21 Time Topology for the Self-Organizing Map

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In this work the time information of the input samples is taken into account when constructing the connections between SOM nodes. Those two nodes are connected which are the best-matching units for two consecutive input samples in time. This gives the time topology to the network. The reference models associated with the SOM nodes are first trained in the usual way, treating the input samples as static vectors and defining the neighborhood of the map nodes on the regular map grid. Once the map has been trained, old node connections are removed and new connections are created according to the time information of the input samples. The SOM training can then be continued by using the new node connections as a neighborhood when adapting the reference models. The result is a network where node connections represent temporal signal paths in the input space. Since any two nodes which are the best-matching units for two consecutive input samples in time can be connected independently of their Euclidean distance on the regular map lattice, the new connections may provide "worm-holes" to the original map lattice space.

In the following example, input data consist of sequences of two-dimensional feature vectors proceeding from the origo to the unit circle, see Fig. 38a. One-dimensional SOM with 100 nodes was constructed using this data. Figures 38b, 38c, and 38d illustrate three different map node connections when the reference vectors of the maps are kept the same. Fig. 38b shows the prototype vectors (depicted by dots) and the neighborhood connections (depicted by line segments) of the original one-dimensional SOM. Fig. 38c shows the connections created between the nodes which are the two best-matching units for each single input sample. Fig. 38d represents the time topology where the connections are created between the best-matching units of two successive input items in time. This gives a representation for temporal signal paths in the feature space. The network in Fig. 38d represents clearly best the original input data of Fig. 38a.

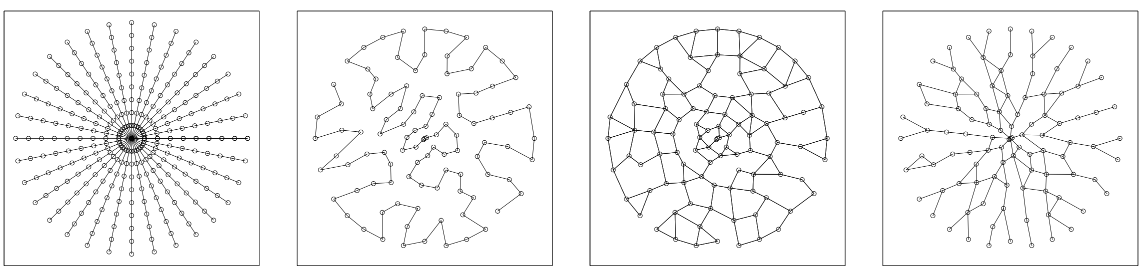

Figure 38: a b c d

The SOM with the time topology was experimented with speech data. 10-dimensional cepstrum vector sequences were computed from 1760 utterances of 20 speakers. Experiments consisted of training the SOM with the regular map lattice and with the time topology. The average quantization error and the word recognition error was then computed using a separate test set. The best results were achieved when the SOM was trained by using the time topology as a node neighborhood. Error in speaker-independent word recognition was 3.6 %.