Spam Mail Detector using Naive Bayes Classification

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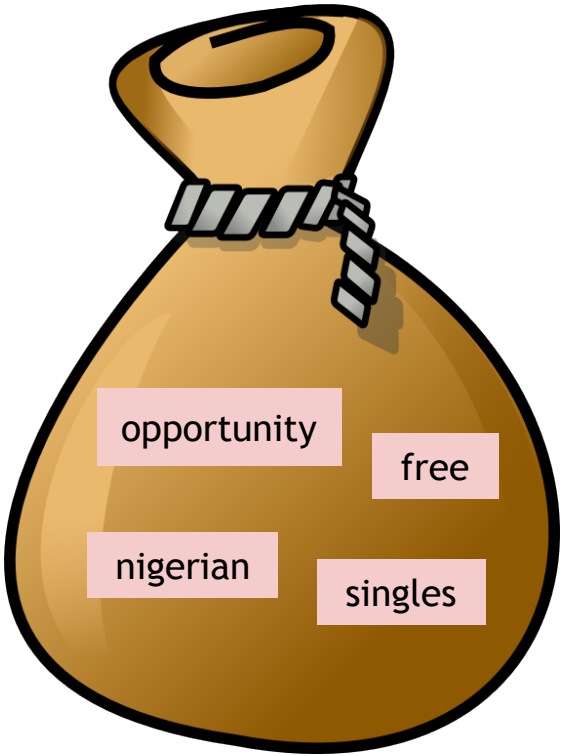
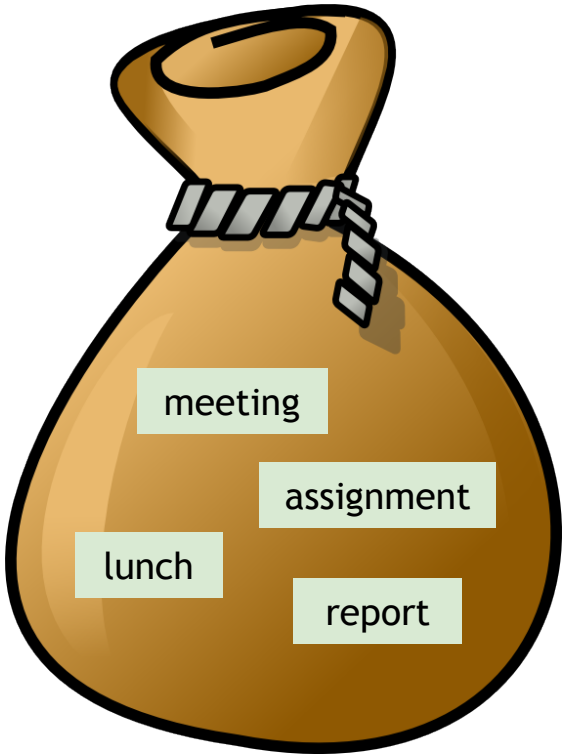
Start out with 2 training sets of emails

