Multiple Training of Vector-Based Neural Networks to detect Density Centers in Input Space

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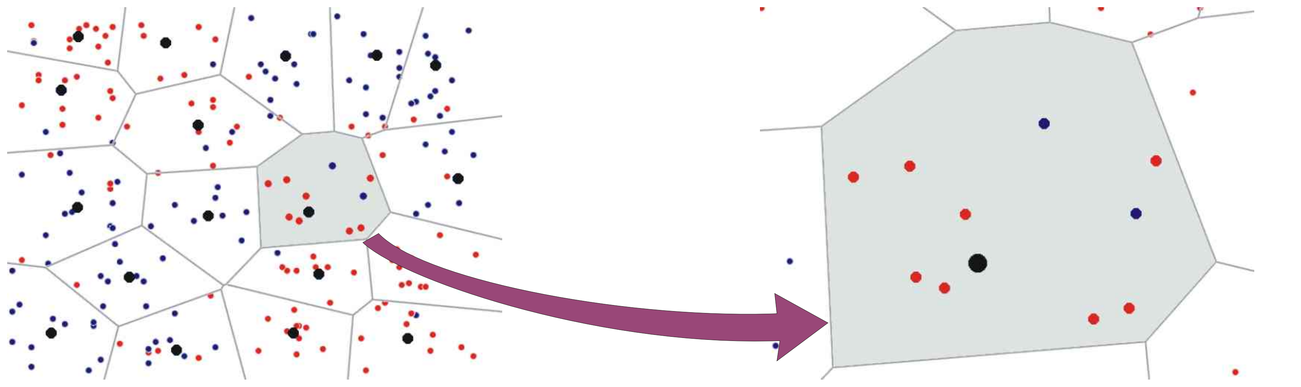
A basic assumption of pattern recognition is the compactness and the separability of regions in feature space. The compactness is diminished in problems with high additive noise. In such cases it is desirable to reduce the adaptivity of neural networks in order to achieve a better generalization.

Aim:
- elimination of such input vectors, which are critical with respect to the classification success
- elimination may reduce the reclassification rate but increases the classification rate (generalization)
- a simplified visualization of SOM is possible

Problems:
- sensor signals are usually noisy
- class memberships are often uncertain
- non-unimodal distributions (multiple density centers per class)



Voronoi set

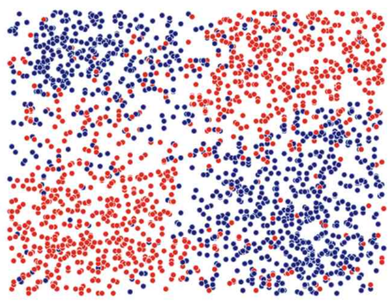
single voronoi cell with prototype vector(black) and 10 input vectors (8 red and 2 blue circles)

Method
- multiple supervised training runs
- eg. with LVQ1 networks
- estimation of a goodness measure for each Voronoi cell
- this measure is assigned to the feature vectors in a recursive way
- after some iterations each feature vector has a mean goodness measure

Estimation of goodness for a 2-class problem after a complete training run:

$g_1 = n_1 / (n_1 + n_2)$
$g_2 = n_2 / (n_1 + n_2)$

n_i - number of input vectors of class i in one voronoi cell

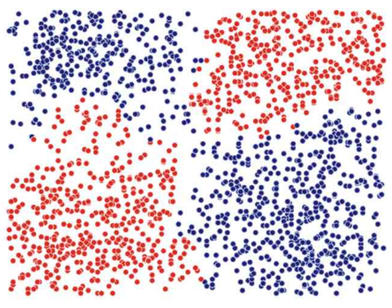


original data set
(class1: red, class2: blue)

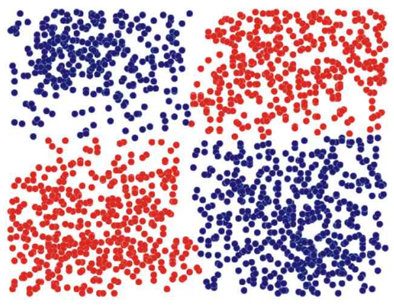
Example: Artificial Data Set

- 2,000 two-dimensional input vectors
- two overlapping classes
- each distributed in two regions

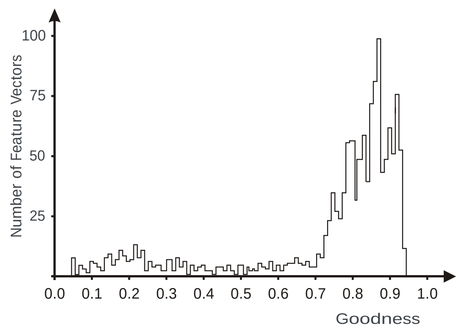
- multiple training of LVQ1 networks
- with 100 training runs
- 20 neurons were used



