22 The Self-Organizing Map and Learning Vector Quantization for Feature Sequences

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The Self-Organizing Map (SOM) and Learning Vector Quantization (LVQ) algorithms are constructed in this work for variable-length and warped feature sequences. Instead of a single feature vector, an entire feature vector sequence is associated as a model with each SOM node. Dynamic time warping is used to obtain time-normalized distances between sequences with different lengths. In addition to the generalized median [2] (see also Sec. 5), an arithmetic average can be defined for feature vector sequences with different lengths [3]. Therefore both incremental learning and the Batch Map method can be used. Starting with random initialization, an ordered feature sequence map then ensues, and Learning Vector Quantization can be used to fine tune the prototype sequences for optimal class separation. The resulting SOM models, the prototype sequences, can then be used for the recognition as well as synthesis of patterns. Although time signals are here of main concern, warping can also be made in other dimensions. As pointed out in [1], many static processes can be reinterpreted as dynamic processes in which an artificial time coordinate is introduced.

Speaker-independent word recognition was experimented using one reference template for each of the 22 Finnish command words in the vocabulary. Recognition tests were repeated 20 times, each time having a different speaker in the test set and the remaining 19 speakers in the training set. 10-dimensional cepstrum vectors were used as features. The average recognition errors are given in Table 10.

reference templates	error, per cent
one randomly picked sequence from each class	18.5
one median sequence from each class	3.1
one LVQ-fine-tuned sequence for each class	1.5

Table 10: Speaker-independent word-recognition experiment with 1760 utterances from the vocabulary of 22 Finnish command words.

References

[1] R. Bellman, Dynamic Programming, Princeton University Press, Princeton, New Jersey, 1957; 6th printing 1972.

[2] T. Kohonen, "Self-organizing maps of symbol strings", Report A42, Helsinki University of Technology, Laboratory of Computer and Information Science, Espoo, Finland, 1996.

[3] D. Sankoff and J. Kruskal, Time warps, string edits, and macromolecules: the theory and practice of sequence comparison, Addison-Wesley, 1983.