SPAM
bad email

HAM
good email

Create 2 bags of words

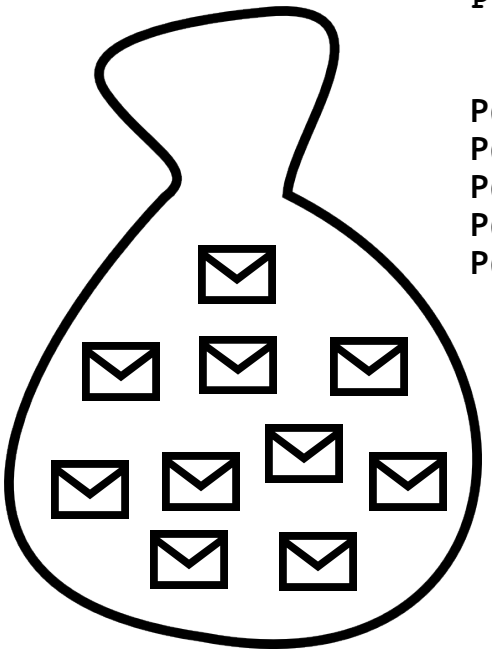


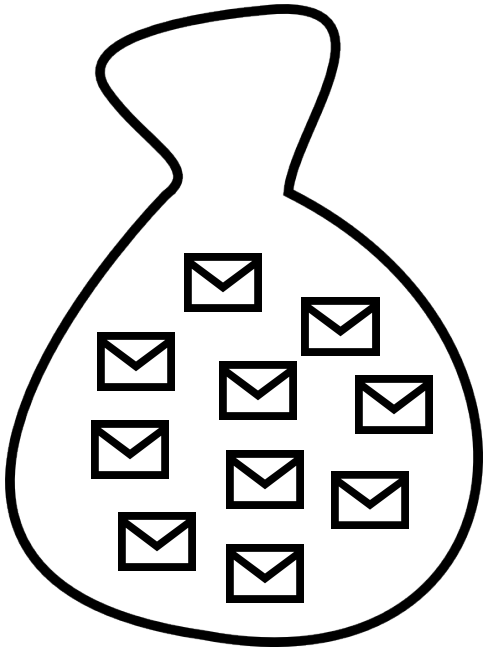


The “spamicity” of a word is determined using Bayes’ theorem, taking into account the frequency a word appears in each of the spam emails vs. the ham emails

$$P(S|W) = \frac{P(W|S) * P(S)}{P(W|S) * P(S) + P(W|H) * P(H)}$$

P(S|W) is probability email containing word is spam
P(W|S) is probability word appears in spam emails
P(W|H) is probability word appears in ham emails
P(S) is initial probability email is spam (assume 0.5)
P(S) is initial probability email is ham (assume 0.5)



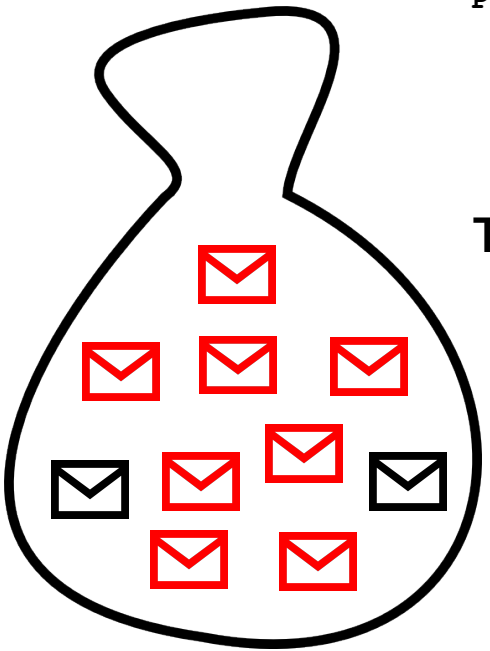


The “spamicity” of a word is determined using Bayes’ theorem, taking into account the frequency a word appears in each of the spam emails vs. the ham emails

$$P(S|winner) = \frac{0.8 * \cancel{0.5}}{0.8 * \cancel{0.5} + 0.1 * \cancel{0.5}}$$

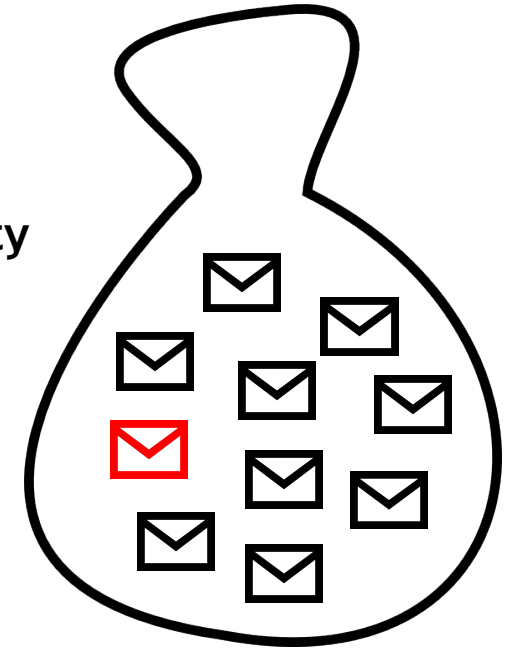
$$\approx 0.8889$$

The word “winner” has a spamicity of about 0.8889



“winner” appears in 8 out of the 10 spam emails.

