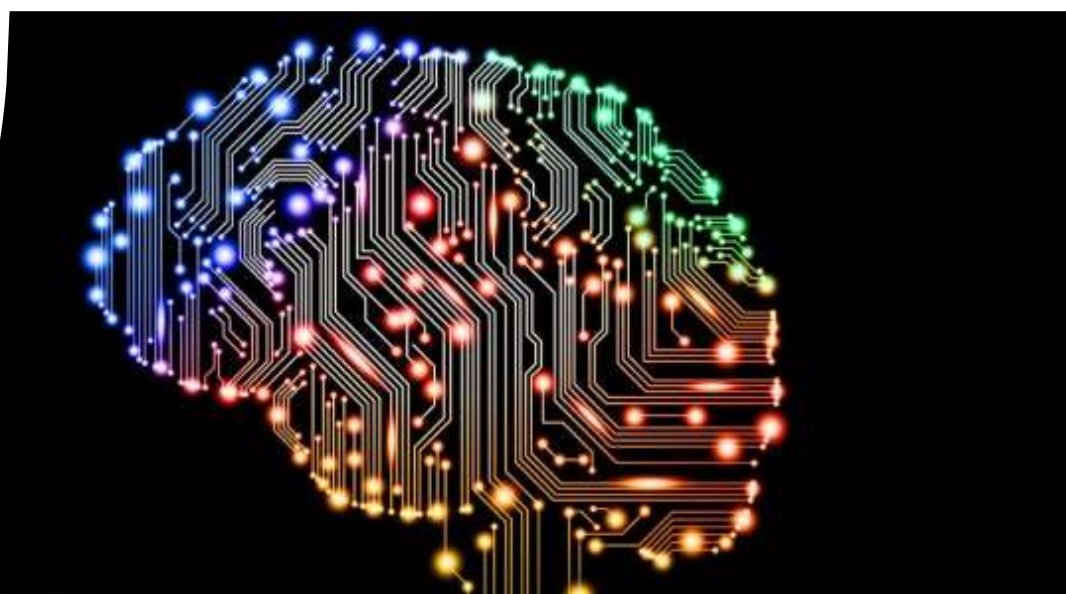


DAWSON
COLLEGE



Naïve Bayes on Email Filtering

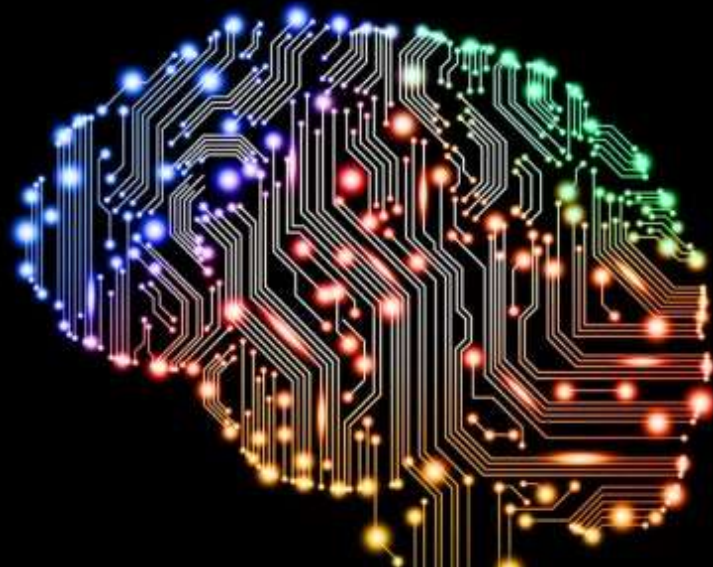
Garry Ka Lok CHU



Reference:

- [Emmanuel GbengaDada](#)
- [Joseph StephenBassi](#)
- [HarunaChiroma](#)
- [Shafi'i MuhammadAbdulhamid](#)
- [Adebayo OlusolaAdetunmbi](#)
- [Opeyemi EmmanuelAjibuwa](#)

**Machine learning for email spam filtering:
review, approaches and open research
problems** *Heliyon, Volume 5, Issue 6, June
2019*





Methods and Techniques:

Content Based Filtering Technique: Content based filtering is usually used to create automatic filtering rules and to classify emails using machine learning approaches, such as **Naïve Bayesian classification**, **Support Vector Machine**, **K Nearest Neighbor**, Neural Networks. This method normally **analyses words, the occurrence, and distributions of words** and phrases in the content of emails and use generated rules to filter the incoming email spams [\[28\]](#).

