

# Architectures of Intelligence

## Assignment 4/Part1

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### INTRODUCTION TO NENGO

#### VALUES

**Figure 1** shows a screenshot of the nengo model of the exercise with  $f(x) = \sin(2x)$  as the stimulus. You can see that the values of  $a$  represent a slightly modified  $\sin$ -function, which is due to the stimulus which can be described as  $f(x) = \sin(2x)$ . Ensemble  $b$  shows a lower amplitude and half the wavelength because of the applied function  $f(x) = x * x - 0.5$ . Ensemble  $c$  both combines values of  $c$  with a latency of 0.1 ms, as well as a transformation to the values of  $b$ , resulting in a function with an amplitude and wavelength in between those of  $a$  and  $b$ . Ensemble  $d$  shows the original stimulus in blue, which matches the values of  $a$  and, the value according to the influence of  $c$  in green.

#### TUNING CURVES

**Figure 2** shows a screenshot of the tuning curves of ensemble  $a$ . You can see 100 lines, one line representing one firing neuron. Each line  $l = f(n)$ , describes the average firing rate of the neuron  $n$  as a function of the stimulus  $x$ . The graph shows a variety of responses to stimulus from  $-1$  to  $1$ . Some neurons tend to fire more often with higher stimuli, while some fire more often with lower values of  $x$ . This results in the pattern which can be observed in the figure.

#### STIMULUS SET TO ZERO

**Figure 3** shows a screenshot of the nengo model of the exercise, where the stimulus is set to zero. The pattern one can observe can be described as follows: the value of  $a$  is zero since the stimulus is zero. Because  $f(x) = x * x - 0.5$  is applied, the value of  $b$  changes to  $-0.5$ . Since the stimulus for ensemble  $c$  then is negative and  $c$  stimulates itself, this value steadily decreases. The screenshot does not show the behaviour, however,  $c$  would normally stay at  $-0.25$  because of the transformation from  $b$  to  $c$ , but since it feeds negative values to itself, the value decreases.  $d$  then mirrors the values of  $a$  in blue and  $c$  in green because no functions or transformations are applied.

## A. ASSIGNMENT 4/PART 1

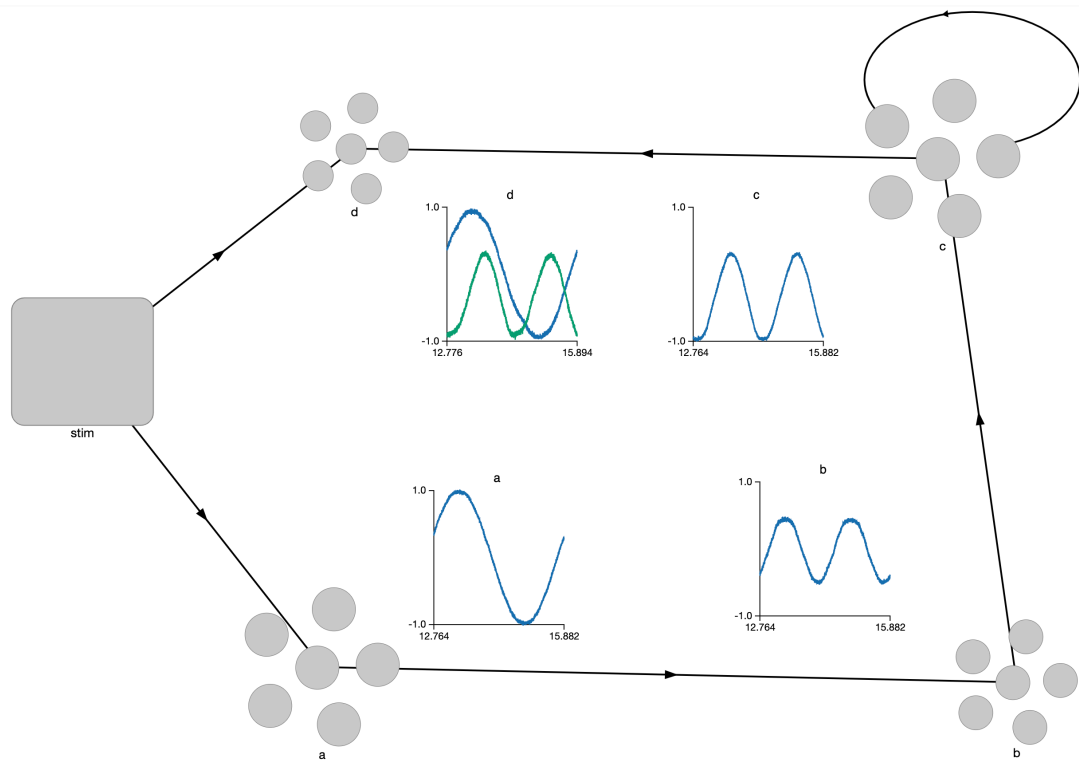


Figure 1: Screenshot of the nengo model with  $f(x) = \sin(2 * x)$  as the stimulus.

