Institute for Computer Science VI, Autonomous Intelligent Systems, University of Bonn

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http://www.ais.uni-bonn.de/WS1920/4204_L_NN.html

New Lecture Location: Meckenheimer Allee 176, HS-IV

Exercises for module Technical Neural Networks (MA-INF 4204), WS1920

Exercises sheet 9, due: Monday 9.12.2019

2.12.2019

Group	Name	52	53	54	55	56	57	58	59	$\sum$ Sheet 9

Assignment 52 (1 Point)

On Wednesday, December 4, 2019, the University of Bonn has the special day *Dies Academicus*. On that day, there are no regular lectures, seminars, lab courses, etc., but the University of Bonn gives the oportunity to visit talks from other scientific subjects.
At the website (sorry, mostly in German)
https://www.uni-bonn.de/studium/studium-universale/dies-academicus
https://www.uni-bonn.de/studium/studium-universale/dies-academicus/dies-zeitung-04.12
you can find the list of special talks for that day.

Have a look at that website, and find the name of the speaker, the title, the time and the location of at least one talk that might be interesting for you.

Assignment 53 (2 Points)

Calculate the memory consumption of a Hopfield Network that consists of $K = 1000$ neurons, when the weights $w_{i,j}$ are stored as integer values.
Hint: please remind, that the maximal number of patterns that can be stored and recalled by a Hopfield Network is bounded, and thus, that the range of the weights should be reasonably bounded as well.

Assignment 54 (3 Points)

Show that the energy E in a Hopfield Network (autoassociator) is never increasing.

$$E = -\frac{1}{2}\sum_{i,j} w_{i,j}x_i x_j + \sum_k x_k \Theta_k$$

Assume an asyncronous update, symmetric weights $w_{i,j} = w_{j,i}$, no self feedback $w_{i,i} = 0$, and the transfer function:

$$x_i(t+1) = \begin{cases} +1 & : \quad \text{if} \quad \sum_j w_{i,j}x_j > \Theta_i \\ -1 & : \quad \text{else} \end{cases}$$

Assignment 55 (2 Points)

Explain the differences for the learning rule, when the Hopfield Network is trained in mode *heteroassociator* compared to a training in mode *autoassociator*.

Assignment 56 (3 Points)

Calculate the weights $w_{i,j}$ for a Hopfield Network that has been trained (as autoassociator) with the three patterns (A,B,C).

$\mathbf{A} = (\ +1,\ +1,\ -1,\ -1,\ +1,\ +1,\ -1,\ -1\ )$
$\mathbf{B} = (\ -1,\ -1,\ -1,\ -1,\ +1,\ +1,\ +1,\ +1\ )$
$\mathbf{C} = (\ +1,\ -1,\ +1,\ -1,\ +1,\ -1,\ +1,\ -1\ )$

Assignment 57 (1 Point)

Describe a case where an *Elman Network* is a *Jordan Network*.

Assignment 58 (2 Points)

Find an application for a recurrent MLP, and describe it in your own words.
Cite the publication you have found in a scientific way.

Assignment 59 (1 Point)

The method of unfolding in time yields different weight changes for different time steps.
Describe why this can be a problem when training the recurrent network.

Programming assignment PA-E (10 Points, Due date: Mon 16.12.2019)

Implement (in C, C++, Java or Python) **either** a Hopfield Network **or** a ROLF-Network (Regional and Online Learnable Field).

Hopfield Network:
Implement a Hopfield Network with up to $K = 1000$ neurons.
Implement two operating modes for the network: a learning mode (autoassociator), and a recall mode (asyncronous update). Use integer weights $w_{i,j}$.
As long as $K < 101$ the network state in every time step shall be depicted as *ASCII art* console output, one ASCII character per neuron, one line per timestep.
When $K > 100$ the energy value E shall be printed in every recall timestep.
Make it possible to set all thresholds Θ_k identical to a user defined value, or to set all thresholds to be the starting pattern $\Theta_k = x_k(t = 0)$, or all thresholds to be zero.

ROLF Network:
Make the ROLF Network work with an input dimension of up to 10, and allow up to 10000 ROLF neurons to be set, and up to 100000 training points, that are read in from a file.
Implement the Init-σ and the Mean-σ method to set the σ-values; and set $\rho = 2.0$.
Write all ROLF centers and sizes into a textfile (gnuplot readable format).