Two-Dimensional Self-Organizing Map with Nonlinear Spring

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Summary

The Self-Organizing Map (SOM) is a subtype of artificial neural networks [1]. It is trained using unsupervised learning and is a model simplifying self-organization process of the brain. However, SOM is still far away from the realization of the brain mechanism. In order to realize more powerful and more flexible mechanism, it is important to propose new models of the brain mechanism and to investigate their behaviors.

In our previous research, as the first step to realize a new nonlinear spring model of SOM, we have proposed a simple one dimensional 2 and 3-neuron model connected by a nonlinear spring [2], [3]. We have investigated its behavior under a simple assumption where input vectors are given to the model periodically.

Furthermore, since SOM arranged in 2-dimension is the most well-used for applications of SOM, we have proposed $N \times M$ SOM model connected by the nonlinear spring [4]. The neurons of the proposed model consists of $N \times M$ neurons located at a rectangular grid. In the SOM algorithm, the neuron nearer to the winner can be updated more significantly. We represent a relationship between the winner and its neighboring neurons. The input vectors are given to the 4 corners of the model, and the neuron nearest to the input becomes a winner and is attracted to the input vector. The other neurons always do not receive the direct effect from the input vector and are influenced only by the restoring force of the nonlinear spring from the neighboring neurons.

In this study, we investigate the behaviors of the model in detail by calculating their attractors, Poincaré maps, bifurcation diagrams and Lyapunov exponents. We confirm that we can obtain the similar behaviors of the model connected in 2×2 for difference input patterns. Furthermore, we consider the model arranged 5×5 array and investigate the chaotic behaviors with taking notice of the relationship between neurons.

References

[1] T. Kohonen, *Self-organizing Maps*, Berlin, Springer, 1995.
[2] H. Matsushita and Y. Nishio, "Nonlinear Spring Model of Self-Organizing Map and its Chaotic Behavior," *Proc. of ICCCAS'07*, vol. 2, pp. 1099–1102, 2007.
[3] H. Matsushita and Y. Nishio, "Three-Neuron Nonlinear Spring Model of Self-Organizing Map," *Proc. of NCSP'08*, pp. 315–318, 2008.
[4] H. Matsushita and Y. Nishio, "Nonlinear Spring Model of Self-Organizing Map Arranged in Two-Dimensional Array," *Proc. of NOLTA'08*, 2008. (Accepted)