present probabilities q(j | s) by new ones. For example, we can imagine a case where even if the distance between neurons is very large, they still may strongly be connected with each other. We can take into account this kind of interaction.

Second, we can create new types of self-organizing maps based upon the social interaction. As mentioned above, our method can create a variety of interactions between neurons. Based upon these different types of interaction, it is possible for networks to self-organize, leading to characteristics different from those by the conventional SOM. If we take into account the different types of cooperation between neurons, new types of self-organizing maps can be created.

IV. CONCLUSION

In this chapter, we proposed a new type of information-theoretic method in which neurons are supposed to form a society. In this society, the interaction of neurons is the product of all neighboring neurons' outputs weighted by their distance. The individual neuron tries to imitate this interaction as much as possible. The difference between neurons with and without interaction is computed by the KL-divergence. By minimizing the KL-divergence, we can obtain the optimal outputs of the neuron and the free energy. By differentiating the free energy, we can obtain the re-estimation rules for connection weights.

We applied our method to the data of the production of Japanese automobiles during the period of 1993 and 2011. We can summarize the final results from two points of view. Technically, the new method showed better performance in clarifying class boundaries, compared with the conventional SOM. Explicit class boundaries were due to the interaction of neurons, similar neurons interacting strongly with each other in terms of distance and firing rates. Second, the strong class boundaries were traced back to the important events or incidents which occurred in the period. For example, the class boundary between the first and the second period was due to the revision of regulation law for mini-cars. Thanks to this revision, the number of mini-cars in production increased gradually. In the third period, a significant production increase at the beginning of the period was accompanied by a decrease in production of other models, with only mini-cars being largely produced in the end. This period was well explained by the economic crisis in 2008.

Though there are some problems such as optimality and topological preservation, as explained in the discussion section, we have shown that it is possible to create different types of neuron societies, where different kinds of interaction can be implemented.

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