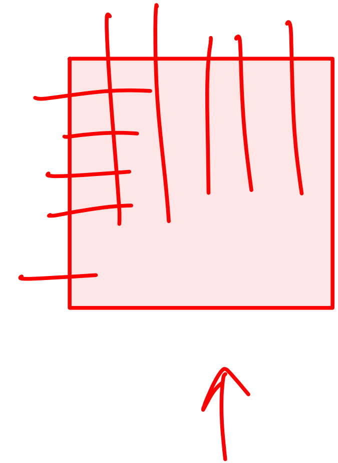
NAIVE BAYES-1

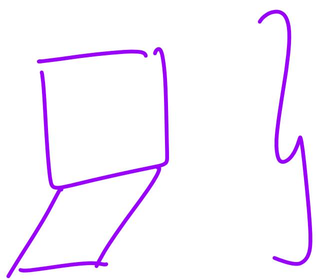
Stopword.

My name is Nikhil Sanghi

I am a Data Scientist.



Seal Cil



⇒ Convert No.s

[- - - - - .]

Vector Embedding.

→ MY NAME is → upper case

→ my name is → lower case

→ My

→ my

_____ _____ _____ _____

train → Compartment

Education

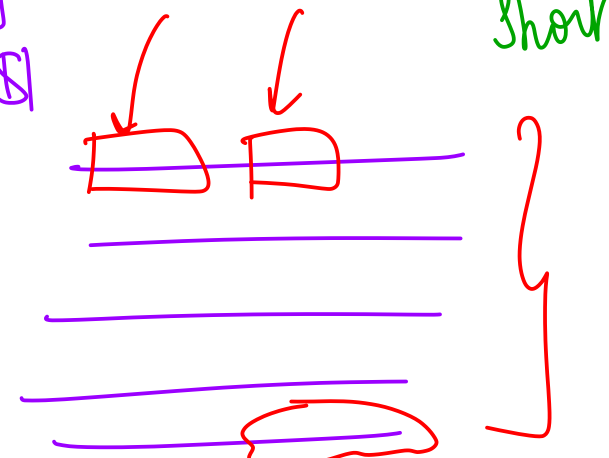
"train" "train_"

Spam, Non Spam → Classification

* Keywords.
* Semantic
* Content → long
  short

" I am $\boxed{\text{Nigerian Prince}}$. I want to give you $\boxed{\text{1M \$}}$ "

Nigerian Prin I am give you 1M $

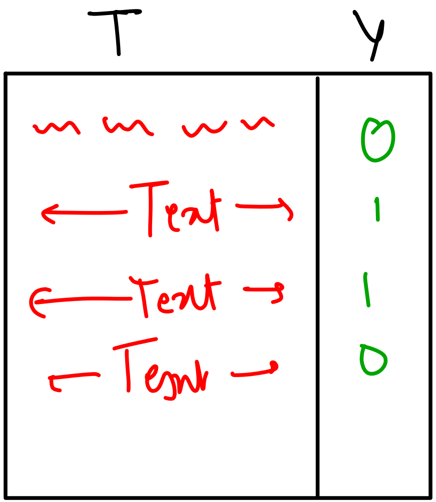


NLP

Attention Mechanism

LSTM

Naive Bayes.



Interpretable

Simple

Fast

Works well for simple use cases.

Spam $(y=1)$ Nonspam $(y=0)$

Probability "Text" is spam / Nonspam

Text 1 → NS 0.3 ⇒ $P(y=0 / \text{Text})$

→ S 0.7 ⇒ $P(y=1 / \text{Text})$

Conditional Probability

$$P(y=1 \mid \text{Text}) = P(y=1 \mid w_1 \cap w_2 \cap w_3 \cdot)$$

$$P(A/B) = \frac{P(A \cap B)}{P(B)}$$

$$P(A/B) = \frac{P(B/A) \cdot P(A)}{P(B)}$$

Conditional Probability

Bayes theorem

$$P(y=1 \mid \text{Text}) = P(y=1 \mid w_1, w_2, w_3, w_4 \dots w_d)$$

Comma is intersection.

$$= \frac{P(w_1, w_2 \dots w_d \mid y=1) \cdot P(y=1)}{P(w_1, w_2\, w_3 \dots w_d)}$$

$$P(\overset{\text{spam}}{y=1} \mid \text{Text}_1) = \frac{P(\text{Text}_1 \mid y=1) \cdot P(y=1)}{\underbrace{P(\text{Text}_1)}_{k}}$$

