עיבוד שפה טבעית - תרגיל 3.

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1 בינואר 2018

1 We saw in class the following regarding forward-backward algorithm:

The marginal $Pr(y_j, y_{j-1}|x_i)$ is the sum over all paths that have edge $(y_{j-1,}y_j)$ between states j-1 and j.

Edge weights between y and y' is Mi(y,y')

$\alpha_i(y)$= $\Sigma_{y'} M_i(y, y') * \alpha_{i-1}(y')$ where M is the edge (transition) weights,

α= sum of weights over all paths of length i-1 ends with y.

$\beta_i(y) = \Sigma_{y'} M_{i+1}(y, y') * \beta_{i+1}(y')$, β = sum of weights over all paths from the end until y.

Let X = $x_1, ..., x_N$= sentence of words

$Pr(y_i, y_{i-1}|X) = \frac{M_i(y_i,y_{i-1})*\beta_i(y_i)*\alpha_{i-1}(y_{i-1})}{Z(x)} \rightarrow Pr(y_i|X) = \frac{\alpha(y_i)*\beta_i(y_i)}{Z(x)} *$

From the defition of conditional probability: $Pr(y_i|y_{i-1}, X) = \frac{Pr(y_i,y_{i-1}|X)}{Pr(y_{i-1}|X)} **$

Now we can assign the terms * and **, we will get that:

$Pr(y_i|y_{i-1}, X) = \frac{\frac{M_i(y_i,y_{i-1})*\beta_i(y_i)*\alpha_{i-1}(y_{i-1})}{Z(x)}}{\frac{\alpha_{i-1}(y_{i-1})*\beta_i(y_{i-1})}{Z(x)}} = \frac{M_i(y_{i-1},y_i)*\beta_i(y_i)}{\beta_{i-1}(y_{i-1})}$

let $Y = y_1, ...y_N = labels\,(tags)$

Let's initialize 2 matrices F, B of size |Y|*|Y|, now let's fill them:

Matrix F: $\alpha_i(y)$= value in row i and column j s.t $y = y_j \in Y$ and

$\beta_i(y) = value\ in\ row\ i\ and\ col\ j$ s.t $y = y_j \in Y$

Notations $F\,[i]\,(y) = \alpha_i(y)$ and $B\,[i]\,(y) = \beta_i(y)$

1.1

input: f- feature function, w- weight vector, $x_1, ..., x_N$ - sentence of words, i - index

- preprocessing: define a Matrix A(|Y|*|Y|) each row represents the probability distribution on a specific y.
- $i = 0$
- for y in Y:
  - $j = 0$
  - for y' in Y:
    - $A[i][j] = \frac{M_i(y,y')*B[i](y')}{B[i-1](y)}$
    - $j++$
  - $i++$
- return A

1.2

Algorithm:

input: f- feature function, w- weight vector, $x_1, ..., x_N$ - sentence of words, i - index

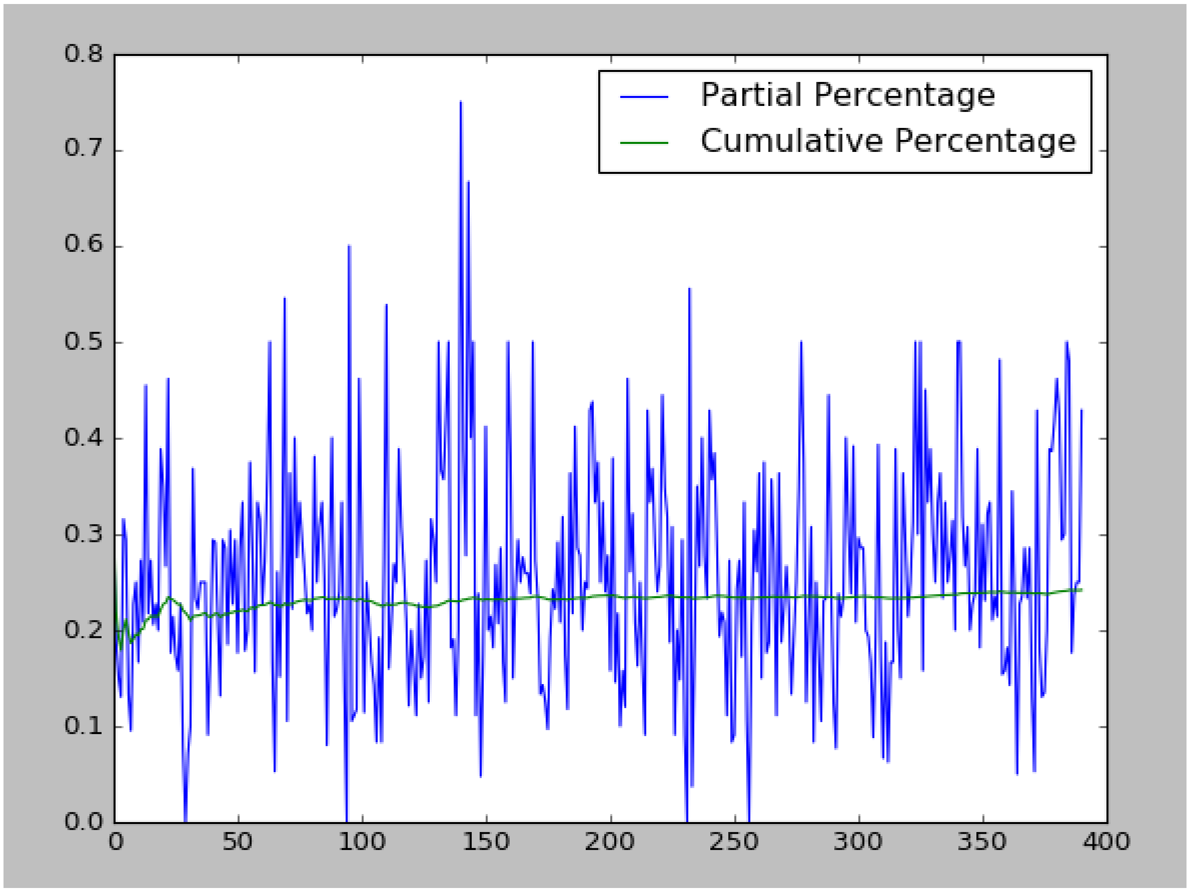
- preprocessing: define v a vector in size |Y| of probabilities.
- $cnt = 0$
- for y in Y:
  - $A[cnt] = \frac{F[i](y)*B[i](y)}{Z(x)}$
- return A