Naïve Bayes on Email Filtering

Top Spam Words:

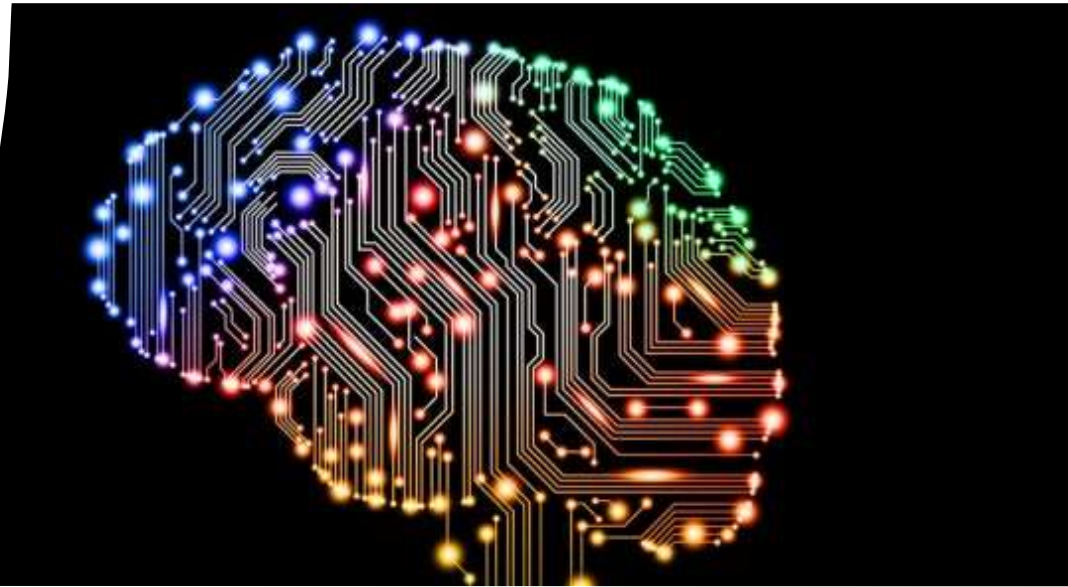
- Dear friend
- Click here
- Free
- Fwd: or Re:
- Great offer
- Guarantee
- Risk-free

Reference:

Emma Email, **7 words sending your email to spam**

[Webpage] Available at:

<https://content.myemma.com/blog/7-words-sending-your-email-to-spam>



Category	Number of mails	Probability	Word	Number of occurrences	Probability
Normal mails	15		See		
			Meet		
			Free		
			Cash		
			Total		
Spam mails	5		See		
			Meet		
			Free		
			Cash		
			Total		
Total	20		Total		



For this in-class activity, randomly select emails from Inbox and Spam folders. In this case, we select 15 normal emails and 5 spam emails. Of course, in the real situation, we may have 15 million normal emails and 5 million spam emails in our training set.

Category	Number of mails	Probability	Word	Number of occurrences	Probability
Normal mails	15	0.75	See		
			Meet		
			Free		
			Cash		
			Total		
Spam mails	5	0.25	See		
			Meet		
			Free		
			Cash		
			Total		
Total	20			Total	



Then compute the proportion of normal and spam emails in the sample. For example, proportion of normal emails in the sample is $15/20 = 0.75$.

