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

Assignments Sheet 6, due: Monday 28.11.2022

21.11.2022

Group	Name	33	34	35	36	37	38	$\sum$ Sheet 6

Assignment 33 (2 Points)

Describe the major steps of training a *Self Organizing Feature Map* (SOM).
Make use of formulas whenever possible.
Define all variables and parameters.

Assignment 34 (2 Points)

Write down a formula that implements an exponential decay for the learning rate $\eta(t)$, starting with η_{init}, and converging towards η_{final} after t_{max} steps
(e.g. see https://demogng.de/papers/sclm.pdf).
Depict the decay of $\eta(t)$ using a diagram.

Assignment 35 (2 Points)

Describe a criterion that measures the quality of the SOM, mapping a given area V of the N-dimensional input space. Write down a formula that implements your criterion.

Assignment 36 (3 Points)

During the training procedure of a SOM (N-dimensional input space, g-dimensional grid of K neurons) it is responding to a stimulus ${}^{p}X$ with the winner neuron i.

The center vectors $\mathbf{C}_k$ are adjusted following the learning rule, and the neighborhood function $h(dist(i,j),t)$ and the distance measure $dist(i,j)$ on the grid G.
Then the same stimulus ${}^{p}X$ is presented to the network directly again, and the winner shall be again neuron i.

What conditions must be met by the neighborhood function $h(dist(i,j),t)$, by the distance measure $dist(i,j)$ and by the learning rate $\eta(t)$ to guarantee that i will be the winner again?

Assignment 37 (4 Points)

Classification and **clustering** are two tasks of information processing, that are sometimes mixed up.
Define both tasks, and indicate explicitly how **clustering** differs from **classification**.
Find and explain an example that shows the differences between these two tasks explicitly.

To support your explanation use scientific literature (NOT Wikipedia) and cite the literature in a scientific way.

Give an examplary application for an explicit **clustering** task and one for an explicit **classification** task.

Assignment 38 (4 Points)

Draw the Voronoi-Tesselation of the $N = 2$-dimensional unit square, for the following $P = 8$ points ${}^{p}X$ with $0.0 \leq x_1 \leq 1.0$ und $0.0 \leq x_2 \leq 1.0$.

${}^{1}X = (0.1, 0.1)$ ${}^{2}X = (0.5, 0.2)$ ${}^{3}X = (0.2, 0.4)$ ${}^{4}X = (0.9, 0.4)$
${}^{5}X = (0.6, 0.5)$ ${}^{6}X = (0.2, 0.6)$ ${}^{7}X = (0.7, 0.7)$ ${}^{8}X = (0.4, 0.9)$

Explain in a few words the algorithm, or the way how you have obtained the Voronoi-Tesselation. You may support your explanations with some drawings.

Extra Assignment (NO Points)

Do some experiments using the simulator by Bernd Fritzke:
https://www.demogng.de/
REMARK: Be aware, that the simulator needs JavaScript.

Start the `full-page simulator` (below the graph), then `stop`, and switch to `2D`. Choose the model `Self-Organizing Map (Kohonen)`, the data distribution `distr.` to be `UnitSquare`, the `Speed` between 4 and 6, and with `n1=1` and `n2=42` and (IMPORTANT) switch `som_FillFaces` to be OFF.

`Start`, watch what happens and `restart` several times to get familiar with the behavior, and then, change the distribution to `Circle`. Describe the difference.

Now, increase the structure to `n2=100` and answer the following question:
How often (e.g. out of 20 trials) is the network producing a *crossing* for the distribution `UnitSquare` and `Circle` with `n1=1, n2=100`?

Write down, and discuss your results in an approprate way.
What do the learning parameters `epsilon_i, epsilon_f, sigma_i, sigma_f, t_max` mean?

Change the set-up to `n1=2, n2=50`, and `n1=10, n2=10` and use further distributions.