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

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http://www.ais.uni-bonn.de/WS2223/4204_L_NN.html

Exercises for module Technical Neural Networks (MA-INF 4204), WS22/23

Assignments Sheet 7, due: Monday 5.12.2022

28.11.2022

Group	Name	39	40	41	42	43	44	45	$\sum$ Sheet 7

Assignment 39 (2 Points)

Name and describe at least two advantages of the *Multi*-variants (Multi-SOM, Multi-N-GAS) compared to the classical approaches SOM, and Neural-Gas.

Assignment 40 (3 Points)

What could be called a "good" clustering ?
Define a criterium that should be met for a "good" clustering of a given set of data points.

Please argue using the *Silhouette Coefficient*, or the *Calinsky and Harabasz* criterium or the *gap statistics*.

Assignment 41 (4 Points)

The learning rules of the neural paradigms *SOM, Neural Gas, Multi-SOM, Multi Neural Gas, LVQ1, LVQ2.1* have a lot in common. Only the way how the neighborhood function is operating to calculate the change of the centers $\Delta\mathbf{C}_j$ is different. Describe these differences, and write down the respective learning rules as formulas.

Assignment 42 (2 Points)

Derive a formula, that calulates the total number F of centers for a Multi-SOM with input dimension N, with M Partner-SOMs, each one having a g-dimensional, rectangular grid, with $f_{m,1}, f_{m,2}, \ldots, f_{m,g}$ number of neurons per direction.
Calculate F using your formula for $N = 17$, $M = 7$, $g = 2$ and $f_{m,1} = 2, f_{m,2} = 3$.

Assignment 43 (1 Point)

Describe a **method** to find a quantization that can classify points $\mathbf{X} \in \mathcal{U}$ from the 8-dimensional unit cube $\mathcal{U}$ into 6561 uniform classes.

Assignment 44 (3 Points)

Write down and explain all parts of the learning rules that adapt the parameters σ and C in a ROLF network.

Assignment 45 (2 Points)

Name and describe (one short phrase) the 4 different methods to initialize the σ-values when creating a new ROLF neuron.

Programming assignment PA-E (10 Points, Due: Mon 12.12.2022)

Implement a Multi-SOM or a Multi-Neural-Gas (your coice) in Python, and use an example to demonstrate that your program is working correctly.

Network: M-SOM or M-Neural-Gas
The M-SOM, or M-Neural-Gas shall have a total of K Neurons, and M partner networks. For the M-SOM the dimension g of the grid $\mathcal{G}$ is resticted to $g \leq 5$, and shall be rectangular, with different numbers of neurons per direction $f_1, f_2, \ldots, f_g$.
The input dimension N (restricted to $N < 7$), the structure, and size of the partner networks and the number of neurons K shall be adjustable (it is O.K. to do this directly in the source code)
To initialize the centers $\mathbf{C}_j$ either randomly from the unit cube, or as a random drawn subset of the training patterns ${}^p\mathbf{X}$. Take the Gaussian for the neighborhood function $h(dist(i,j),t)$ with adjustable but fixed size s; implement an exponentially decaying learning rate $\eta = \eta(t)$ decaying from $\eta_0 = \eta(t=0)$ to an end value η_{end}.

A program that trains the M-SOM, or M-Neural-Gas:
The parameters of the net M, N, g, K, the structure of the grid $(f_1, ..., f_g)$, the training patterns ${}^p\mathbf{X}$ the learning rate parameters η_0, η_{end} and the width of the gaussians shall be adjustable within the program (not necessarily at runtime). The program shall read in the training patterns either from the file `PA-E-train.txt` or shall be generated randomly from two circular, non overlapping areas within the unit cube.

Demonstrate that your program works properly by using a $M = 4$ network structure with $N = 2, g = 2$ to learn patterns drawn randomly, equally distributed from 3 non-overlapping areas within the unit cube. Please specify the boundaries of the areas you have used.

Write the found positions of the centers (one center per line, both components) of your network into a file `PA-E-net.txt`.

As an alternative you can implement a ROLF network:
If you plan to do so, please ask for implementation details.