



Review Test Submission: Fall 2018 Assignment 3

Review Test Submission: Fall 2018 Assignment 3

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Course	Fall 2018-CS 510-Advanced Information Retrieval-Section A1
Test	Fall 2018 Assignment 3
Started	9/22/18 12:13 PM
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Attempt Score	100 out of 100 points
Time Elapsed	7 hours, 4 minutes
Results Displayed	All Answers, Submitted Answers, Correct Answers, Feedback, Incorrectly Answered Questions

Question 1 10 out of 10 points



Unigram Language Model is a special class of N-Gram Language Model where the next word in the document is assumed to be independent of the previous words generated by the model. Mathematically, this is written as $P(w_m|w_{m-1},...,w_1) = P(w_m)$.

We can estimate the parameters of a Unigram Language Model through Maximum Likelihood Estimation. Given a particular document d and the vocabulary set V, the maximum likelihood estimator for a Unigram Language Model is given by the following formula:

$$P_{ML}(w|d) = \frac{c(w,d)}{\sum_{w' \in V} c(w',d)}$$

Now, let us assume that, we have seen the following document d: "science without religion is lame, religion without science is blind." Assuming that this document was generated by a Unigram Language Model and words in the document d constitute the entire vocabulary, what are the parameters of this Unigram Language Model? Estimate the values of all these parameters using the maximum likelihood estimator (The symbol # indicates the 'beginning of sentence' marker).

Selected Answer:

Answers:

$$p("without"|d) = 2/21$$

$$p("religion"|d) = 2/21$$

$$p("is"|d) = 2/21$$

$$p("lame"|d) = 1/21$$

$$p("blind"|d) = 1/21$$

$$p(","|d) = 1/21$$

$$p(" "|d) = 9/21$$

$$p("."|d) = 1/21$$

$$p("science"|d) = 2/11$$

$$p("without"|d) = 2/11$$

$$p("religion"|d) = 2/11$$

$$p("is"|d) = 2/11$$

$$p("lame"|d) = 1/11$$

$$p("blind"|d) = 1/11$$

$$p(\#|d) = 1/11$$

```
p("science"|d) = 2/6
p("without"|d) = 2/6
p("religion"|d) = 2/6
p("is"|d) = 2/6
p("lame"|d) = 1/6
p("blind"|d) = 1/6
```

Question 2 10 out of 10 points



Continuing the setup of the previous question; now assume that, the entire vocabulary V consists of the set:

{science, religion, without, is, lame, blind, retrieval, model, BM25}

If we consider the same document d: "science without religion is lame, religion without science is blind." and assume again that this document was generated by a Unigram Language Model, what are the parameters of this Unigram Language Model in this case? Estimate the values of all these parameters using the maximum likelihood estimator (The symbol # indicates a 'beginning of sentence' marker).

Selected Answer: p("science"|d) = 2/10

p("without"|d) = 2/10

p("religion"|d) = 2/10

p("is"|d) = 2/10

p("lame"|d) = 1/10

p("blind"|d) = 1/10

p("retrieval"|d) = 0/10

p("model"|d) = 0/10

p("BM25"|d) = 0/10



p("science"|d) = 2/10Answers:

p("without"|d) = 2/10

p("religion"|d) = 2/10

p("is"|d) = 2/10

p("lame"|d) = 1/10

p("blind"|d) = 1/10

p("retrieval"|d) = 0/10

p("model"|d) = 0/10

p("BM25"|d) = 0/10

p("science"|d) = 2/21

p("without"|d) = 2/21

p("religion"|d) = 2/21

p("is"|d) = 2/21

p("lame"|d) = 1/21

p("blind"|d) = 1/21

p(","|d) = 1/21

p(" "|d) = 9/21

p("."|d) = 1/21

p("retrieval"|d) = 0/21

p("model"|d) = 0/21

p("BM25"|d) = 0/21

p("science"|d) = 2/9

p("without"|d) = 2/9

p("religion"|d) = 2/9

p("is"|d) = 2/9

p("lame"|d) = 1/9

p("blind"|d) = 1/9

p("retrieval"|d) = 0/9

p("model"|d) = 0/9

p("BM25"|d) = 0/9

p("science"|d) = 2/11

p("without"|d) = 2/11

p("religion"|d) = 2/11

p("is"|d) = 2/11

p("lame"|d) = 1/11

p("blind"|d) = 1/11

p("retrieval"|d) = 0/11

p("model"|d) = 0/11

p("BM25"|d) = 0/11

 $oldsymbol{0}{\circ}$ p(#|d) = 1/11

Question 3

10 out of 10 points



Bigram Language Model is another special class of N-Gram Language Model where the next word in the document depends only on the immediate preceding word. Mathematically, this is written as the conditional probability, $P(w_m|w_{m-1},...,w_1) = P(w_m|w_{m-1})$.