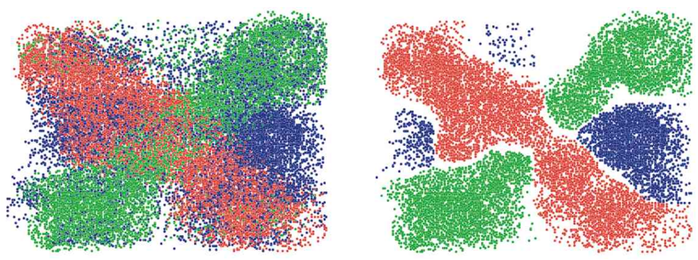
filtered data, threshold=0.5
approx 15% of data removed



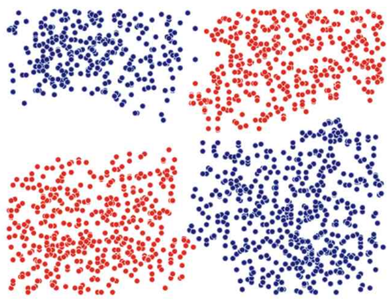
filtered data, threshold=0.65
but only 4 neurons were used
simple class borders were found



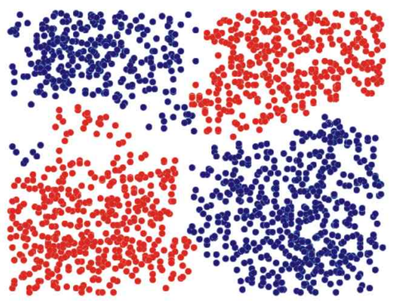
histogram of input vector weights for the artificial data set; mostly there are high input vector weights; only some input vectors are assigned to wrong class



example of a three class problem
(left: original data set; right: filtered data set)

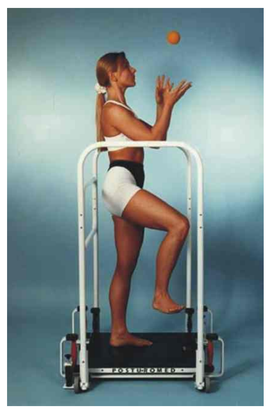


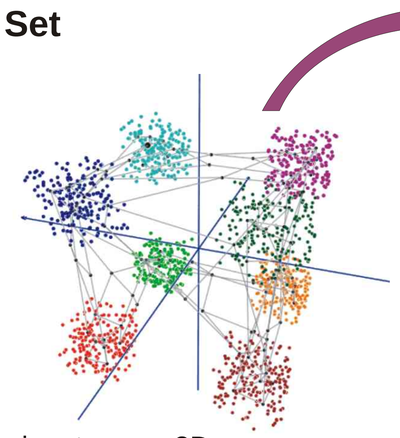
filtered data, threshold=0.65
approx 20% of data removed



filtered data, threshold=0.65
but 100 neurons were used
class borders are more complex

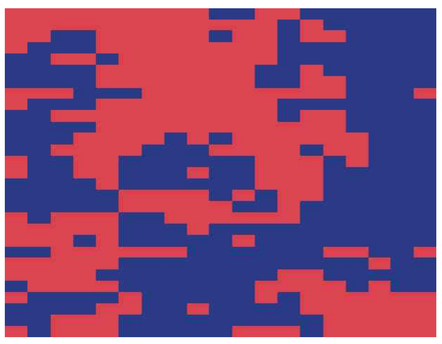
Example: Experimental Data Set



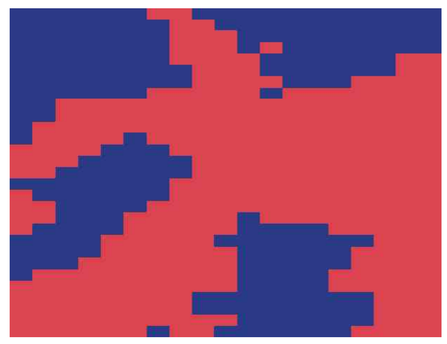


input space 3D

output space 2D



20x30 SOM for the original experimental data set blue: with alcohol; red: without alcohol



20 x 30 SOM for experimental data set, previously filtered with multiple LVQ training approximately 20% of data were removed blue: with alcohol red: without alcohol

- a motoric ability test (posturography):
- two-dimensional oscillatory movement x(t) and y(t)
- balancing on the left or right leg
- without and under influence of alcohol
- 21 normal subjects aged between 18 and 32 years
- 5 sec segments -> discrete Fourier transform
- 810 labeled input vectors, 36 dimensional

visualization with Self-Organizing Map (SOM)

- dimensionality reducing neural network
- calibration with class labels

other variants

- modification of learning rates
- goodness evaluation of test set data only