Assignment 4: Hidden Markov Models

L645, Sandra Kuebler

DUE: at beginning of class on Thursday, October 23

1. **Forward / Backward Algorithm**

   Consider the example of the HMM for POS tagging the sentence "a myth is a female moth". Calculate the following forward accumulators given the following probabilities.

   If you are enrolled in B659, write a program to calculate this. Submit your code and an output. Otherwise, you can do the calculation manually.

   initial vector: [0.45 0.35 0.15 0.05]

   transition matrix:

t / t+1	DT	JJ	NN	VB
DT	0.03	0.42	0.50	0.05
JJ	0.01	0.25	0.65	0.09
NN	0.07	0.03	0.15	0.75
VB	0.30	0.25	0.15	0.30

   emission matrix:

w / s	DT	JJ	NN	VB
a	0.85	0.05	0.03	0.05
myth	0.01	0.10	0.45	0.10
is	0.02	0.02	0.02	0.60
female	0.01	0.60	0.25	0.05
moth	0.12	0.13	0.25	0.20

   (a) $\alpha_4(NN)$

   (b) $\alpha_3(VB)$

   (c) $\alpha_1(DT)$

   (d) $\beta_4(NN)$

   (e) $\beta_3(NN)$

   Give the probabilities of the accumulators that you need for these calculations and explain how you got to your results. In a program, that translates into having explicit output and comments in the program.

   20 pts.

2. **Viterbi Algorithm**

   Consider the definitions for initialization, induction, and storing the backtrace on slide 6. Modify the formulas so that the HMM uses a trigram model instead of a bigram model. If you need to introduce new subscripts, explain what they are!

   10 pts.

3. Additional: **Parameter Estimation**

   Write a program that reestimates the first n rounds of Baum-Welch for the POS tagging example on slide 9 of the state sequence slides for the signal sequence "a female moth is a myth". Use the formulas on page 12 of the parameter estimation slidesfor the reestimation.

   additional 20 pts.