Given the same document d: "science without religion is lame, religion without science is blind." and the vocabulary set from the previous question:

{science, religion, without, is, lame, blind, retrieval, model, BM25}

Assume that document d is now generated by a Bigram Language Model, how many parameters does this Bigram Language Model have? (Do not forget to consider the beginning of sentence marker # in your calculations)

Selected Answer: 7 90

Correct Answer: 👩 90

Answer range +/- 0 (90.0 - 90.0)

Response How many P(A|B) do we need to specify? Since there are 9 unique words in the Feedback: vocabulary, |A| = 9, and |B| = 10 (since we need to count the beginning of the

sentence marker # too). Thus there are: 9*10 = 90 parameters to specify.

Question 4 10 out of 10 points



Continued from Question 3:

Using the maximum likelihood estimator, estimate the values of the following parameters (assume # to be the start of the sentence marker):

P("without"|"science") = [a]

P("science"|"without") = [b]

P("religion"|"is") = **[c]**

P("is"|"religion") = [d]

P("is"|"blind") = **[e]**

P("lame"|"blind") = [f]

P("model"|"is") = [g]

P("model"|"retrieval") = [h]

P("science"|#) = [i]

P("BM25"|#) = [j]

(Round your answer to 1 decimal point. Example: 74 --> 74.0)

Specified Answer for: a 0.5

Specified Answer for: b 👩 0.5

Specified Answer for: c 🕜 0.0

Specified Answer for: d 🕜 0.5

Specified Answer for: e 🕜 0.0

Specified Answer for: f 0.0

Specified Answer for: g 🚫 0.0 Specified Answer for: h 💍 0.0 Specified Answer for: i 🚫 1.0 Specified Answer for: j 💍 0.0

Correct Answers for: a		
Evaluation Method	Correct Answer	Case Sensitivity
	0.5	
Correct Answers for: b		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.5	
Correct Answers for: c		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0	
Correct Answers for: d		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.5	
Correct Answers for: e		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0	
Correct Answers for: f		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0	
Correct Answers for: g		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0	
Correct Answers for: h		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0	
Correct Answers for: i		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	1.0	
Correct Answers for: j		
Evaluation Method	Correct Answer	Case Sensitivity

Question 5 20 out of 20 points

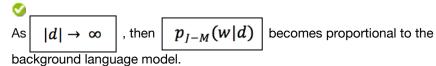


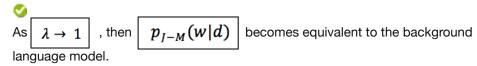
Let $p_{I-M}(w|d)$ represent a Unigram Language model smoothed using Jelinek-Mercer smoothing.

And let $p_{Dir}(w|d)$ represent a Unigram Language model smoothed using Dirichlet Prior smoothing.

Which of these statements are correct? (Choose all that apply)

Selected Answers:





 $p_{Dir}(w|d)$, then becomes equivalent to the maximum likelihood estimate of the unigram language model.

becomes equivalent to the maximum $\lambda \rightarrow 0$, then likelihood estimate of the unigram language model.

As
$$\mu o \infty$$
 , then $p_{Dir}(w|d)$ becomes equivalent to the background language model.

Answers:

As
$$|d| o \infty$$
 , then $p_{J-M}(w|d)$ becomes proportional to the background language model.

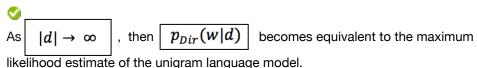
As
$$\lambda o 0$$
 , then $p_{J-M}(w|d)$ becomes equivalent to the

background language model.

As
$$|d| o \infty$$
 , then $p_{Dir}(w|d)$ becomes equivalent to the

background language model.

As
$$\mu \to \infty$$
, then $p_{Dir}(w|d)$ becomes equivalent to the maximum likelihood estimate of the unigram language model.



