Exercises for the course

Machine Learning 2

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Exercise Sheet 9

Exercise 1: Hidden Markov Models (10+10+20 P)

Consider the Hidden Markov Model with transition matrix

$$A = \begin{pmatrix} 0.1 & 0.9 \\ 0.5 & 0.5 \end{pmatrix}$$

and emission matrix

$$B = \begin{pmatrix} 0.2 & 0.8 \\ 0.4 & 0.6 \end{pmatrix}$$

The initial probability vector is

$$\pi = \begin{pmatrix} 1 & 0 \end{pmatrix}.$$

(a) *Draw* the graph of the model. As usual, use round shapes for hidden states and square shapes for visible states, and arrows for transitions/emissions; include transition/emission probabilities.

(b) We interpret the above as a model for an experiment with two hidden (possibly unfair) coins and two visible coins. *Describe* such an experiment which can be modeled by the Markov model given above. Here, heads should correspond to the first indices in A, b, π, tails to the second.

(c) Using the Bayes formula for conditional probabilities, *compute* for the model above the probability distribution

$$P\left((q_1, q_2) \mid (O_1, O_2) = (\text{tails}, \text{tails})\right),$$

where $(q_1, q_2) \in S \times S$ is a sequence of states of length two and $S = \{S_1, S_2\}$ is the set of symbols of the hidden Markov model. That is, for all possible sequences (q_1, q_2), compute the probability that it were at the origin of the sequence of observations $(\text{tails}, \text{tails})$.

Exercise 2: Programming Exercise (60 P)

Download the IPython notebook on ISIS and follow the instructions.