CSE 325/425 (Spring 2021) Homework 2

Due on 11:55pm, Mar 3, 2021

Grading: All questions have the same points (25 each). We will randomly grade some of the questions.

Submitting: Only electronic submissions on Coursesite are accepted. You can handwrite your answers on papers and then scan them to images. If you need to plot figures using a computer, the plotted files should be saved and included in the submitted pdf file. Submit a single pdf file named

<Your LIN>HW2.pdf

Other format will not be accepted.

Questions:

1. Given four POS tags *Noun, Determiner, Verb, Adjective*, construct a valid example of transition probability matrix A for an HMM that use these tags as hidden states. Pay attention to the shape of the matrix and any constraint that the elements in the matrix should satisfy.

2. Given observed sentence $O = [o_1, o_2, o_3]$ and a given POS tag sequence $Q = [q_1, q_2, q_3]$, use the forward algorithm to expand the probability $\Pr([o_1, o_2, o_3, q_1, q_2, q_3])$ in terms of the elements in the HMM parameters A, B, and π. You need to write down each step when the recursive equation in the algorithm is used.

3. Re-do the previous question with the same requirements, but use the backward algorithm.

4. Run the Viterbi algorithm to predict the best POS-tag sequence Q^* given the input $O = [o_1, o_2, o_3]$ with the four POS tags *Noun, Determiner, Verb, Adjective*. You need to draw a trellis, with the v values (based on Viterbi) annotating the correct nodes. Then write down the process of computing $v_1(Noun)$ and $v_3(Verb)$ using the Viterbi algorithm.

5. Run the forward and backward algorithms to compute the necessary probabilities to find $\xi_2(Noun, Verb)$ on the input training sequence $O = [o_1, o_2, o_3]$.