

**EXAMINATION FOR THE COURSE:
NEVR3004 – Neural Networks**

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Examination date: 8 June 2012
Examination time: 9 am. – 1 pm.
ECTS-credits: 7.5

Supporting materials: Calculator, standardized language dictionaries (e.g. Norwegian-English/English-Norwegian).

Language of examination: English
Number of pages: 3 (including front page).

Examination results will be made available on Studentweb three weeks after the last assignment is due.

1. (a) Define the tuning curve, noise and signal correlations. (each 5 points)
 - (b) Consider two neurons, with Bell shaped tuning curves. If these two neurons are positively signal correlation, how does the presence or absence of noise correlations between them neurons influence stimulus-response mutual information? (10 points)
2. Describe two consequences of the inhibition-excitation balance in a recurrent network. (each 5 points)
3. Define the following terms
 - (a) Supervised learning (5)
 - (b) Bistability (5)
 - (c) Basin of attraction (5)
 - (d) Spike-triggered and double-spike triggered averages. (10)
- 4 . (a) Given the response of a neurons R to stimuli S, how is the stimulus response mutual information defined? (5 points)

Suppose you present 3 stimuli to an animal each 100 times except for the last one which is presented 300 times. Assume that this presentation protocol reflects the prior about the stimuli $p(s)$, and that the following response frequencies were collected

Stimulus/ Response	5 spikes	10 spikes	20 spikes
stimulus 1	50 times	50 times	0 times
stimulus 2	50 times	25 times	25 times
stimulus 3	100 times	150 times	50 times

- (b) What is the entropy of stimulus set? (5 points)
- (c) What is the entropy of responses? (5 points)
- (d) What is the stimulus response mutual information? (5)
- (e) Assume that after these measurements, someone shows one of the stimuli to the animal. Assuming the same stimulus prior as before,
 - What is the maximum likelihood stimulus if the neuron emits 10 spikes (5 points)?
 - What is the maximum a posteriori stimulus (5 points)?

5. In the network below, neurons shown as squares are binary neurons (0 and 1 output) with a firing threshold of 2 and are receiving inputs as shown. The neuron shown as circle is a threshold-linear neuron, with the threshold of 1 and gain of 2. The number on each arrow is the weight of the coupling.

- (a) What is the output? (8 points)
- (b) What happens to the output if we double all the weights to the binary (square) neurons (2 points)?
- (c) What happens to the output if we double all weights in the network (5 points)?

