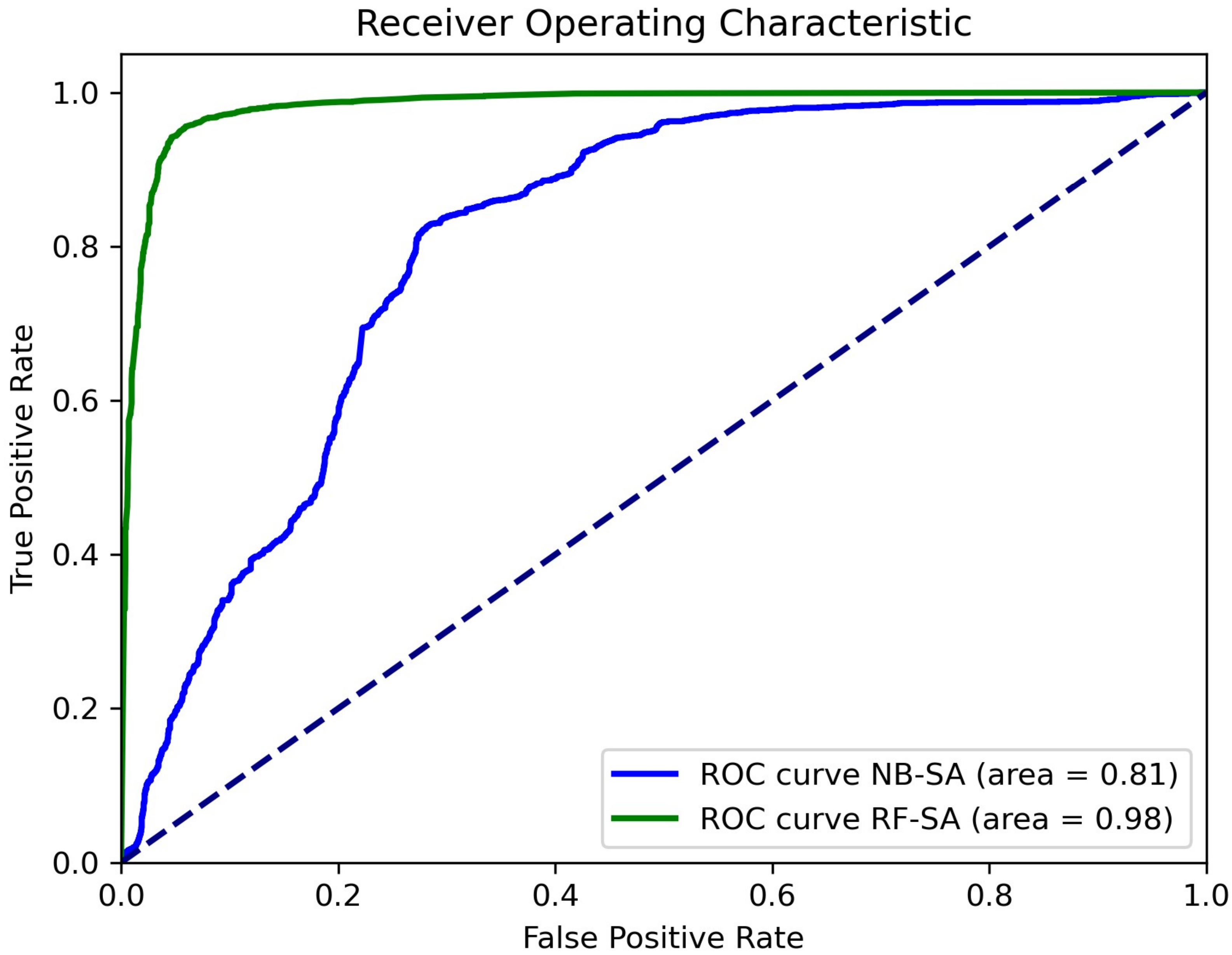
ROC Curves for NB-SA and RF-SA Models



Future Directions

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Thanks To

Chinese American Scholars Association

Questions