Category	Number of mails	Probability	Word	Number of occurrences	Probability
Normal mails	15	0.75	See	9	
			Meet	8	
			Free	2	
			Cash	6	
			Total	25	
Spam mails	5	0.25	See	4	
			Meet	1	
			Free	10	
			Cash	5	
Total	20		Total	20	



In reality, we can analyse every single word in the emails. But for simplicity, we analyse 4 words in this activity. Count the occurrences of different words and record them.

Category	Number of mails	Probability	Word	Number of occurrences	Probability
Normal mails	15	0.75	See	9	0.36
			Meet	8	0.32
			Free	2	0.08
			Cash	6	0.24
			Total	25	1
Spam mails	5	0.25	See	4	0.2
			Meet	1	0.05
			Free	10	0.5
			Cash	5	0.25
			Total	20	1



Afterwards, compute the probability of occurrence for each word. We now construct the probability distribution tables for normal and spam emails.

Category	Number of mails	Probability	Word	Number of occurrences	Probability
Normal mails	15	0.75	See	9	0.36
			Meet	8	0.32
			Free	2	0.08
			Cash	6	0.24
			Total	25	1
Spam mails	5	0.25	See	4	0.2
			Meet	1	0.05
			Free	10	0.5
			Cash	5	0.25
Total	20		Total	20	1

Given an email is having the words "Free" and "Cash", the probability of this email is normal is proportional to

$$(0.75) (0.08) (0.24)$$

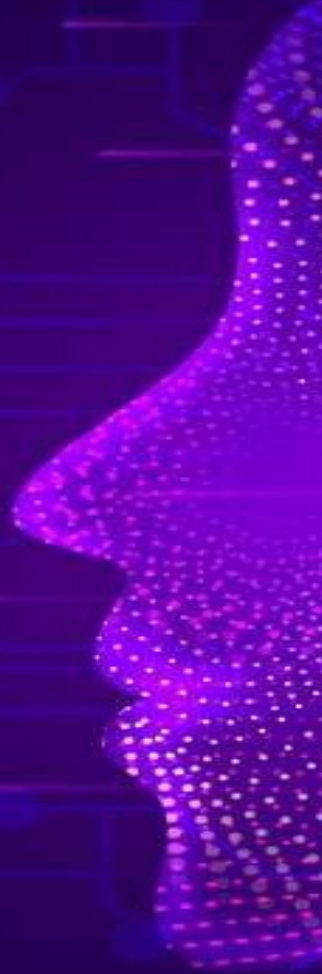
$$= 0.0144$$

Category	Number of mails	Probability	Word	Number of occurrences	Probability
Normal mails	15	0.75	See	9	0.36
			Meet	8	0.32
			Free	2	0.08
			Cash	6	0.24
			Total	25	1
Spam mails	5	0.25	See	4	0.2
			Meet	1	0.05
			Free	10	0.5
			Cash	5	0.25
Total	20		Total	20	1

Given an email is having the words "Free" and "Cash", the probability of this email is spam is proportional to

