Research Internship

Brain-inspired feature extraction for embedded image classification

Context

During the last years, Deep Neural Networks (DNNs) have reached the best accuracy in image classification. Nevertheless, such a success is mainly based on supervised and off-line learning. Hence, they require huge labeled datasets for learning, and once the learning is completed, DNNs cannot adapt to any change in the data from the environment.

In the context of the Self-Organizing Machine Architecture (SOMA) project, we follow an interdisciplinary approach (computational neuroscience, machine-learning, digital electronics) to implement online unsupervised learning in Artificial Neural Networks (ANNs) [1]. This internship will focus on adding feature extraction using Self-Organizing Maps (SOMs), a particular model of ANNs inspired from the cortical plasticity of the brain. The goal of the internship is to implement the Convolution and Pooling layers of classical DNNs using the SOM mechanisms, and to compare the performance of the system (accuracy, dynamicity, scalability) with Spiking Neural Networks (SNNs) [2] implemented in SpykeTorch [3].

The feature extraction mechanism will be integrated in a multimodal association framework proposed at LEAT, where the goal is to enhance the overall system's accuracy by fusing different but complementary modalities such as sight and sound.

Internship mission

The internship mission will be organized in several periods:

- Theoretical study of neural networks and neuromorphic engineering in the scientific literature,
- Propose a model for convolution and pooling layers with unsupervised learning based on SOMs,
- Experiment the proposed feature extraction neural model with natural images,
- Integrate the feature extraction into a multimodal association framework developed at LEAT.

References

[1] L. Khacef, B. Miramond, D. Barrientos, and A. Upegui, "Self-organizing neurons: toward brain-inspired unsupervised learning," in 2019 International Joint Conference on Neural Networks (IJCNN), 2019.
[2] S. R. Kheradpisheh, M. Ganjtabesh, S. J. Thorpe, and T. Masquelier, "Stdp-based spiking deep convolutional neural networks for object recognition," Neural Networks, vol. 99, pp. 56 – 67, 2018.
[3] M. Mozafari, M. Ganjtabesh, A. Nowzari-Dalini, and T. Masquelier, "Spyketorch: Efficient simulation of convolutional spiking neural networks with at most one spike per neuron," CoRR, vol. abs/1903.02440, 2019.

Practical information

Location : LEAT Lab, Sophia Antipolis
Duration : 6 months from March/April 2020
Grant : 529.20 € / month
Profile : Machine learning, neural networks, embedded systems, sensors/actuators, Python.

Contact

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