**CSC-343 ARTIFICIAL INTELLIGENCE**

**LECTURE 5.3**

**PROGRAMMING ASSIGNMENT 4**

**DATA:**

emails = [(“Where to hide a dead body”, 1), (“Grateful dead body of work”, 0)]

**MODEL: *(Naïve Bayes)***

𝑃 (Spam|𝑤𝑜𝑟𝑑1,𝑤𝑜𝑟𝑑2,...𝑤𝑜𝑟𝑑𝑛) =𝛂 𝑃 (Spam) ∏ 𝑃 (𝑤𝑜𝑟𝑑𝑖|Spam)

**CLASSIFIER:**

𝑃 (spam| 𝑤𝑜𝑟𝑑1, 𝑤𝑜𝑟𝑑2,...𝑤𝑜𝑟𝑑𝑛) > 𝑃( ¬ spam| 𝑤𝑜𝑟𝑑1, 𝑤𝑜𝑟𝑑2,... 𝑤𝑜𝑟𝑑𝑛)

B-BOW:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *email* | Where | To | Hide | A | Dead | Body | Grateful | Of | Work | Spam |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | True |
| 2 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | False |

**PART 1 - PRIORS**

𝑃 (Spam|𝑤𝑜𝑟𝑑1,𝑤𝑜𝑟𝑑2,...𝑤𝑜𝑟𝑑𝑛) =𝛂 𝑃 (Spam) ∏ 𝑃 (𝑤𝑜𝑟𝑑𝑖|Spam)

𝑃(𝑠𝑝𝑎𝑚) = 𝑐𝑜𝑢𝑛𝑡(𝑠𝑝𝑎𝑚 𝑒𝑚𝑎𝑖𝑙𝑠) / 𝑐𝑜𝑢𝑛𝑡(𝑎𝑙𝑙 𝑒𝑚𝑎𝑖𝑙𝑠)

𝑃(¬𝑠𝑝𝑎𝑚)= 𝑐𝑜𝑢𝑛𝑡(ℎ𝑎𝑚 𝑒𝑚𝑎𝑖𝑙𝑠) / 𝑐𝑜𝑢𝑛𝑡(𝑎𝑙𝑙 𝑒𝑚𝑎𝑖𝑙𝑠)

|  |  |
| --- | --- |
| **Spam** | **P(Spam)** |
| True | p1 ½ = 0.5 |
| False | p2 ½ = 0.5 |

**PART 2 – JOINT PROBABILITIES**

𝑃 (Spam|𝑤𝑜𝑟𝑑1,𝑤𝑜𝑟𝑑2,...𝑤𝑜𝑟𝑑𝑛) =𝛂 𝑃 (Spam) ∏ 𝑃 (𝑤𝑜𝑟𝑑𝑖|Spam)

𝑃 (𝑤𝑜𝑟𝑑𝑖 | Spam) = P(𝑤𝑜𝑟𝑑𝑖, Spam) / P(Spam)

Joint Probabilities: P(𝑤𝑜𝑟𝑑𝑖, Spam)

jp1 = count(spam emails containing 𝑤𝑜𝑟𝑑𝑖) / count(all emails)

jp2 = count(spam emails NOT containing 𝑤𝑜𝑟𝑑𝑖) / count(all emails)

jp3 = count(ham emails containing 𝑤𝑜𝑟𝑑𝑖) / count(all emails)  
jp4 = count(ham emails NOT containing 𝑤𝑜𝑟𝑑𝑖) / count(all emails)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Where** | | |  | **To** | | |  | | **Hide** | | |
| **wordi** | **Spam** | **P(wordi, Spam)** |  | **wordi** | **Spam** | **P(wordi, Spam)** |  | | **wordi** | **Spam** | **P(wordi, Spam)** |
| T | T | jp1 ½ = 0.5 | T | T | jp1 0.5 | T | T | jp1 0.5 |
| F | T | jp2 0/2 = 0 | F | T | jp2 0 | F | T | jp2 0 |
| T | F | jp3 0 | T | F | jp3 0 | T | F | jp3 0 |
| F | F | jp4 0.5 | F | F | jp4 0.5 | F | F | jp4 0.5 |
| **A** | | | | **Dead** | | | | **Body** | | | |
| **wordi** | **Spam** | **P(wordi, Spam)** |  | **wordi** | **Spam** | **P(wordi, Spam)** |  | | **wordi** | **Spam** | **P(wordi, Spam)** |
| T | T | jp1 0.5 | T | T | jp1 ½ = 0.5 | T | T | jp1 0.5 |
| F | T | jp2 0 | F | T | jp2 0 | F | T | jp2 0 |
| T | F | jp3 0 | T | F | jp3 ½ = 0.5 | T | F | jp3 0.5 |
| F | F | jp4 0.5 | F | F | jp4 0 | F | F | jp4 0 |
| **Grateful** | | | | **Of** | | | | **Work** | | | |
| **wordi** | **Spam** | **P(wordi, Spam)** |  | **wordi** | **Spam** | **P(wordi, Spam)** |  | | **wordi** | **Spam** | **P(wordi, Spam)** |
| T | T | jp1 0 | T | T | jp1 0 | T | T | jp1 0 |
| F | T | jp2 0.5 | F | T | jp2 0.5 | F | T | jp2 0.5 |
| T | F | jp3 0.5 | T | F | jp3 0.5 | T | F | jp3 0.5 |
| F | F | jp4 0 | F | F | jp4 0 | F | F | jp4 0 |