2 Practical Question

2.1

2.2

cumulative score : 0.24. (2 iterations, learning rate = 1)

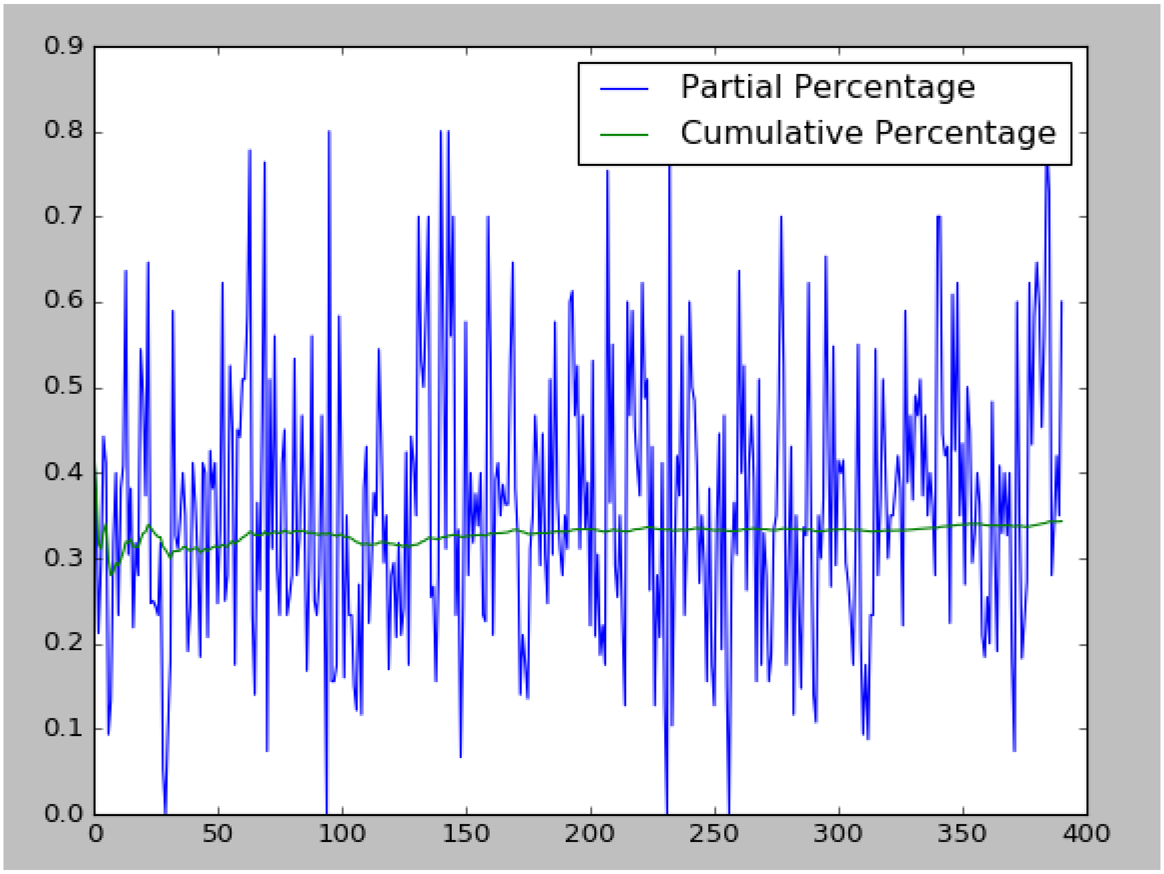


2.3

2.4

2.5

Cumulative score : 0.34. (2 iteration, adding 4 cells for distance)


Partial Percentage
Cumulative Percentage
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
50
100
150
200
250
300
350
400