CS 613 - Machine Learning

Extra Credit - Hidden Markov Models
Fall 2016

Introduction

In this assignment we will look at graph-based/temporal learning algorithms: Hidden Markov Models.

Grading

Evaluation Problem	+5pts to HW4
Learning Problem	+5pts
Report	+0pts

You will receive no credit if your code doesn't generalize as requested and/or you don't have a report.

1 Hidden Markov Models

Hidden Markov Models are a graph-based learning algorithm that is useful when data that transitions over time. In this section you will implement the hidden markov model algorithms discussed in class on the criminal example data provided in class.

Your initial transition matrix should be:

From/To	**LA**	**NY**
LA	0.5	0.5
NY	0.5	0.5

Table 1: Initial Transition Matrix

Your initial emission matrix should be:

Where/Report	**LA**	**NY**	**NULL**
LA	0.4	0.1	0.5
NY	0.1	0.5	0.4

Table 2: Initial Emission Matrix

Write a script that:

1. **Evaluates** the initial HMM for the observations:
   $O = (NULL, LA, LA, NULL, NY, NULL, NY, NY, NY, NULL, NY, NY, NY, NY, NY, NULL, NULL, LA, LA, NY)$.
   Or in other words, write a script that can compute $P(O|\lambda)$ for some arbitrary O and λ.

2. **Learn** the HMM that maximizes the probability of generating these observations; that is find $\hat{\lambda}$ that maximizes $P(O|\lambda)$. Keep track of $P(O|\lambda)$ for each iteration of your algorithm and plot it when your algorithm terminates.

Implementation Details

1. All implementation should be from scratch (no HMM library functions).

2. Initialize your starting locations probabilities to be uniform.

3. Terminate your learning algorithm when the change in probability $|(P(O|\lambda_t) - P(O|\lambda_{t-1})|$ is below the Matlab value *eps*.

In your report you will need:

1. $P(O|\lambda)$ for part (a) as well as what the probability would be of observing that sequence *randomly*.
2. Your graph of $P(O|\lambda)$ vs iteration from part (b).
3. Your final HMM model parameters, $\lambda = \{\pi, A, B\}$.

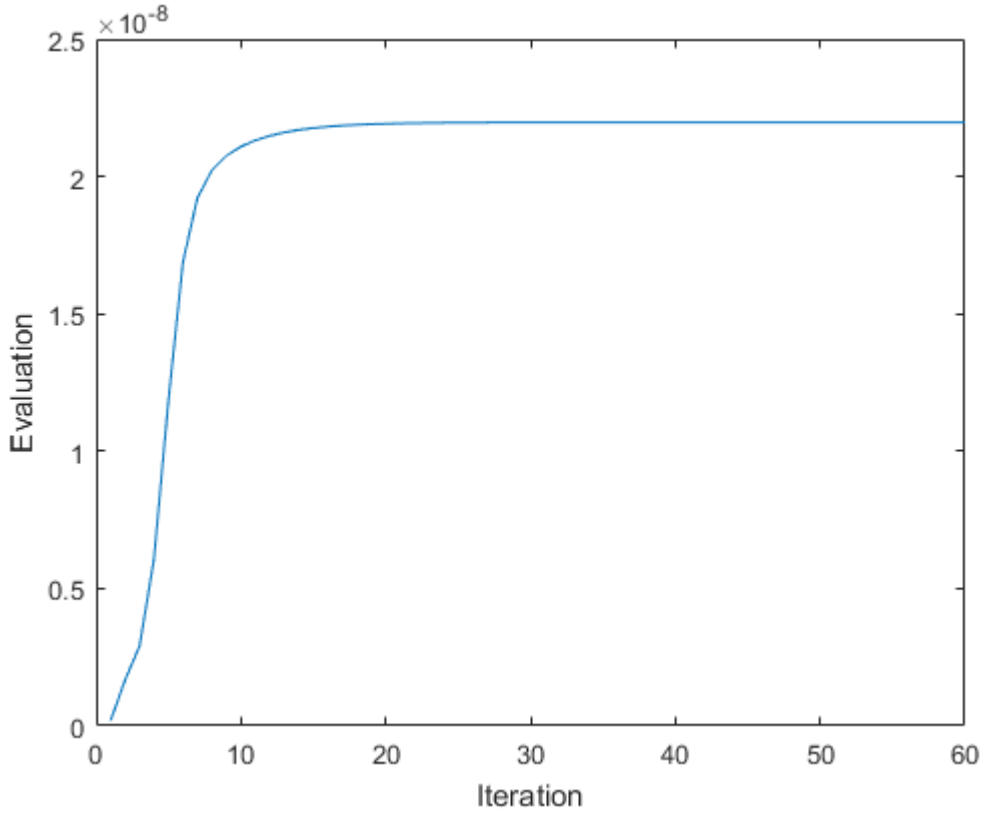

Figure 1: HMM Learning Process

Submission

For your submission, upload to Blackboard a single zip file containing:

1. PDF Writeup
2. Source Code
3. readme.txt file

The readme.txt file should contain information on how to run your code to reproduce results for each part of the assignment.

The PDF document should contain the following:

1. Part 1:
   (a) $P(O|\lambda)$ and $P(O|random)$ for part (a).
   (b) Your graph of $P(O|\lambda)$ vs. iteration for part (b).
   (c) Your final model $\lambda = \{\pi, A, B\}$ for part (b).