TR－H－011

Dynamical Control of Cluster Boundaries by Changing the State Space Structure of an Associative Memory Model

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1993. 7. 16

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July 15, 1993

Summary

This paper proposes a "new concept to dynamically control cluster boundaries by changing the state space structure with bifurcations." We investigate the realization of this concept using an autonomous associative memory model with diverse attractors, ranging from a stable point to chaos, of an oscillatory neural network with excitatory-inhibitory (E-I) pairs. As a typical characteristic, the state space structure for the visible units (E-cells) in the model is controlled by the initial states of the hidden units (I-cells). The drastic change of the state space structure uses bifurcations positively. Computer simulation of the three-dimensional model shows that the basin of attraction is expanded or shrunk by the initial state of the hidden units, which corresponds to a pattern predicted from a higher context. This confirms the computational meaning beyond the interaction between a higher context and a lower pattern.
To ascertain the usefulness of this dynamical control, an application of dynamical pattern recognition using a character-word interactive model shows an adaptive recognition result to a prediction from words.

Thus, this new concept is not only very useful for adaptive and dynamical pattern recognition according to a prediction from a higher context, but also contributes to the first step in developing a dynamical information processing mechanism for a spatiotemporal pattern in the brain.

key words dynamic brain function for a spatiotemporal pattern, control of cluster boundaries by changing the state space structure with bifurcations, autonomous associative memory model, expanding or shrinking the basin of attraction, limit cycle and chaos, adaptive recognition with context effect.

*This paper is submitted to IEICE Trans. on Inf. and Syst. in Japan.