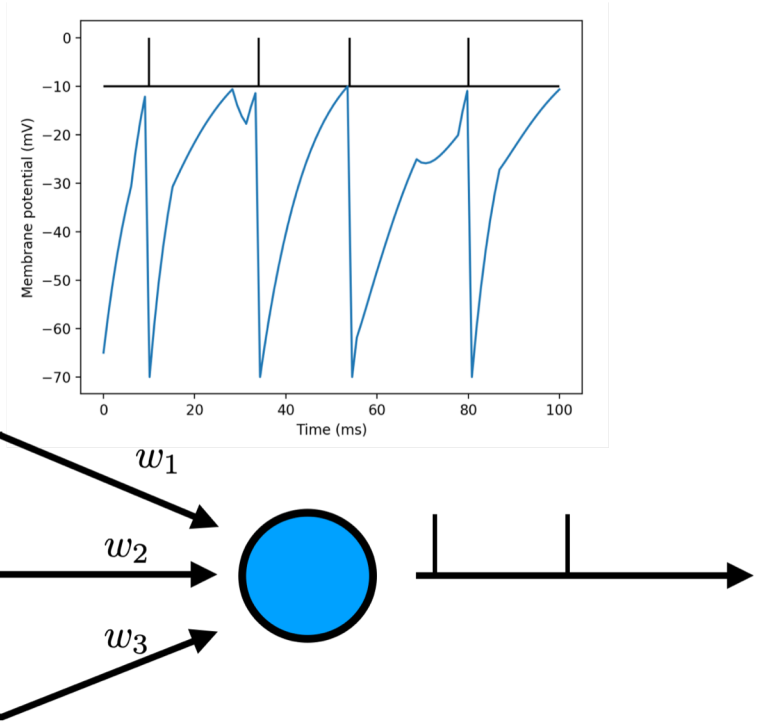
A surrogate gradient spiking baseline for speech command recognition

Alexandre Bittar

Spiking neuron:

- internal state = membrane potential
- transmitted information = sparse binary events

- linear integration of input stimuli
- decay back to rest in absence of input
- emits spike if potential above threshold
- afterspike reset and refractory period
- spike-frequency adaptation



A. Bittar, P. Garner *A surrogate gradient spiking baseline for speech command recognition*, Frontiers in Neuroscience, 2023.

Spiking Neural Networks

Spiking Neural Networks (SNNs)

- Special case of a recurrent neural network (RNN)
- Threshold operation is not differentiable
- Surrogate gradient allows backpropagation
- Sparse and binary information can lead to energy-efficient hardware implementations.

Speech command recognition

- Improve upon SNN state-of-the-art
- Competing results with fewer parameters compared to gated RNNs.

Networks	Accuracy
Adaptive RSNN (Shaban et al. 2021)	91%
Attention RNN (De Andrade et al. 2018)	93.9%
Our best SNN (RadLIF) (This work)	**94.5%**
Our best ANN (GRU) (This work)	95.1%
Transformers (Gong et al. 2021)	98.1%

= SNNs

= ANNs

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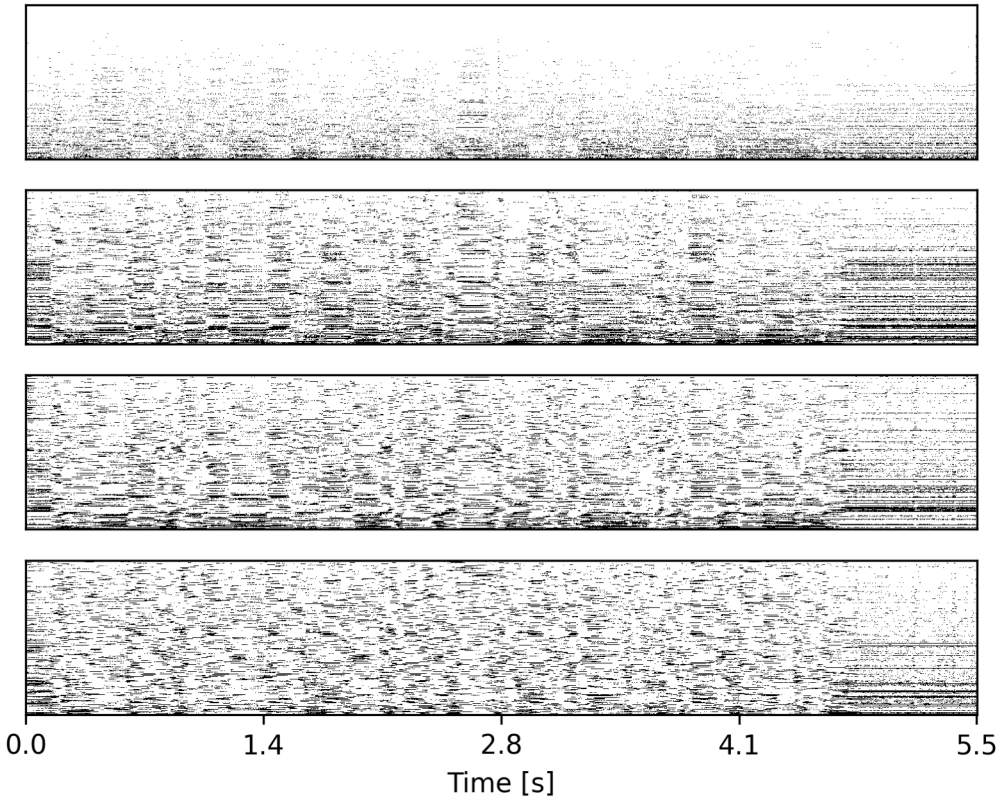
Spiking Neural Networks

Follow-up work:

- Extended the approach to large vocabulary continuous speech recognition.
- Used hybrid architecture with spiking speech encoder and standard decoder.

Current focus:

- Started spike train analysis of the encoded information through the trained network.
- Comparison with neuroscience observations in the human auditory pathway.
- Towards a better understanding of how the brain processes speech.



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