Stakes of Neuromorphic Encoding and Preprocessing

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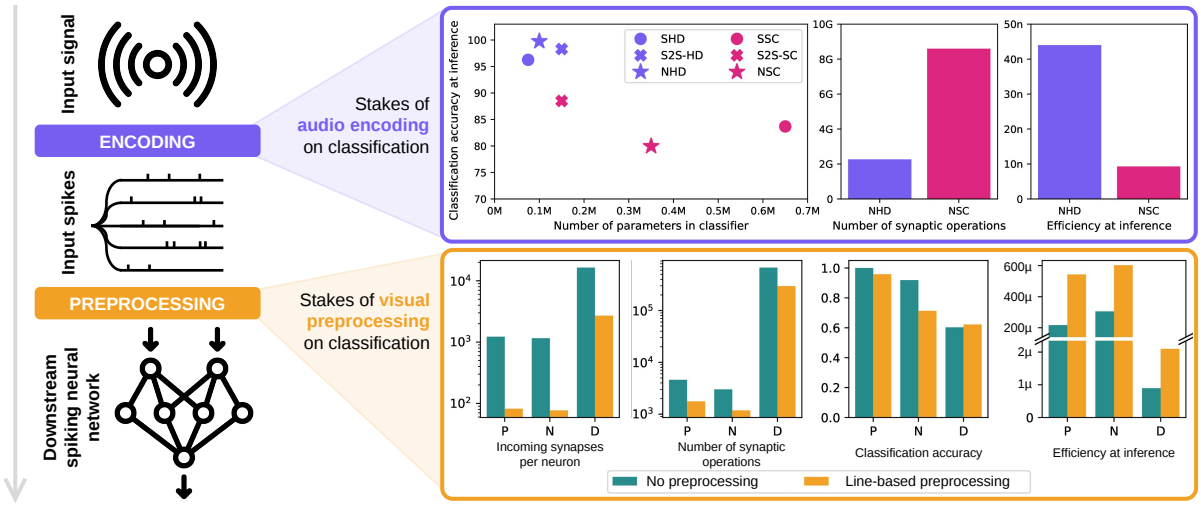
Despite the significant progress of neuromorphic computing in recent years, optimising its energy requirements still remains a challenge within the community, especially for embedded applications. We believe that one solution towards low-energy neuromorphic systems resides in the encoding and preprocessing strategies used to produce the spiking data: they might be optimised to enhance the overall performance while lowering the dynamic energy cost on neuromorphic hardware, proportional to the number of synaptic operations propagated within the model.

We highlight here two strategies developed by our team to achieve this goal of energy efficiency:
Audio encoding: Our first strategy targets the encoding of audio into spikes: our simple approach to cochlear encoding [1] provides a lighter, more hardware-friendly alternative to benchmark audio datasets. Recent results attest that conjointly optimising encoding and classification allows our simple, fully neuromorphic pipeline to outperform the state-of-the-art on the spiked dataset Heidleberg Digits (reaching a 99.77% accuracy) while significantly reducing the overall synaptic activity.
Visual preprocessing: Our second, recently published strategy demonstrates the benefits of the line-based preprocessing of event-based data [2]. This bio-inspired preprocessing leads to an advantageous trade-off between energy consumption, classification performance and hardware memory usage on benchmark DVS datasets. In more complex scenarios, the added preprocessing step increases significantly the classification performance while halving the synaptic activity per second.

Our strategies systematically lead to a significant improvement of the neuromorphic classification efficiency, often combined with an increased performance. Our results highlight the need for adequate and adaptable encoding and preprocessing according to the considered data and the tasks undertaken to reverberate positively on low energy consumption. We thus lay down the groundwork towards a more frugal neuromorphic intelligence thanks to a necessary encoding and preprocessing step.



Neuromorphic computing with intermediate spike encoding and preprocessing. Top: comparison of classification of audio datasets (HD: Heidelberg Digits, SC: Google Speech Commands) with different encoding (S*: Lauscher, S2S-*: Speech2Spikes, N*: ours). Bottom: benefits of line-based preprocessing on event datasets' processing (P: PokerDVS, N: N-MNIST, D: DVS-128Gesture).

[1] V. Meunier, A. Gruel, A. F. Vincent and S. Saïghi. "Comparison of Hardware-friendly, Audio-to-spikes Cochlear Encoding for Neuromorphic Processing". *IEEE AICAS*, pp. 1-5, doi: 10.1109/AICAS64808.2025.11173106, 2025.

[2] A. Gruel, P. Lewden, A.F. Vincent and S. Saïghi. "Line-based Event Preprocessing: Towards Low-Energy Neuromorphic Computer Vision". *Neuromorphic Computing and Engineering*, doi:10.1088/2634-4386/ae5128, 2026.