Machine Learning
Exercise Sheet 12 (REVIEW QUESTIONS)

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Exercise 23: Hidden Markov Models (0 Points)

Assume you want to create a pet robot that is supposed to entertain the owner if he is sad. To model the hidden states of the owner ("sad" (S), "not sad" (N)) use a Hidden Markov Model. The robot is able to identify only these actions: crying (C), eating (E), sleeping (S) and watching TV (W).

Detailed experiments have shown that sad people remain sad in 90% of the cases when they switch actions but remain not sad in 80% of the time. Initially, 80% of the people are not sad. Further statistics are collected in the following table.

	N	S
C	0	0.4
E	0.2	0.3
S	0.1	0.2
W	0.7	0.1

To understand the table: the first entry in the table (C,H) says that a not sad person is crying in 0% of the actions.

a) To show that you understand the setting, estimate $p(z_0 = S)$, $p(z_t = S | z_{t-1} = N)$ and $p(x_t = E | z_t = S)$.

b) Estimate the probability that a person is sad if he did the following actions in this order: E, C, S.

c) Derive the Bayes update rule

$$p(z_t | x_{1:t}) = \frac{p(z_t | x_t) \cdot p(z_t | x_{1:t-1})}{\sum_{z_t} p(x_t | z_t) \cdot p(z_t | x_{1:t-1})}$$

for discrete observations x_t. Explain intermediate steps in detail.

Exercise 24: Logistic Regression - Repetition (0 Points)

Learn the parameters of the model of the logistic regression with the Newton algorithm using a step size $\alpha = 1$ and an initial starting point $\hat{\beta}_0 = 0$ for 2 iterations.

x_1	x_2	y
1	1	+
3	2	+
2	2	-
0	3	-

Exercise 25: Prepare for the exam

Put some effort on your studies. Review the slides, books and exercises. Bring any papers you want.

Calculators are allowed, but only simple ones (not programming ones).

Use the review exam from last year!

We wish you good studies and a good examination!