## Tuning curves

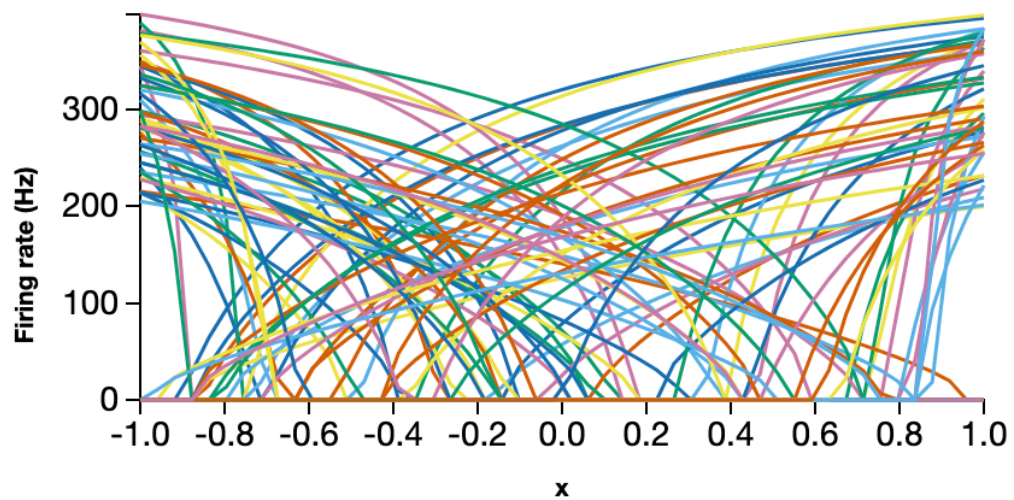
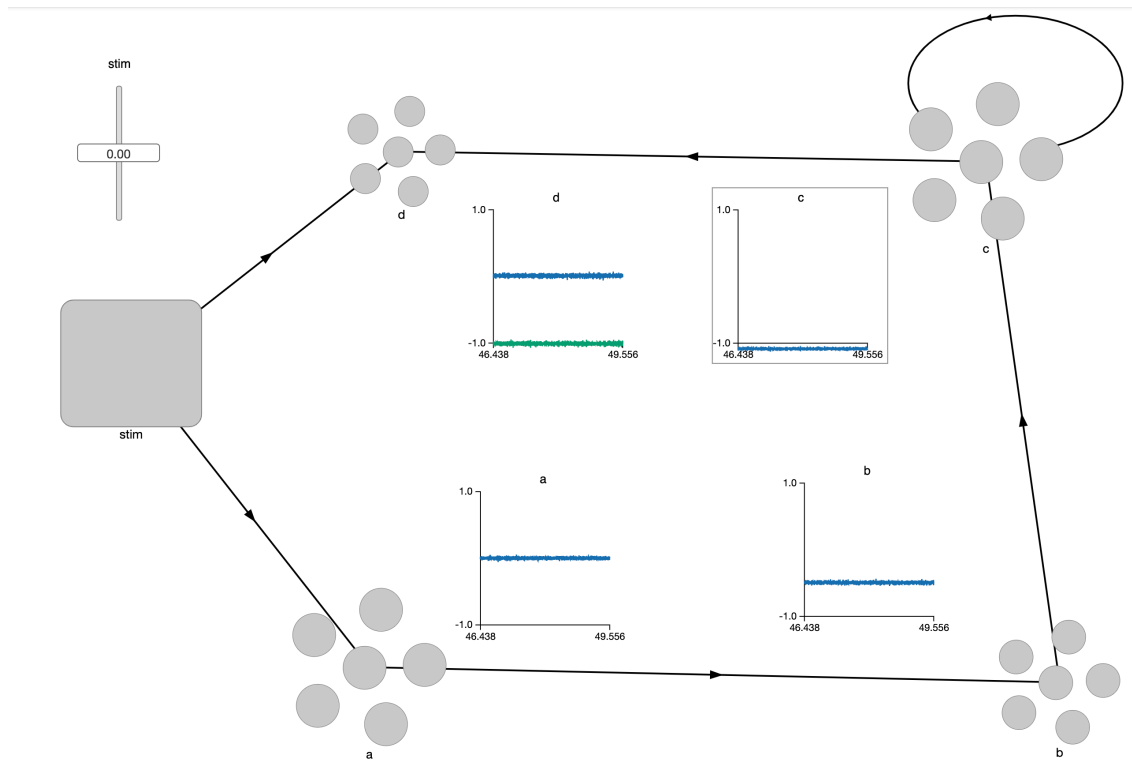


Figure 2: Screenshot of the tuning curves of ensemble a.



**Figure 3:** Screenshot of the nengo model with zero as the stimulus.