$$(0.25) (0.5) (0.25)$$

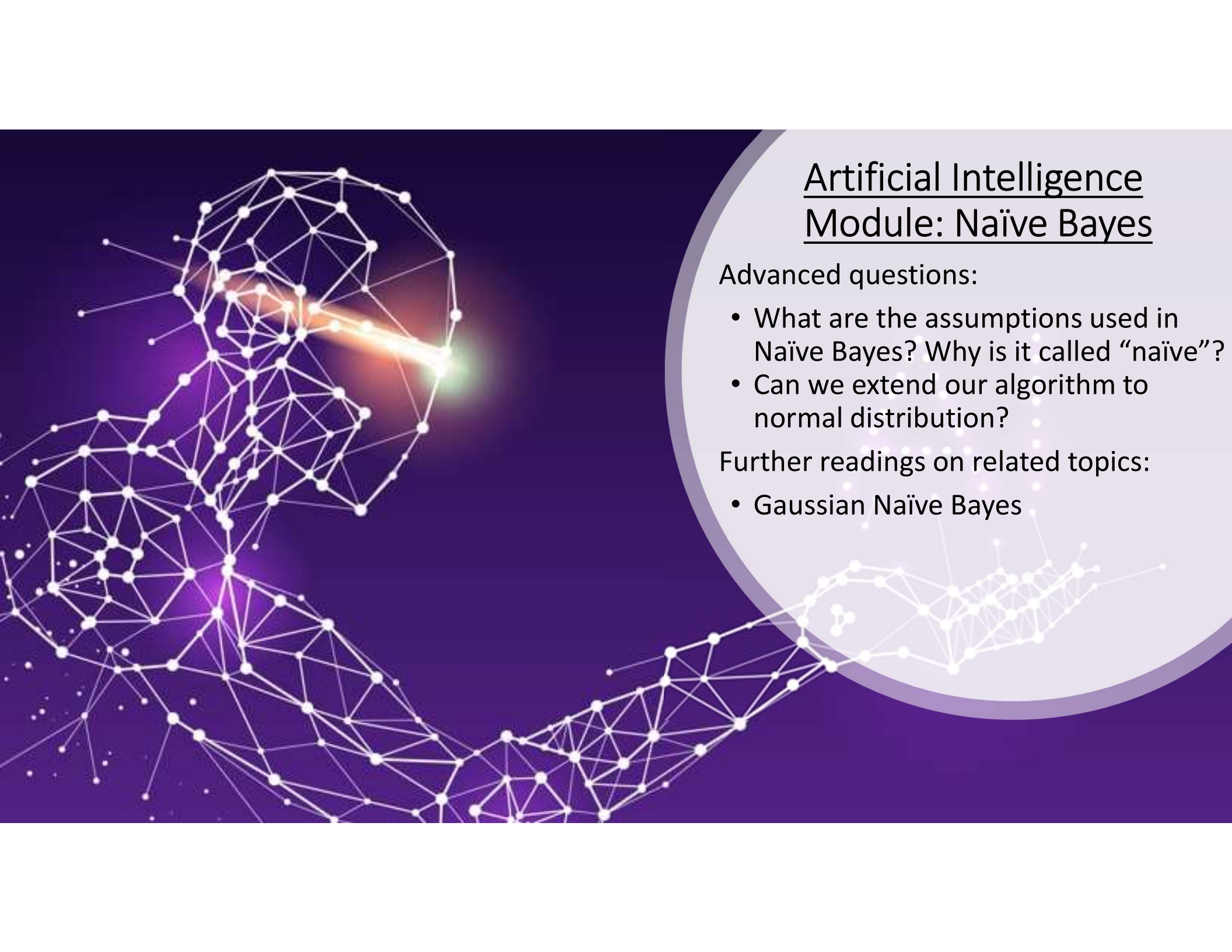
$$= 0.03125 > 0.0144$$



Category	Number of mails	Probability	Word	Number of occurrences	Probability
Normal mails	15	0.75	See	9	0.36
			Meet	8	0.32
			Free	2	0.08
			Cash	6	0.24
			Total	25	1
Spam mails	5	0.25	See	4	0.2
			Meet	1	0.05
			Free	10	0.5
			Cash	5	0.25
Total	20		Total	20	1

Conclusion:

Given an email is having the words “Free” and “Cash”, most probably, it is a spam email.



Artificial Intelligence Module: Naïve Bayes

Advanced questions:

- What are the assumptions used in Naïve Bayes? Why is it called “naïve”?
- Can we extend our algorithm to normal distribution?

Further readings on related topics:

- Gaussian Naïve Bayes

Further Applications:

- **Classification of Emails**

Incoming emails go into different folders:
“Family”, “Friends”, “Dawson”, etc.

- **Categorization of Products**

Use description to assign a product into categories:
“Books”, “Toys”, “Clothing”, etc.

- **Classifying Reviews of Products**