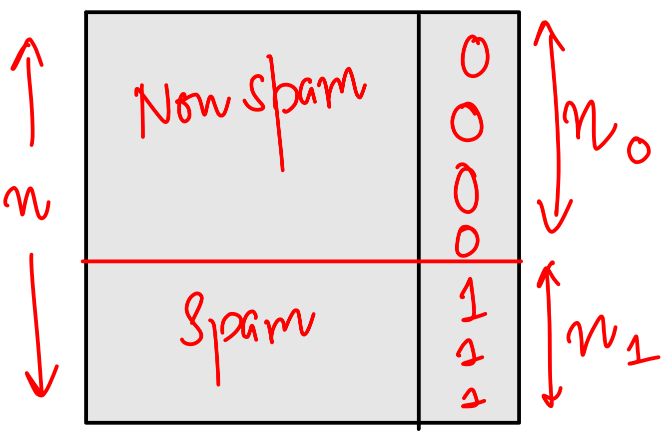
compare

$$P(\underset{\text{Nonspam}}{y=0} \mid \text{text}_1) = \frac{P(\text{text}_1 \mid y=0)\, P(y=0)}{\underbrace{P(\text{Text}_1)}_{k}}$$

denominator are same.

$$P(y=1) = \frac{\#\text{ of datapoints with class} = 1}{\#\text{ Total}} = \frac{n_1}{n}$$

$$P(y=0) = \frac{\#\text{ of datapoint with class} = 0}{\#\text{ total}} = \frac{n_0}{n}$$



$$P(y=1) = \frac{n_1}{n}$$

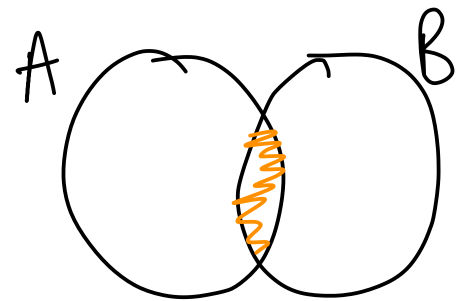
$$P(y=0) = \frac{n_0}{n}$$

$$P(\text{Text}_1 \mid y=1) = P(w_1, w_2, w_3, w_4 \ldots w_d \mid y=1)$$

Words are independently conditioned on class.

$$= P(w_1 \mid y=1) \cdot P(w_2 \mid y=1) \ldots \ldots P(w_d \mid y=1)$$

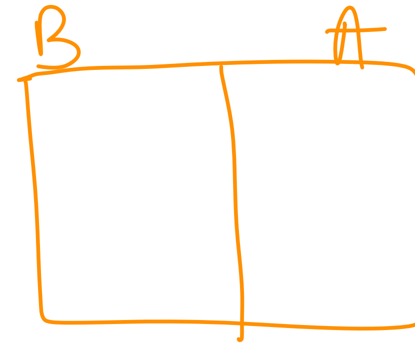
$$P(A \cap B) = P(A) + P(B) - P(A \cup B)$$



$$P(A \cup B) + P(A \cap B) = P(A) + P(B)$$

Mutually exclusive

$$P(A \cap B) = 0$$



Independent

$$P(A \cap B) = P(A) \cdot P(B)$$

$$P(H \cap H) = 0.5 \times 0.5 = \underline{0.25}$$

$P(HH)$

HH, HT, TH, TT

$$\cancel{P(w_1 \cap w_2 \cap w_3) = P(w_1) \cdot P(w_2) \cdot P(w_3)}$$

$$P(w_1 \cap w_2 \cap w_3 / y=1) = P(w_1 / y=1) \cdot P(w_2 / y=1) \cdot P(w_3 / y=1)$$

<u>NAIVE ASSUMPTION.</u>

$$\prod_{i=1}^{3} P(w_i / y=1)$$

class prior

$$P(y=1 / \text{Text}) = \frac{P(y=1) \cdot \prod_{i=1}^{d} P(w_i / y=1)}{\cancel{K}}$$

likelihood.

$$P(y=0 / \text{text}) = \frac{P(y=0) \cdot \prod_{i=1}^{d} P(w_i / y=0)}{\cancel{K}}$$