As
$$\lambda \to 1$$
 , then $p_{J-M}(w|d)$ becomes equivalent to the background language model.

As
$$\mu o 0$$
 , then $p_{Dir}(w|d)$ becomes equivalent to the

background language model

As
$$\lambda \to 1$$
, then $p_{J-M}(w|d)$ becomes equivalent to the maximum likelihood estimate of the unigram language model.

As
$$|d| \to \infty$$
, then $p_{I-M}(w|d)$ becomes proportional to the maximum likelihood estimate of the unigram language model.

As
$$\mu \to 0$$
, then $p_{Dir}(w|d)$ becomes equivalent to the maximum likelihood estimate of the unigram language model.

 $p_{J-M}(w|d)$ becomes equivalent to the maximum likelihood estimate of the unigram language model.

 $\mu \rightarrow \infty$ As language model.

 $p_{Dir}(w|d)$, then

becomes equivalent to the background

Question 6 10 out of 10 points



Again, Consider the document d: "science without religion is lame, religion without science is blind."

This time, assume that we have a background word distribution (pre-computed somehow) denoted by REF which is characterized as follows:

PREF("science") = 0.18

PRFF("religion") = 0.17

PREF("without") = 0.13

 $P_{REF}("is") = 0.02$

 $P_{REF}("lame") = 0.05$

PREF("blind") = 0.04

PRFF("retrieval") = 0.16

PRFF("model") = 0.10

 $P_{REF}("BM25") = 0.15$

Assume document d is generated by a Unigram Language Model. Estimate the parameters of the Unigram Language Model using Dirichlet Prior Smoothing assuming u = 4:

P("science"|d) = [a]

P("religion"|d) = [b]

P("without"|d) = [c]

P("is"|d) = [d]

P("lame"|d) = [e]

P("blind"|d) = [f]

P("retrieval"|d) = [g]

P("model"|d) = [h]

P("BM25"|d) = [i]

(Round your answers to 4 decimal places. Example: 0.12045 --> 0.1205)

Specified Answer for: a 👩 0.1943

Specified Answer for: b 🚫 0.1914

Specified Answer for: c 👩 0.1800

Specified Answer for: d	② 0.1486
Specified Answer for: e	② 0.0857
Specified Answer for: f	② 0.0829
Specified Answer for: g	② 0.0457
Specified Answer for: h	② 0.0286
Specified Answer for: i	0.0429

Correct Answers for: a		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.1943	
Correct Answers for: b		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.1914	
Correct Answers for: c		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.1800	
Correct Answers for: d		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.1486	
Correct Answers for: e		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0857	
Correct Answers for: f		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0829	
Correct Answers for: g		
Evaluation Method	Correct Answer	Case Sensitivity
	0.0457	
Correct Answers for: h		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0286	
Correct Answers for: i		
Evaluation Method	Correct Answer	Case Sensitivity
Sexact Match	0.0429	

Question 7 10 out of 10 points



Repeat the previous question assuming u = 100. Do the results match with your intuition and your formulas in Question 5?

P("science"|d) = [a]

P("religion"|d) = **[b]**

P("without"|d) = [c]

P("is"|d) = [d]

P("lame"|d) = [e]

P("blind"|d) = [f]

P("retrieval"|d) = [g]

P("model"|d) = [h]

P("BM25"|d) = [i]

(Round your answers to 4 decimal places. Example: 0.12045 --> 0.1205)

Specified Answer for: a 👩 0.1818

Specified Answer for: b 👩 0.1727

Specified Answer for: c 👩 0.1364

Specified Answer for: d 👩 0.0364

Specified Answer for: e 🕜 0.0545

Specified Answer for: f 🚫 0.0455

Specified Answer for: g 👩 0.1455

Specified Answer for: h 👩 0.0909

Evaluation Method

Specified Answer for: i 🚫 0.13	364	
Correct Answers for: a		
Evaluation Method	Correct Answer	Case Sensitivity
Sexact Match	0.1818	
Correct Answers for: b		
Evaluation Method	Correct Answer	Case Sensitivity
Sexact Match	0.1727	
Correct Answers for: c		
Evaluation Method	Correct Answer	Case Sensitivity
Sexact Match	0.1364	
Correct Answers for: d		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0364	
Correct Answers for: e		
Evaluation Method	Correct Answer	Case Sensitivity
Sexact Match	0.0545	
Correct Answers for: f		
Evaluation Method	Correct Answer	Case Sensitivity
Sexact Match	0.0455	
Correct Answers for: g		

