ELEC 425 - Fall 2018
Machine Learning and Deep Learning
Assignment III

Due: 9:00 p.m., Wednesday November 28^{th}, 2018

Important Notes

Please kindly understand this assignment is an **"individual"** assignment. You are allowed to discuss the general idea of the assignment but your discussion may not include the specific answers to any of the problems. Please kindly understand that any form of plagiarism may lead to a mark of 0 for your assignment.

Submission Guide

- Submit a **zip** file to "Assignment 3" Dropbox folder on onQ, which should contain:
  - A **pdf** report that includes your answers to the questions.
  - **All your source code.** For example, if you use Matlab, you should include all your .m files.
  - **A README file** telling us what each program/code file is for and how to run your code.
- **Late submission:** If you are late, for every 2 hours, you will lose **15**% of your assignment marks.

1 Calculate Joint Probabilities in HMM (2 marks)

Consider the Dishonest Casino example we discussed in the lecture, and assume the model parameters are given in Figure 1. (Note that the transition probabilities are different from those in our lecture).

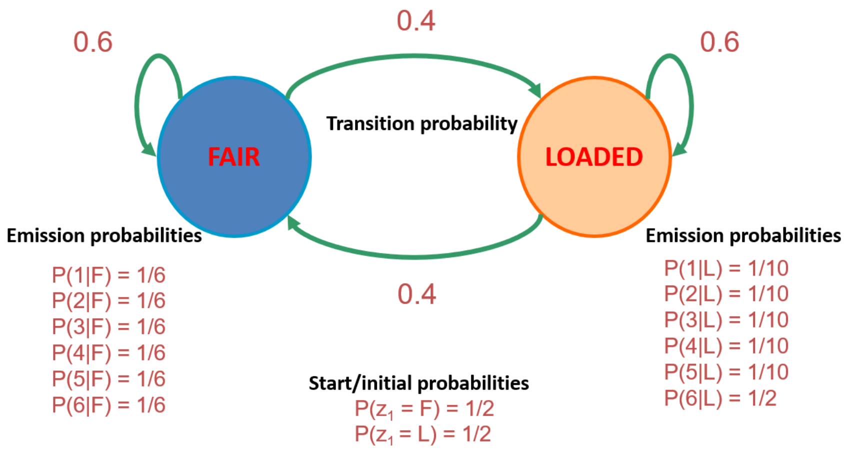

Figure 1: An HMM model.

Given the following observation sequence of rolls and the corresponding hidden state sequence:

$$\mathbf{x} = 1, 2, 6, 3, 6 \tag{1}$$
$$\mathbf{z} = Fair, Fair, Loaded, Fair, Fair \tag{2}$$

What is the probability of this scenario $p(\mathbf{x}, \mathbf{z})$? Please write down how you derive your result. (You do not need to write code for this question.)

2 Viterbi algorithm (4 marks)

Given the following observation sequence:

$$\mathbf{x} = 1, 2, 6 \tag{3}$$

you are asked to follow the Viterbi algorithm to manually compute the V matrix and Ptr matrix discussed in the class. Use the version of Viterbi described in Figure 2.

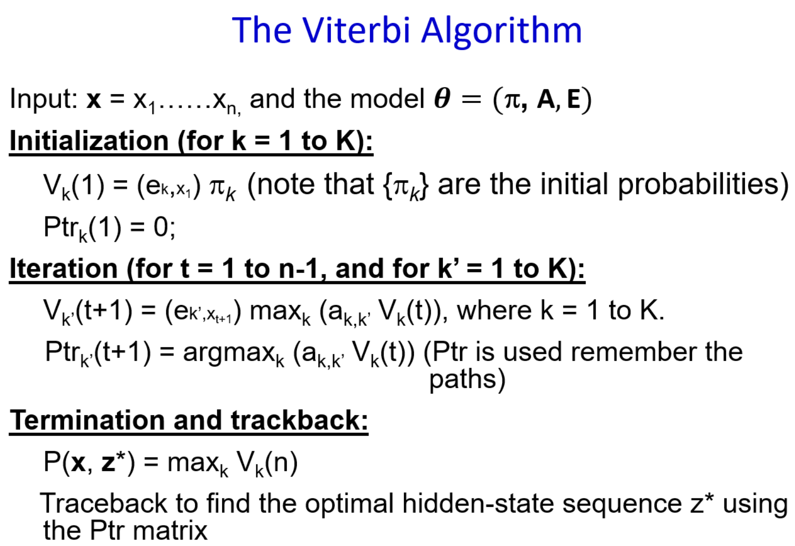

Figure 2: The Viterbi algorithm.

Specifically, the following tables give you the V matrix and Ptr matrix in which the initialization step of the Viterbi algorithm has been done.

- In your pdf report, manually follow the Viterbi algorithm to fill out these two tables.
- What is the $p(\mathbf{x}, \mathbf{z}^*)$ and the hidden state sequence $\mathbf{z}^*$ that you found?

The V Matrix

	t = 1	t = 2	t = 3
k = 1 (Fair)	$\frac{1}{6} * \frac{1}{2}$		
k = 2 (Loaded)	$\frac{1}{10} * \frac{1}{2}$		
observation	"1"	"2"	"6"

The Ptr Matrix

	t = 1	t = 2	t = 3
k = 1 (Fair)	0		
k = 2 (Loaded)	0		
observation	"1"	"2"	"6"

3 Feed Forward Neural Networks (4 marks)

Download lab 3 solutions from onQ (under "week 10"). Create the following 3 files:

- activation_tanh.m: in this file you need to implement a tahn activation function. Make sure the name of the function is same as the file name.

- activation_tanh_gradient.m: in this file you need to implement a function that calculates and returns the gradient of the tanh function. Make sure the name of the function is same as the file name.

- feedforward_network_tanh.m: create this file and copy the content from feedforward_network_sigmoid.m to this file. Then make some necessary changes in the code to let it use the tanh activation and tanh gradient function that you have just created above.

Run feedforward_network_tanh.m to make sure your code is correct. Submit all the 3 files.