$x_q = [w_1, w_2, w_3]$

spam / Non spam

w_1	w_2	w_3	0
w_2	w_3	w_4	0
w_5	w_6	w_1	0
w_1	w_2	w_4	0
w_5	w_6	w_2	1
w_1	w_2	w_5	1
w_3	w_4	w_1	1

n, n_0, n_1

$P(y=1) = 3/7$

$P(y=0) = 4/7$

$P(w_1 / y=0) = \frac{n_{w_1}}{n_0}$

Unique Words

$P(w_1/y=1) \cdot P(w_2/y=1) \cdot P(w_3/y=1)$

$\frac{2}{3} \cdot \frac{2}{3} \cdot \frac{1}{3} = \frac{4}{27}$

$$P(w_1 | y=0) \cdot P(w_2 | y=0) \cdot P(w_3 | y=0)$$

$$\frac{3}{4} \quad \frac{3}{4} \quad \frac{2}{4} = \frac{18}{64}$$

$$P(y=1 | w_1, w_2 w_3) = P(y=1) \prod_{i=1}^{3} P(w_i | y=1)$$

$$3/7 \times 4/27 = 0.0634$$

$$P(y=0 | w_1 w_2 w_3) = P(y=0) \prod_{i=1}^{3} P(w_i | y=0)$$

$$4/7 \times 18/64 = 0.16$$

$w_1 w_2 w_3 = y = 0$

Nonspam.

When will this fail?

$$x_q = [w_1 \quad w_2 \quad w']$$

Not present in training

$$P(y=1 \mid w_1 \cap w_2 \cap w') = P(y=1) \cdot P(w_1 \mid y=1)\, P(w_2 \mid y=1)\, P(w' \mid y=1)$$

$$0$$

$$P(w_j \mid y=0) = \frac{n_j^{00}}{n_0}$$

$$P(w' \mid y=0) = \frac{0}{n_0}$$

$$P(w_j \mid y=1) = \frac{n_j^1}{n_1}$$

$100 \rightarrow 80$ NS $\rightarrow 0$

$100 \rightarrow 20$ S $\rightarrow 1$

hack

$$P(w_j \mid y=1) = \frac{n_j^1 + \alpha}{n_1 + \alpha C}$$

taken as 2

$C \rightarrow 2$

Laplace Smoothing

Additive Smoothing.

$\alpha = 1 \quad C = 2$

$$P(w^1 \mid y=1) = \frac{0+1}{20+1\times 2} = \frac{1}{22} = 0.045$$

$$\frac{a}{b + 10^{-6}}$$

$0 \rightarrow b$

Zero division.

w' — Not present → Laplace Smoothing,

$$P(w' \mid y=1) = \frac{n_j + \alpha}{n_j + \alpha r}$$

$r \rightarrow 2$

$\alpha = 10000$

$$C = 2 \quad P\left(w' / y=1\right) = \frac{0 + 10000}{20 + 10000 \times 2} = \frac{10000}{20020} \approx 0.5$$

$$r = 1 \quad P\left(w' / y=1\right) = \frac{0 + 10000}{20 + 10000} = \frac{10000}{10020} \approx 1$$

$$\alpha \uparrow \longrightarrow \text{Underfitting}$$

$$\alpha \downarrow \longrightarrow \text{Overfitting.}$$

$$P(w_1 \mid y=1) = \frac{2+10000}{3+2\times 10000} = \frac{10000}{3+20000} \approx 0.5$$

$$P(w_1 \mid y=1) = \frac{1+1}{80+1\times 2} = 0.0245$$

$$\frac{n_j^1+\alpha}{n_1+\alpha c} \approx \frac{n_j^1}{n_1}$$

$$\frac{n_j^1}{n_1} \approx n_j$$

Quiz time!

Quiz Ended!

Let's say:

the probability of dangerous fires are rare (1%)

but smoke is fairly common (10%) due to barbecues,

and 90% of dangerous fires make smoke

Can you find the probability of dangerous Fire when there is Smoke?

23 users have participated

A ✓	0.09	61%
B	0.9	26%
C	0.1	13%

$P(DF) = 0.01$

$P(S) = 0.1$

$P(S/D) = 0.9$

$$P(D/S) = \frac{P(S/D) \cdot P(D)}{P(S)}$$

$$= \frac{0.9 \times 0.01}{0.1}$$

$$= 0.09$$

Quiz time!

Quiz Ended!

Naive assumption is 'In a sentence, given the class label, words are independent of each other':

19 users have participated

A	False	11%
B	True	89%

Quiz time!

Quiz Ended!

Which of the following statement is TRUE about the Bayes classifier?

19 users have participated

A	Bayes classifier is an unsupervised learning algorithm.	0%
B	Bayes classifier works on the Bayes theorem of probability.	89%
C	Bayes classifier is a Reinforcement Learning Algorithm	0%
D	It assumes the independence between the independent variables or features.	11%

NB

KNN

Tree

Naive

Mon

15 min

f_1 f_2 f_3 y

w_1 w_2 w_3

w_4 w_5