10 Fast Evolutionary Learning in the SOM

Teuvo Kohonen

Above we dealt with vector-valued $\mathbf{x}(t)$ and $\mathbf{m}_i(t)$. The SOM philosophy, however, can be much more general. The structures of the models and data can be different: it will suffice that some *fitness function* is definable between the general inputs X and the general models M_i, respectively. Let this function be denoted $f(X, M_i)$. *Notice carefully that we do not need any distance function in the X space, nor in the M_i space.*

Even under the above conditions, the SOM can be computed in an "evolutionary" process (cf. [1], Sec. 5.7). We may initialize the models as random samples from the set of possible models. Next we input the samples of X, one at a time, and at each step determine that model M_c for which

$$c = \arg\max_i \{f(X, M_i)\} \ . \tag{77}$$

The next step is some kind of *variation* of the M_i in the neighborhood set N_c of the fittest model M_c. This variation usually means random but statistically independent replacement of each M_i, $i \in N_c$ by some other possible model M on the condition $f(X, M) > f(X, M_i)$.

The evolutionary learning can be implemented by the batch-type SOM without random probing, whereupon it proceeds fast:

1. Initialize the models M_i, e.g., by a random choice of their parameter values from a set of possible values.

2. Input a number of items X and list each of them under the respective winner unit (i.e. that M_i for which some fitness function $f(X, M_i)$ is maximum). In case there is a tie, i.e., two or more M_i have the same fitness to X, select one of them randomly for the effective unique "winner" under which the listing is made.

3. Find a new value M_i' for each M_i such that if U_i is the union of lists relating to model M_i in the same way as in the Batch Map algorithm discussed in Sec. 1, the sum of the fitness-function values $f(X, M_i')$, $X \subset U_i$ is increased. If there exist ties, a random choice between the best M_i' is made.

4. Repeat from step 2.

References

[1] T. Kohonen, *Self-Organizing Maps*, Springer-Verlag, Berlin, 1995; 2nd edition, 1997.

[2] T. Kohonen, Fast evolutionary learning with batch-type self-organizing maps. To appear in *Neural Processing Letters*, 1999.