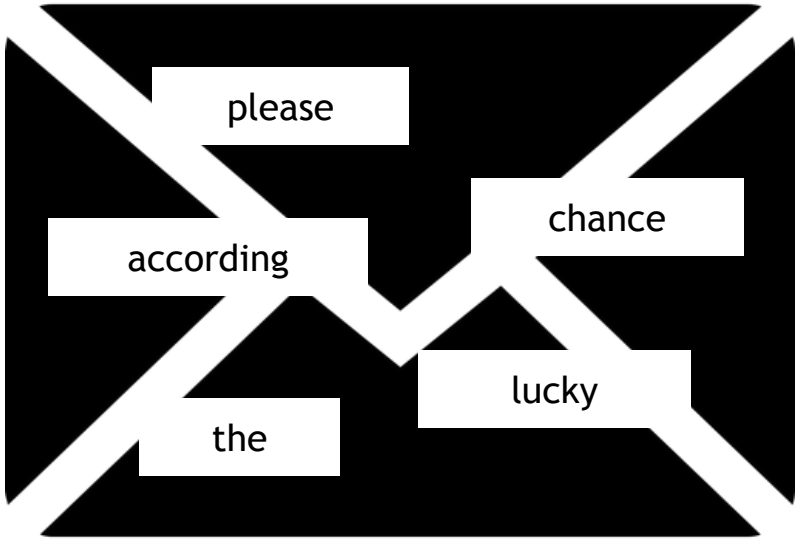
“winner” appears in 1 out of the 10 ham emails.



To find the probability that a certain email is spam, we use Bayes' theorem again, this time using the product of the spamicities of all the words in the email.

$$p = \frac{p_1 p_2 \ldots p_N}{p_1 p_2 \ldots p_N + (1 - p_1)(1 - p_2) \ldots (1 - p_N)}$$

p is the probability that a given email is spam
p1 … pN are the spamicities of the words in the email
(1 - p1) … (1 - pN) are the inverse spamicities of the words



To find the probability that a certain email is spam, we use Bayes' theorem again, this time using the product of the spamicities of all the words in the email.

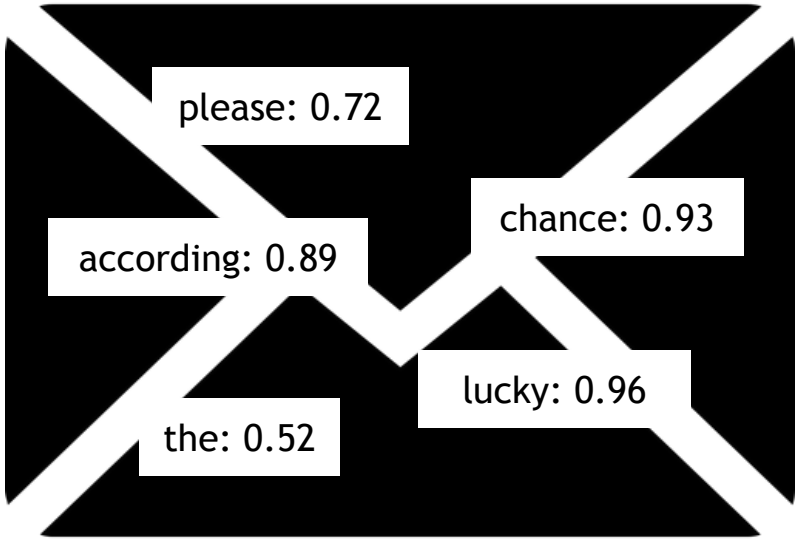
$$0.72 * 0.93 * 0.96 * 0.89 * 0.52 = 0.2975$$
$$(1 - 0.72) \quad \ldots \quad (1 - 0.52) = 0.00004$$

$$p = \frac{0.2975}{0.2975 + 0.00004} \approx 0.9999$$

This message is

SPAM!

(probably)



My Implementation

- Spam success rate (percentage of correctly labelled spam):
  - Around **96%**
- Ham success rate (percentage of correctly labelled ham):
  - Around **99%**

A success! ✔

Optimizations

- Only consider the top N words, sorted by the most “interesting” spamicities (farthest from 0.5)
- Ignore words that don’t occur often (not a trustworthy source of information)