Lecture Questions

1 The Tagging Problem

1.1 Question (time: 6:15)

Say we are given the following sentence with named-entity boundaries

- (Person Jane Smith) lives in (Location England)

If we encode these boundaries as a tag sequence, what is the tag for the word "Jane"?

(a) CP

(b) SP

(c) NA

(d) P

1.2 Question (time: 6:15)

Say we are given the following sentence

- Profits are topping all estimates

We also are told that

- "Profits" has 2 possible tags: N and V
- "are" has 1 possible tag: V
- "topping" has 3 possible tags: N, ADJ, and V
- "all" has 3 possible tags: DT, ADV, and N
- "estimates" has 2 possible tags: N and V

How many tag sequences are possible for this sentence?

2 HMMs

2.1 Question (time: 7:12)

Say we are given a tagset $\mathcal{S} = \{\mathrm{D}, \mathrm{N}\}$, a vocabulary $\mathcal{V} = \{\mathrm{the}, \mathrm{dog}\}$, and a hidden Markov model. The HMM has transition parameters

- $q(\mathrm{D}|*, *) = 1$
- $q(\mathrm{N}|*, \mathrm{D}) = 1$
- $q(\mathrm{STOP}|\mathrm{D}, \mathrm{N}) = 1$
- $q(s|u, v) = 0$ for all other q params

and emission parameters

- $e(\mathrm{the}|\mathrm{D}) = 0.9$
- $e(\mathrm{dog}|\mathrm{D}) = 0.1$
- $e(\mathrm{dog}|\mathrm{N}) = 1$

Under this model, how many pairs of sequences $x_1 \ldots x_n, y_1 \ldots y_{n+1}$ satisfy $p(x_1, ...x_n, y_1, ...y_{n+1}) > 0$?

2.2 Question (time: 9:20)

Say we have a tag set $\mathcal{S} = \{\mathrm{D}, \mathrm{N}, \mathrm{V}\}$, a vocabulary $\mathcal{V} = \{\mathrm{the}, \mathrm{cat}, \mathrm{drinks}, \mathrm{milk}, \mathrm{dog}\}$, and a hidden Markov model with parameters $q(s|u, v) = 1/4$ for all s, u, v and $e(x|s) = 1/5$ for all tags s and words x.

What is the value of $p(\mathrm{the\ cat\ drinks\ milk}, \mathrm{D\ N\ V\ N\ STOP})$ under this model?

(a) $(1/4)^4(1/5)^5$

(b) $(1/4)^5(1/5)^5$

(c) $(1/4)^5(1/5)^4$

(d) $(1/4)^4(1/5)^4$

2.3 Question (time: 12:00)

Which of the following is a suitable definition for $p(x_1 \ldots x_n, y_1 \ldots y_{n+1})$ under a ¡b¿bigram¡/b¿ hidden Markov model?

(a) $\prod_{i=1}^{n} q(y_i|y_{i-1}) \prod_{i=1}^{n} e(x_i|y_i)$

(b) $\prod_{i=1}^{n+1} q(y_i|y_{i-1}) \prod_{i=1}^{n} e(x_i|y_i)$

(c) $\prod_{i=1}^{n+1} q(y_i|y_{i-1}) \prod_{i=1}^{n} e(x_i, x_{i-1}|y_i)$

3 Estimation

3.1 Question (time: 5:02)

Consider the following training corpus of tagged sentences

- the dog barks → D N V STOP
- the cat sings → D N V STOP

Say we compute the maximum-likelihood estimates of a trigram hidden Markov model from this data. What is the value for the parameter $e(\text{cat}|\text{N})$ of this HMM?

3.2 Question (time: 5:02)

Consider the following training corpus of tagged sentences

- the dog barks → D N V STOP
- the cat sings → D N V STOP

Say we estimate the parameters for a hidden Markov model from this data using linear interpolation with $\lambda_i = 1/3$ for $i = 1 \ldots 3$.

What is the value of the parameter $q(\text{STOP}|\text{N}, \text{V})$ under this model?

4 Viterbi 1

4.1 Question (time: 12:00)

We are given a hidden Markov model with transition parameters

- $q(\text{D}|*, *) = 1$, $q(\text{N}|*, \text{D}) = 1$
- $q(\text{V}|\text{D}, \text{N}) = 1$, $q(\text{STOP}|\text{N}, \text{V}) = 1$

and emission parameters

- $e(\text{the}|\text{D}) = 0.8$, $e(\text{dog}|\text{D}) = 0.2$
- $e(\text{dog}|\text{N}) = 0.8$, $e(\text{the}|\text{N}) = 0.2$
- $e(\text{barks}|\text{V}) = 1.0$

Say we have the sentence

- the dog barks

What is the value of $\pi(3, \text{N}, \text{V})$?

5 Viterbi 2

5.1 Question (time: 3:31)

Say we are given a tag set $\mathcal{S} = \{\mathrm{D}, \mathrm{N}, \mathrm{V}, \mathrm{P}\}$ and a hidden Markov model with parameters

- $q(\mathrm{D}|\mathrm{N}, \mathrm{P}) = 0.4$
- $q(\mathrm{D}|w, \mathrm{P}) = 0$ for $w \neq N$
- $e(\text{the}|\mathrm{D}) = 0.6$

We are also given the sentence

- Ella walks to the red house

Say the dynamic programming table for this sentence has the following entries

- $\pi(3, \mathrm{D}, \mathrm{P}) = 0.1$, $\pi(3, \mathrm{N}, \mathrm{P}) = 0.2$
- $\pi(3, \mathrm{V}, \mathrm{P}) = 0.01$, $\pi(3, \mathrm{P}, \mathrm{P}) = 0.5$

What will be the value of $\pi(4, \mathrm{P}, \mathrm{D})$?

A Answers

- (1.1) b
- (1.2) 36
- (2.1) 2
- (2.2) c
- (2.3) b
- (3.1) 0.5
- (3.2) 0.75
- (4.1) 0.64
- (5.1) 0.048