# Text Classification



## Is this spam?

Subject: Important notice!

From: Stanford University <newsforum@stanford.edu>

Date: October 28, 2011 12:34:16 PM PDT

To: undisclosed-recipients:;

#### **Greats News!**

You can now access the latest news by using the link below to login to Stanford University News Forum.

http://www.123contactform.com/contact-form-StanfordNew1-236335.html

Click on the above link to login for more information about this new exciting forum. You can also copy the above link to your browser bar and login for more information about the new services.

© Stanford University. All Rights Reserved.



## Is this spam?

Subject Important notice!

From: Staniora University <newsforum@stanford.edu>

Date: October 28, 2011 12:34:16 PM PDT

To: undisclosed-recipients:

Dan

**Greats News!** 

You can now access the latest news by using the link below to login to Stanford University News Forum.

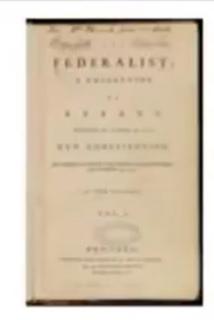
http://www.123contactform.com/contac-form-StanfordNew1-236335.html

Click on the above link to login for more information about this new exciting prum. You can also copy the above link to your browser bar and login for more information about the new services.

© Stanford University. All Rights Reserved.



## Who wrote which Federalist papers?



- 1787-8: anonymous essays try to convince New York to ratify U.S Constitution: Jay, Madison, Hamilton.
- Authorship of 12 of the letters in dispute
- 1963: solved by Mosteller and Wallace using Bayesian methods



James Madison



Alexander Hamilton



### Male or female author?

- By 1925 present-day Vietnam was divided into three parts under French colonial rule. The southern region embracing Saigon and the Mekong delta was the colony of Cochin-China; the central area with its imperial capital at Hue was the protectorate of Annam...
- Clara never failed to be astonished by the extraordinary felicity of her own name. She found it hard to trust herself to the mercy of fate, which had managed over the years to convert her greatest shame into one of her greatest assets...





## Positive or negative movie review?

- unbelievably disappointing
- Full of zany characters and richly applied satire, and some great plot twists
- this is the greatest screwball comedy ever filmed
- It was pathetic. The worst part about it was the boxing scenes.





### **Text Classification**

- Assigning subject categories, topics, or genres
- Spam detection
- Authorship identification
- Age/gender identification
- Language Identification
- Sentiment analysis

• ...





### **Text Classification: definition**

- Input:
  - a document d
  - a fixed set of classes  $C = \{c_1, c_2, ..., c_j\}$

Output: a predicted class c ∈ C

0



# Classification Methods: Hand-coded rules

- Rules based on combinations of words or other features
  - spam: black-list-address OR ("dollars" AND"have been selected")
- Accuracy can be high
  - If rules carefully refined by expert
- But building and maintaining these rules is expensive



# Classification Methods: Supervised Machine Learning

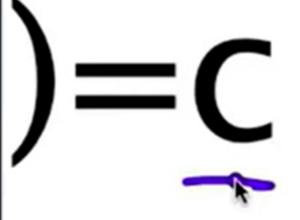
- Input:
  - a document d
  - a fixed set of classes  $C = \{c_1, c_2, ..., c_J\}$
  - A training set of m hand-labeled documents (d<sub>1</sub>,c<sub>1</sub>),....,(d<sub>m</sub>,c<sub>m</sub>)
- Output:
  - a learned classifier y:d → c



## The bag of words representation



I love this movie! It's sweet, but with satirical humor. The dialogue is great and the adventure scenes are fun... It manages to be whimsical and romantic while laughing at the conventions of the fairy tale genre. I would recommend it to just about anyone. I've seen it several times, and I'm always happy to see it again whenever I have a friend who hasn't seen it yet.



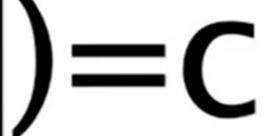




## The bag of words representation



I love this movie! It's sweet, but with satirical humor. The dialogue is great and the adventure scenes are fun... manages to be whimsical and romantic while laughing at the conventions of the fairy tale genre. I would recommend it to just about anyone. I've seen it several times, and I'm always happy to see it again whenever I have a friend who hasn't seen it yet.





































## Multinomial Naïve Bayes Classifier

$$c_{MAP} = \underset{c \in C}{\operatorname{argmax}} P(x_1, x_2, \dots, x_n \mid c) P(c)$$

$$c_{NB} = \underset{c \in C}{\operatorname{argmax}} P(c_j) \prod_{x \in X} P(x \mid c)$$



## Learning the Multinomial Naïve Bayes

- First attempt: maximum likelihood estir
  - simply use the frequencies in the data

$$\hat{P}(c_j) = \frac{doccount(C = c_j)}{N_{doc}}$$

$$\hat{P}(w_i \mid c_j) = \frac{count(w_i, c_j)}{\sum_{w \in V} count(w, c_j)}$$

#### Dan Jurafsky



$$\hat{P}(c) = \frac{N_c}{N}$$

$$\hat{P}(w \mid c) = \frac{count(w,c) + 1}{count(c) + |V|}$$

	Doc	Words	Class
Training	1	Chinese Beijing Chinese	С
	2	Chinese Chinese Shanghai	С
	3	Chinese Macao	С
	4	Tokyo Japan Chinese	j
Test	5	Chinese Chinese Tokyo Japan	?

#### Priors:

44

Priors:  

$$P(c) = \frac{3}{4} \frac{1}{4}$$

### Conditional Probabilities:

P(Chinese | c) = 
$$(5+1) / (8+6) = 6/14 = 3/7$$
  
P(Tokyo | c) =  $(0+1) / (8+6) = 1/14$   
P(Japan | c) =  $(0+1) / (8+6) = 1/14$   
P(Chinese | j) =  $(1+1) / (3+6) = 2/9$   
P(Tokyo | j) =  $(1+1) / (3+6) = 2/9$   
P(Japan | j) =  $(1+1) / (3+6) = 2/9$ 

### Choosing a class:

$$P(c|d5) \propto 3/4 * (3/7)^3 * 1/14 * 1/14$$
  
  $\approx 0.0003$