Conversion of Analoge to Spiking LSTM

Background

Recurrent neural networks (RNN) in combination with Long short-term memory (LSTM) offer great performance for pattern recognition in temporal sequences. The computation however results in a large energy consumption, which makes the use in low-powered embedded systems disadvantageous. The development of appropiate neuromorphic hardware could reduce the need to a fraction, but would require adapted algorithms in form of spiking neural networks.

Direct training of spiking neural networks (SNN) results in inferior performance compared to todays state of the art analogue neural networks (ANN) trained with backpropagation. Best results are obtained by the conversion of trained ANNs to SNNs [1] and are the benchmark for SNN performance for feedforward and convolutional neural networks [2]. Appropiate solutions for the conversion of LSTM-based RNNs are missing so far.

Description

The objective of the thesis is to build and train LSTM-based RNN models, convert the memory cells into spiking equivalent (e.g. as proposed in [3]) and to evaluate the resulting networks.

Tasks

This student project consists of the following tasks:

- Getting familiar with the topics LSTM, spiking neural networks and conversion
- Choose and train suitable RNN models
- Convert and validate networks to spiking equivalent
- Improve performance
- Documenting the results

References

[1] M. Pfeiffer and T. Pfeil, "Deep Learning With Spiking Neurons: Opportunities and Challenges," *Frontiers in Neuroscience*, vol. 12, 2018.

[2] A. Tavanaei, M. Ghodrati, S. R. Kheradpisheh, T. Masquelier, and A. Maida, "Deep Learning in Spiking Neural Networks," *Neural Networks*, vol. 111, pp. 47–63, 2019.

[3] G. Bellec, D. Salaj, A. Subramoney, R. Legenstein, and W. Maass, "Long short-term memory and learning-to-learn in networks of spiking neurons," *arXiv:1803.09574 [cs, q-bio]*, 2018. arXiv: 1803.09574 [cs, q-bio].

Technical University of Munich

Faculty of Informatics

Chair of Robotics, Artificial Intelligence and Embedded Systems

Supervisor:
Prof. Dr.-Ing. Alois Knoll

Advisor:
Etienne Müller, M.Sc.

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For more information please contact us:

Phone: +49.89.289.18133

E-Mail:
etienne.mueller@tum.de

Internet:
https://www6.in.tum.de/