ECE 457 B: COMPUTATIONAL INTELLIGENCE

ASSIGNMENT #3

Due Date: Feb 26, 2023

NOTE: To help with the adequate marking of your assignments, please follow these rules carefully:

1. All work should be carried out **individually.** Submission of the solutions is mandatory and the mark has to be at least 40% to be counted.
2. The first page of the assignment must have the name and ID of the student
3. The items required must be numbered, labelled, and in numerical order.
4. The solutions can be handwritten (in very neat way) or typewritten (best option). All graphs should be computer generated. You can use existing libraries. Please include the code for each problem and mention which library you have used.
5. All pages must be numbered sequentially
6. Show your steps and state any additional assumption you make.
7. Presentation of your results and the organization of your copy count for **10% of the overall mark. Completion level of the assignment count for 5%.**

Problem 1 (Radial Basis Function Network) (10 marks)

We need to construct an interpolator using the Radial Basis Function (RBF) network with seed functions the Gaussian mappings where the standard deviations are all equal to σ_i. The original function is given by

$$f(x) = \sqrt{|x|}\sin(\frac{\pi}{2}x)$$

a. Build a radial basis function network and find the interpolation function $\hat{f}(x)$ in the interval [-6 6] using training data at the points x=-6, x=-5, x=-2, x=0, x=1, x=3, x=5 with σ_i=1. Draw the curves comparing the two functions (the original one and the interpolated). What is the value of the estimated interpolator at x=3.6?
b. Redo the same for σ_i= 0.5, 3, 6.
c. Draw your conclusions

Problem 2 (Kohonen Self Organizng Map: Unsupervised Learning) (10 marks)

We need to design a Kohonen self organizing map (SOM), which gives as an output some shades of color mapped over 100 by 100 grid of neurones. The training input of the SOM are 24 colors (use shades of red, green, blue, with some yellow, teal and pink) which you can choose from the "RGB Color Table: Basic Colors" section of this page: http://www.rapidtables.com/web/color/RGB_Color.htm

Using a time varying learning rate $\alpha(k) = \alpha(0)\exp(-\frac{k}{T})$ (where ***k*** is the current training epoch (starts with epoch 0), $\alpha(0) = 0.8$, and T is the Total number of training epochs equal to 1000. Note that the epoch training involves all twenty four input samples for the 24 chosen colors to the network (hint: calibrate the color codes to values between 0 and 1, instead of being between 0 and 255). Initial weights are randomized.

The topological neighbourhood $N_{i,j}(k)$ of node (*j*) around the winning unit (*i*) is given by

$$N_{i,j}(k) = \exp(-\frac{d_{i,j}^2}{2\sigma^2(k)})$$

where

$$\sigma(k) = \sigma_0 \exp(-\frac{k}{T})$$

and $d_{i,j}$ is the distance between winning node *i* and surrounding node *j*. Initial value of $\sigma_0 = 1$

a) Basically, we need to have as the output of the SOM colors something similar to: http://www.cs.hmc.edu/~kpang/nn/som.html (under the part called "demonstration section").

   Generate, a figure of the original grid (randomly selected) followed by figures of the SOM grid after 20, 40, 100, 1000 epochs.

b) Draw your conclusions.

Hint: There is a Matlab library and some code under this link, which you may use: http://www.cis.hut.fi/somtoolbox/