

CSE 250A Assignment 7

This assignment is due at the start of class on **Tuesday** November 27, 2012. Instructions are the same as for previous assignments. You must work in partnership with one other student, but you may keep the same partner or change partners, as you wish.

1, 2, 3, 4.

Do problems 6.1, 6.2, 6.3, and 6.4 on the assignment written by Lawrence Saul that is available at <http://cseweb.ucsd.edu/classes/fa11/cse250A-a/hw/hw6/hw6.pdf>. Note that problem 6.3 uses datasets available in the parent directory <http://cseweb.ucsd.edu/classes/fa11/cse250A-a/hw/hw6/>.

5. Computing with log probabilities

(a) With hidden Markov models and with other probabilistic models, one often needs to evaluate an expression of the form $S = \sum_{i=1}^n p_i$ where each p_i is a probability. To avoid underflow, we compute with $x_i = \log p_i$ instead of with p_i . So, we need a function whose input is a vector of length n of values x_i and whose output is $L = \log S$. Mathematically,

$$L = \log \sum_{i=1}^n \exp x_i.$$

Write this function carefully in your preferred programming language, in a way that avoids underflow and overflow as much as possible. Also avoid preventable numerical inaccuracy, as caused for example by adding values with opposite signs that are close in magnitude.

Assume that logarithms are natural and that you are using IEEE standard double-precision floating-point arithmetic. However, you do not need to delve into the details of computer arithmetic. Show the source code of your function, and provide a printout of usage examples showing that it works well.

(b) Dr. Wight says that computing using log probabilities can be faster than using probabilities. Explain why Dr. Wight is right. Is he right specifically about the function described in part (a)?

(c) GPUs (graphics processing units) are the fastest commonly available floating-point hardware. However, they often provide only single precision, and not double precision. Is single precision adequate for applications using HMMs? Answer this question based on part (a) and on problems 6.1 to 6.4 mentioned above.