

Quiz 4: Markov Models - Hidden Markov Models

Introduction to Supervised Learning

*Required

1. Email address *

2. Please enter your name: *

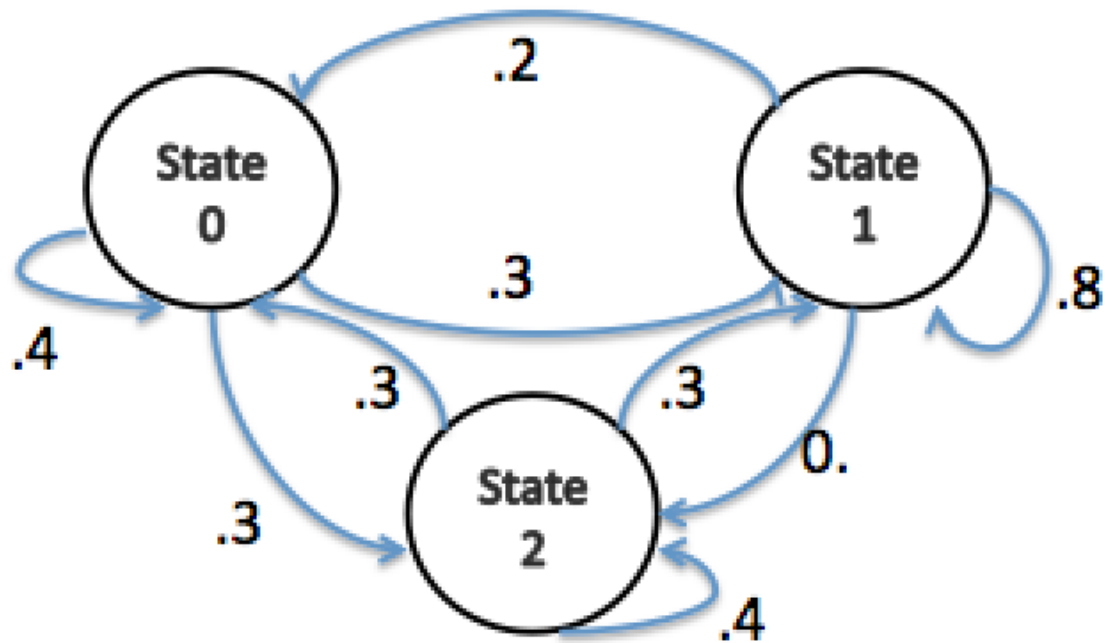
Generative Classifier

3. We want to create a generative classifier for sequential data as explained in the lecture. To that end, we learn two models: Model 0 (parameterized by θ_0) on the samples associated to the target 0 and Model 1 (parameterized by θ_1) on the samples associated to the target 1. Calculate the probability of getting a positive target for the sequence $X_1 \dots X_T$ using the following probabilities: 1 point

$$\left. \begin{aligned} p_{\theta_0}(X^1, \dots, X^T | Y = 0) &= 10^{-1} \\ p_{\theta_1}(X^1, \dots, X^T | Y = 1) &= 10^{-2} \\ p(Y = 1) &= 0.7 \end{aligned} \right\} p(Y = 1 | X^1, \dots, X^T) \text{ ?}$$

Markov Models

After fitting a Markov Model on sequences of discrete data (with 3 possible states for each sample). We end up with the following graph.



-
4. What is the number of parameters of a Markov Model with 3 states?

1 point

Mark only one oval.

- ☐ 6
- ☐ 9
- ☐ 12

5. What is the probability of transitioning from state 2 to state o? 1 point

Mark only one oval.

- ☐ 0.2
☐ 0.3
☐ 0.4

6. If we are at state 1, what is the most likely next state? 1 point

Mark only one oval.

- ☐ State 0
☐ State 1
☐ State 2

7. Explain why it is impossible to have this sequence of states in the training data: 1 2 o o 2. 1 point

We want to use an HMM model to fit discrete observations taking values in $\{0, 1, 2\}$.

8. What would be the number of parameters of the HMM model if we use M hidden states? (as a function of M)

1 point

After fitting an HMM with 3 hidden states on the previous observations, we end up with the following parameters.

$$\pi = \begin{pmatrix} 0.7 \\ 0.2 \\ 0.1 \end{pmatrix} \quad Q = \begin{pmatrix} 0.7 & 0.1 & 0.2 \\ 0.3 & 0.6 & 0.1 \\ 0.1 & 0.2 & 0.7 \end{pmatrix} \quad O = \begin{pmatrix} 0.2 & 0.3 & 0.5 \\ 0.8 & 0.1 & 0.1 \\ 0.1 & 0.7 & 0.2 \end{pmatrix}$$

9. What is the probability of transitioning from the hidden state o to the hidden state r ?

1 point

Mark only one oval.

☐ 0.7

☐ 0.1

☐ 0.2

10. What is the distribution of the discrete observations conditioned on the hidden state o ?

1 point

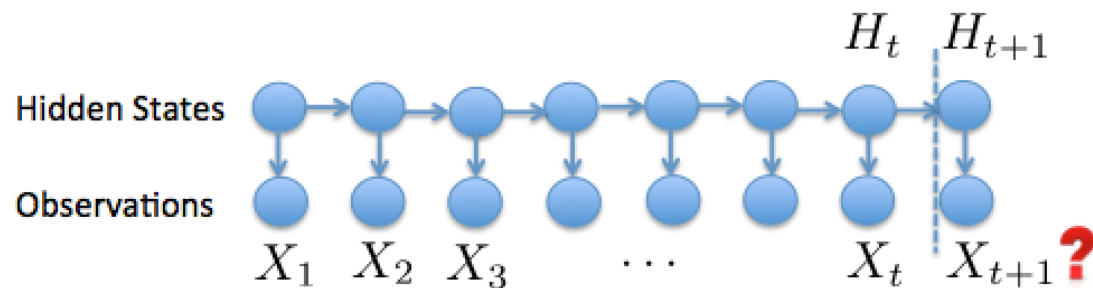
Mark only one oval.

☐ [0.2, 0.3, 0.5]

☐ [0.2, 0.8, 0.1]

☐ [0.7, 0.2, 0.1]

We want to predict the next observation $X_{(t+1)}$ based on the observations $X_{(1)} \dots X_{(t)}$



11. Using the following filtering probabilities and the previous fitted parameters, what is the most likely next observation $X(t+1)$? Justify your answer. 2 points

$$[p(H_t = h | X_1 = x_1, \dots, X_t = x_t)]_{h \in \{0,1,2\}} = \begin{pmatrix} 0.7 \\ 0.2 \\ 0.1 \end{pmatrix}$$

Programming Session

12. Did you understand the problem?

Mark only one oval.

☐ Yes

☐ No

If you have any question about the use of the hmmlearn library, feel free to send us a message.

13. Any comment?

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