**PART 3 – CONDITIONAL PROBABILITIES**

𝑃 (Spam|𝑤𝑜𝑟𝑑1,𝑤𝑜𝑟𝑑2,...𝑤𝑜𝑟𝑑𝑛) =𝛂 𝑃 (Spam) ∏ 𝑃 (𝑤𝑜𝑟𝑑𝑖|Spam)

𝑃 (𝑤𝑜𝑟𝑑 𝑖| Spam) = 𝑃 (word 𝑖, Spam) / 𝑃 (Spam)

cp1 = jp1 / P(Spam=True)

cp2 = jp2 / P(Spam=True)

cp3 = jp3 / P(Spam=False)

cp4 = jp4 / P(Spam=False)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Where** | | |  | **To** | | |  | | **Hide** | | |
| **wordi** | **Spam** | **P(wordi | Spam)** |  | **wordi** | **Spam** | **P(wordi | Spam)** |  | | **wordi** | **Spam** | **P(wordi** | **Spam)** |
| T | T | cp1 = jp1 / P(Spam=True) = 1 | T | T | cp1 1 | T | T | cp1 1 |
| F | T | cp2 0 | F | T | cp2 0 | F | T | cp2 0 |
| T | F | cp3 0 | T | F | cp3 0 | T | F | cp3 0 |
| F | F | cp4 1 | F | F | cp4 1 | F | F | cp4 1 |
| A | | | | Dead | | | | Body | | | |
| **wordi** | **Spam** | **P(wordi** | **Spam)** |  | **wordi** | **Spam** | **P(wordi, Spam)** |  | | **wordi** | **Spam** | **P(wordi, Spam)** |
| T | T | cp1 1 | T | T | cp1 1 | T | T | cp1 1 |
| F | T | cp2 0 | F | T | cp2 0 | F | T | cp2 0 |
| T | F | cp3 0 | T | F | cp3 1 | T | F | cp3 1 |
| F | F | cp4 1 | F | F | cp4 0 | F | F | cp4 0 |
| Grateful | | | | Of | | | | Work | | | |
| **wordi** | **Spam** | **P(wordi | Spam)** |  | **wordi** | **Spam** | **P(wordi | Spam)** |  | | **wordi** | **Spam** | **P(wordi** | **Spam)** |
| T | T | cp1 0 | T | T | cp1 0 | T | T | cp1 0 |
| F | T | cp2 1 | F | T | cp2 1 | F | T | cp2 1 |
| T | F | cp3 1 | T | F | cp3 1 | T | F | cp3 1 |
| F | F | cp4 0 | F | F | cp4 0 | F | F | cp4 0 |

**PART 4 – CLASSIFICATION**

**e.g.Where to hide a dead body?**

**P(Spam | where to hide a dead body) = P(Spam=True) \* (cp1\_where \* cp1\_to \* cp1\_hide \* …. )**

**P(**¬**Spam | where to hide a dead body) = P(Spam=False) \* (cp3\_where \* cp3\_to \* cp3\_hide \* …. )**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *email* | P(spam | email)  = 𝑃 (spam|𝑤𝑜𝑟𝑑1,𝑤𝑜𝑟𝑑2,...𝑤𝑜𝑟𝑑𝑛)  = 𝑃 (spam) ∏ 𝑃 (𝑤𝑜𝑟𝑑𝑖|spam)  = 𝑃 (spam) **cp1** | P(¬spam | email)  = 𝑃 (¬spam|𝑤𝑜𝑟𝑑1,𝑤𝑜𝑟𝑑2,...𝑤𝑜𝑟𝑑𝑛)  = 𝑃(¬spam) ∏ 𝑃 (𝑤𝑜𝑟𝑑𝑖|¬spam)  = 𝑃(¬spam) **cp3** | Our Prediction  P(spam | email)  >  P(¬spam | email) | *Data*  Spam |
| 1 | 1 \* P(Spam = True)   * 1. \* (1 \* 1 \* 1 \* 1 \* 1 \* 1) | 0 | True | True |
| 2 | 0 | 1 \* P(Spam=False)  1 \* 0.5 = 0.5 | False | False |

**PART 5 – ACCURACY**

**Accuracy = Count(Our Prediction == Prediction from Data) / Count(Emails)**

( 1 + 1 ) / 2 = 100% accuracy