Correct Answer

Case Sensitivity

C Exact Match	0.1455	
Correct Answers for: h		
Evaluation Method	Correct Answer	Case Sensitivity
Sexact Match	0.0909	
Correct Answers for: i		
Evaluation Method	Correct Answer	Case Sensitivity
Sexact Match	0.1364	

Question 8 20 out of 20 points



Repeat Question 6 with Jelinek-Mercer smoothing instead of Dirichlet Prior Smoothing assuming

$$\lambda = \{0.01, 0.9\}$$

Do the results match with your intuition about what happens when lambda approaches 0 or approaches 1?

$$\lambda = 0.01$$

$$P("science"|d) = [a]$$

$$P("religion"|d) = [b]$$

$$P("without"|d) = [c]$$

$$P("is"|d) = [d]$$

$$P("lame"|d) = [e]$$

$$P("blind"|d) = [f]$$

$$P("retrieval"|d) = [g]$$

$$P("model"|d) = [h]$$

$$P("BM25"|d) = [i]$$

$$\lambda = 0.9$$

$$P("science"|d) = [j]$$

$$P("religion"|d) = [k]$$

$$P("without"|d) = [1]$$

$$P("is"|d) = [m]$$

$$P("lame"|d) = [n]$$

$$P("blind"|d) = [o]$$

$$P("retrieval"|d) = [p]$$

$$P("model"|d) = [q]$$

$$P("BM25"|d) = [r]$$

(Round your answers to 4 decimal places. Examples: 0.12045 --> 0.1205, and 0.012 --> 0.0120)

Specified Answer for: a **0.1998**

Specified Answer for: b **0.1997**

Specified Answer for: c **0.1993**

Specified Answer for: d **0.1982**

Specified Answer for: e **0.0995**

Specified Answer for: f **0.0994**

Specified Answer for: g **0.0016**

Specified Answer for: h **0.0010**

Specified Answer for: i **0.0015**

Specified Answer for: j 0.1820

Specified Answer for: k **0.1730**

Specified Answer for: I 0.1370

Specified Answer for: m 👩 0.0380

Specified Answer for: n **0.0550**

Specified Answer for: o **0.0460**

Specified Answer for: p **0.1440**

Specified Answer for: q 💍 0.0900

Specified Answer for: r 💍 0.1	350	
Correct Answers for: a		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.1998	
Correct Answers for: b		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.1997	
Correct Answers for: c		
Evaluation Method	Correct Answer	Case Sensitivity
Sexact Match	0.1993	
Correct Answers for: d		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.1982	
Correct Answers for: e		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0995	
Correct Answers for: f		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0994	
Correct Answers for: g		
Evaluation Method	Correct Answer	Case Sensitivity

Review	V Test Submission: Fall 2018 Assign	iniciti 3 – Pall
Exact Match	0.0016	
Correct Answers for: h		
Evaluation Method	Correct Answer	Case Sensitivity
Exact Match	0.0010	
Correct Answers for: i		
Evaluation Method	Correct Answer	Case Sensitivity
	0.0015	
Correct Answers for: j		
Evaluation Method	Correct Answer	Case Sensitivity
	0.1820	
Correct Answers for: k		
Evaluation Method	Correct Answer	Case Sensitivity
	0.1730	
Correct Answers for: I		
Evaluation Method	Correct Answer	Case Sensitivity
	0.1370	
Correct Answers for: m		
Evaluation Method	Correct Answer	Case Sensitivity
Sexact Match	0.0380	
Correct Answers for: n		
Evaluation Method	Correct Answer	Case Sensitivity
	0.0550	
Correct Answers for: o		
Evaluation Method	Correct Answer	Case Sensitivity
	0.0460	
Correct Answers for: p		
Evaluation Method	Correct Answer	Case Sensitivity
	0.1440	
Correct Answers for: q		
Evaluation Method	Correct Answer	Case Sensitivity
	0.0900	
Correct Answers for: r		
Evaluation Method	Correct Answer	Case Sensitivity

Saturday, September 22, 2018 7:17:43 PM CDT

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