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Natural Language Processing

Chapter 04:

NAIVE BAYES AND SENTIMENT CLASSIFICATION

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Book: Speech and language processing Book
(Authors of book: Daniel Jurafsky and James H.Martin**)**

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1. Assume the following likelihoods for each word being part of a positive or negative movie review, and equal prior probabilities for each class.

	pos	neg
I	0.09	0.16
always	0.07	0.06
like	0.29	0.06
foreign	0.04	0.15
films	0.08	0.11

What class will Naive bayes assign to the sentence “I always like foreign films.”?

Solution:

We ignore the equal prior probabilities in our computation because it's having equal effect on both results.

P(“I always like foreign films”|pos) = $0.09 \times 0.07 \times 0.29 \times 0.04 \times 0.08 = 0.000005846$

P(“I always like foreign films”|neg) = $0.16 \times 0.06 \times 0.06 \times 0.15 \times 0.11 = 0.000009504$

$P(s|neg) > P(s|pos)$ so the Naive bayes assigns a neg class.

2. Given the following short movie reviews, each labeled with a genre, either comedy or action:
    a. 1. fun, couple, love, love **comedy**
    b. 2. fast, furious, shoot **action**
    c. 3. couple, fly, fast, fun, fun **comedy**
    d. 4. furious, shoot, shoot, fun **action**
    e. 5. fly, fast, shoot, love **action**

   and a new document D:

    f. fast, couple, shoot, fly

   compute the most likely class for D. Assume a naive Bayes classifier and use add-1 smoothing for the likelihoods.

Solution:

Vocabulary (V) = [fun, couple, love, fast, furious, shoot, fly]

len(V) = 7

Sentence (S) = fast, couple, shoot, fly

Classes (C)= [comedy(c), action(a)]

bigdoc[c] = [fun, couple, love, love, couple, fly, fast, fun, fun] = 9

bigdoc[a] = [fast, furious, shoot, furious, shoot, shoot, fun, fly, fast, shoot, love] = 11

We will only find the probabilities of the test sentence (S)

P(c) = ⅖

P(a) = ⅗

$P(fast|c) = \frac{1+1}{9+7} = \frac{2}{16}$ $P(fast|a) = \frac{2+1}{11+7} = \frac{3}{18}$

$P(couple|c) = \frac{2+1}{9+7} = \frac{3}{16}$ $P(couple|a) = \frac{0+1}{11+7} = \frac{1}{18}$

$P(shoot|c) = \frac{0+1}{9+7} = \frac{1}{16}$ $P(shoot|a) = \frac{4+1}{11+7} = \frac{5}{18}$

$P(fly|c) = \frac{1+1}{9+7} = \frac{2}{16}$ $P(fly|a) = \frac{1+1}{11+7} = \frac{2}{18}$

c = ⅖ x 2/16 x 3/16 x 1/16 x 2/16 = 0.000073242

a = ⅗ x 3/18 x 1/18 x 5/18 x 2/18 = 0.000171468

The selected class will be = argmax(c,a) = a = Action

3. Train two models, multinomial naive Bayes and binarized naive Bayes, both with add-1 smoothing, on the following document counts for key sentiment words, with positive or negative class assigned as noted.

doc	"good"	"poor"	"great"	(class)
d1.	3	0	3	pos
d2.	0	1	2	pos
d3.	1	3	0	neg
d4.	1	5	2	neg
d5.	0	2	0	neg

Use both naive Bayes models to assign a class (pos or neg) to this sentence:

A good, good plot and great characters, but poor acting.

Do the two models agree or disagree?

Solution:

Vocabulary (V) = [good, poor, great]

len(V) = 3

Sentence (S) = A good, good plot and great characters, but poor acting.

Classes (C)= [pos, neg]

Prior probabilities:

P(pos) = ⅖

P(neg) = ⅗

a) Multinomial naive Bayes

bigdoc[pos] = [good, good, good, great, great, great, poor, great, great] = 9

bigdoc[neg] = [good, poor, poor, poor, good, poor, poor, poor, poor, poor, great, great, poor, poor] = 14

P(good|pos) = $\frac{3+1}{9+3}$ = $\frac{4}{12}$ P(good|neg) = $\frac{2+1}{14+3}$ = $\frac{3}{17}$

P(great|pos) = $\frac{5+1}{9+3}$ = $\frac{6}{12}$ P(great|neg) = $\frac{2+1}{14+3}$ = $\frac{3}{17}$

P(poor|pos) = $\frac{1+1}{9+3}$ = $\frac{2}{12}$ P(poor|neg) = $\frac{10+1}{14+3}$ = $\frac{11}{17}$

[pos] = 0.4 × (4÷12) × (6÷12) × (2÷12) = 0.011111111

[neg] = 0.6 × (3÷17) × (3÷17) × (11÷17) = 0.012090372

So P(neg) > P(pos) we assert that multinomial naive bayes will assign class negative (neg)

b) Binarized naive Bayes

bigdoc[pos] = [good, great, great, poor] = 4

bigdoc[neg] = [good, poor, good, poor, great, poor] = 6

P(good|pos) = $\frac{1+1}{4+3}$ = $\frac{2}{7}$ P(good|neg) = $\frac{2+1}{6+3}$ = $\frac{3}{9}$

P(great|pos) = $\frac{2+1}{4+3}$ = $\frac{3}{7}$ P(great|neg) = $\frac{1+1}{6+3}$ = $\frac{2}{9}$

P(poor|pos) = $\frac{1+1}{4+3}$ = $\frac{2}{7}$ P(poor|neg) = $\frac{3+1}{6+3}$ = $\frac{4}{9}$

[pos] = 0.4 × (2÷7) × (3÷7) × (2÷ 7) = 0.013994169

[neg] = 0.6 × (3÷ 9) × (2÷9) × (4÷9) = 0.019753086

Hence, P(neg) > P(pos) we assert that binarized naive Bayes will assign class negative (neg)

In this case, both models are agreed.