Paper: *Introduction to spiking neural networks: Information processing, learning and applications*

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Summary

Ponulak et al. summarize the basic properties of spiking neural networks (SNN) which represent a class of artificial neural network and SNN work on spike-based information coding, synaptic plasticity and learning. SNN can be applied to all the problems solvable by non-spiking neural networks and are computationally more powerful than perceptrons and sigmoidal gates.

The three general categories SNN can be classified into are feedforward networks, recurrent networks and hybrid networks. Hybrid networks can be further divided into two classes, synfire chain and and reservoir computing. Many studies done on different animals like cats, macaque, bats are presented and it is found that neural code point out particularly to the high importance of each individual spike in the biological neural signals. In the learning section, various models of learning (supervised, unsupervised and reinforcement) for spiking neural networks that explore spiking timing based synaptic plasticity is presented. An overview on the application of SNN is discussed in the next section and a number of specific, real-life tasks performed with the use of self-organizing SNN is covered. SNN have been used for real-world data classification, image recognition, odor recognition, spatial navigation and spatial and mental exploration of the environment. SNN trained according to the supervised learning paradigm have also been used in tasks such as motor control and trajectory tracking, supervised data classification and decision making with application to financial market. SNN trained with reinforcement methods have been applied to tasks like spatial navigation and path planning, decision making and action selection and rehabilitation.

Additionally, using SNN in fields like modeling and analyzing the biological neural structures has benefited them heavily. Hence, the survey done in this paper about SNN and its applications are computationally useful in terms of both theoretical models and practical applications. It is expected that the availability of more efficient learning methods for spiking networks will bring benefit to new areas of its application and in particular applications in the biological field.

Strengths

- The paper is well organized and the transitions between sections are easy to follow.
- New concepts introduced in the paper are well defined and described.
- In particular, I was fascinated by the applications of SNN.

Weaknesses

- Numbering the sections could have been useful for the readers.

Points of Confusion

- How does SNNs explore the phase coding strategy for odor discrimination tasks?
- Some of the theoretical findings discussed in “Information processing in Spiking Neurons” section was confusing.

Discussion Questions

- What is the current level of research in SNN and have they being deployed in any practical scenarios?
- Is there any comparison study done in the data classification and recognition tasks done by SNNs and ANNs?
- A discussion on Fig. 6 to get an intuitive understanding of the network.