Exercise: Radial Basis Function Networks

Expected time: 1.5h

This exercise introduces to Radial Basis Function Networks. You find the main code in *RBnet.m*. The software provides you the basic setup to compute a stimulus response in head centered coordinates using an eye position signal. The stimulus is initially given in retinocentric coordinates.

Matlab files: *RBnet.m, tc.m, tempsimXb.m, tempsimXa.m, weights.m*

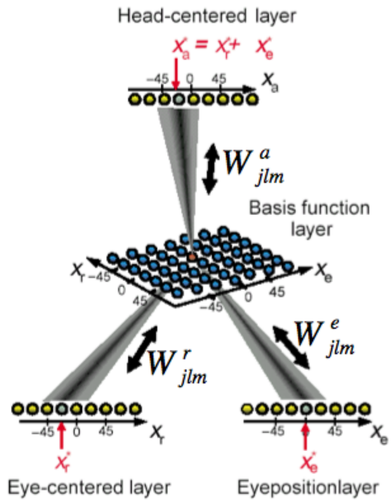

Figure 1: Radial Basis Function Network. The input and output layers consist of topographically organized layers with N neurons. The index of each neuron, $j = 1...N$ refers to the position of the neuron in the layer. The basis-function layer is a 2D map of $N/2 * N/2$ neurons, whose position is determined by l, m, with $l = 2, 4, ..., N$ and $m = 2, 4, ..., N$.

A. Eye- and head-centered stimulus representations

1. The maps in the basis function network are not connected with each other (Fig. 1). Study the software implementation and add the connectivity between the maps. Implement the connections of the maps in the file *weights.m* by using the equations of W^r, W^e and W^a given in the lecture. Please only

use a feedforward connection pattern. Please note, that the basis function network uses less neurons ($N/2*N/2$ instead of $N*N$) to save computation time.

2. Verify the network by presenting a stimulus at $0°$ using 3 different eye positions at $-20°$, $0°$ and $20°$. Plot the eye-centered and the head-centered stimulus response in these conditions. By how much degrees does the head-centered response shift in these conditions?

B. Representations of the basis function units

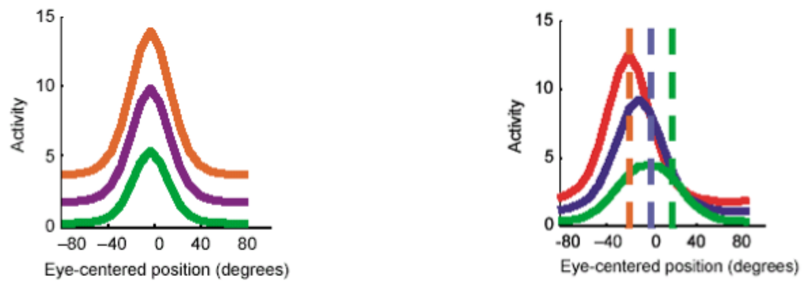

Figure 2: Tuning curves of a neuron in the the basis function layer. The different colors show the change in tuning dependent on eye position. Left and right show cases with two different parameter settings.

Fig. 2 show examples of tuning curve changes with respect to eye position. The tuning curve can vary in strength and, dependent on the parameters, it can shift its peak.

Note the second question is optional.

1. Plot the tuning curve of a basis function units as a function of the eye-centered position by using three different eye positions. Please note that the construction of a tuning curve requires you to systematically vary the eye-centered stimulus position and plot the response of the unit as a function of this position. How do the tuning cures in the network look like? Compare them with those shown in Fig. 2.

2. Now implement an additional additive feedback from the head centered units to the basis function layer (Xa to Xb). Please implement the same

connectivity pattern but simply in a different direction. Plot the tuning curve of the basis function units as a function of the eye-centered position using three different eye positions and vary the strength of the feedback connection (weight the pattern by a multiplier). How does the tuning curve in Xb change with increasing feedback strength? Plot your simulation results.