Some open problems for application of spiking neural P systems

Hong Peng

School of Computer and Software Engineering,
Xihua University, Chengdu, China
E-mail: ph.xhu@hotmail.com

Recently, three variants of spiking neural P systems have been proposed: coupled neural P systems (CNP systems) [1], dynamic threshold neural P systems (DTNP systems) [2] and nonlinear spiking neural P systems (NSNP systems) [3]. It was proven that the three variants are Turing universal number generating/accepting devices and function computing devices. The potential motivation of proposing the variants is to provide a modeling tool for real-life applications, for example, image processing tasks. Some open problems related to the variants are listed as follows.

Q1 As stated in the existing SNP systems, some problems that refer to these variants can be investigated, for example, language generator, sequential and asynchronous modes.

Q2 CNP systems and DTNP systems have all or part of spiking mechanism, coupling mechanism and dynamic threshold mechanism. How to apply the two variants to deal with some image processing tasks? for example, image fusion, image segmentation, object segmentation, feature extraction, object detection, and so on. Since image is two-dimensional (or three-dimensional for color image), CNT (or DTNP) systems can be considered as two- dimensional (or three-dimensional) array of neurons. Moreover, due to local spatial characteristics of an image, local topological structure should be further considered.

Q3 NSNP systems has a nonlinear spiking mechanism. Potentially, NSNP systems as a modelling tool could have the ability to handle nonlinear problems. Similarly, how to apply the variant to deal with these image processing tasks?

Q4 Local convolutional structures are easily introduced into these variants with local topological structure, like convolutional neural networks (CNN). How to use them to build deep SNP systems? How to develop the corresponding learning algorithms?

References

1. H. Peng, J. Wang. Coupled neural P systems. *IEEE Transactions on Neural Networks and Learning Systems*, 2019, 30(6), 1672-1682.
2. H. Peng, J. Wang, M.J. Pérez-Jiménez, A. Riscos-Núñez. Dynamic threshold neural P systems. *Knowledge-Based Systems* 163, 2019, 875–884.
3. H. Peng, Z. Lv, B. Li, X. Luo, J. Wang, X. Song, T. Wang, M.J. Pérez-Jiménez, A. Riscos- Núñez. Nonlinear spiking neural P systems, *International Journal of Neural Systems*, 2020. https://doi.org/10.1142/S0129065720500082