Sound Detection and Classification
using Spiking Neural Networks

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Outline

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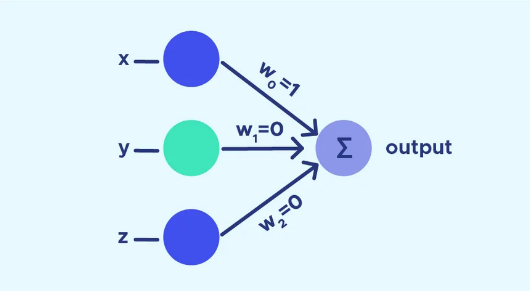
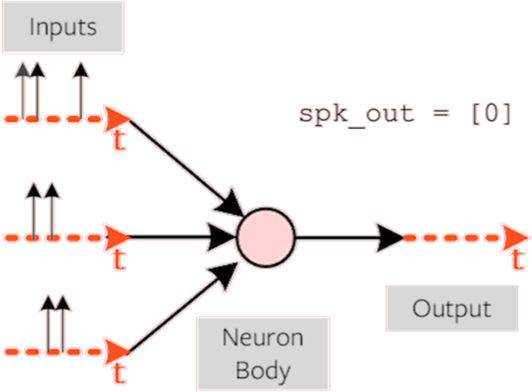
Comparison: ANN vs SNN

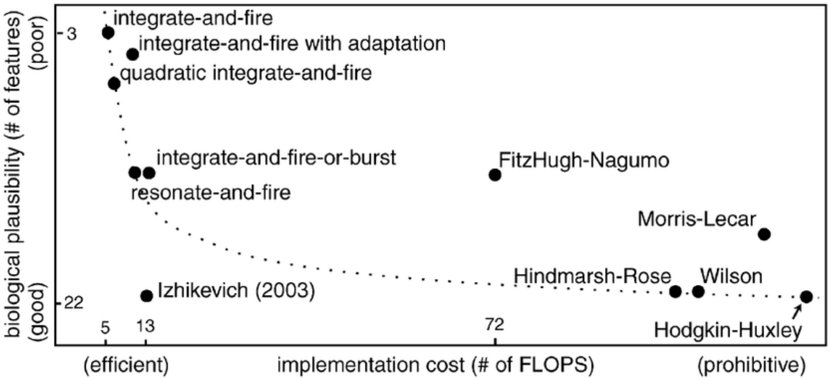




Specificities of SNNs

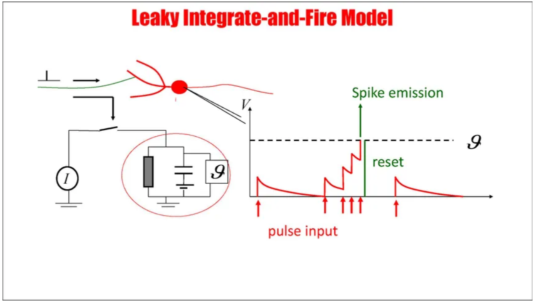
- Neurons communicates with each other by sending spikes.
- More biologically realistic than ANNs.
- More energy efficient than ANNs (real time processing, event driven processing, sparse representation).
- Loss function is not differentiable and cannot be optimized using gradient descent for backpropagation.

Comparison between spiking neural models



Principle of LIF

- Leaky integrate-and-fire in SNNs:
- Accumulates input currents over time
- Leaking a fraction of the charge per unit time
- Fires when the accumulated charge surpasses a threshold.



LIF Model Equations

$$C_m \frac{dV_m}{dt} = I(t) - \frac{V_m}{R_m}$$

- C_m is the membrane capacitance
- V_m is the membrane potential
- $I(t)$ is the input current
- R_m is the membrane resistance

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Choosing the Type of Training Data

- Understanding the challenges of training SNNs compared to ANNs.
- Criteria for selecting data: Less computationally intensive, adaptable to pre-recorded and real-time processing.

Feasibility

- Selection of Google AudioSet database.
- Addressing copyright concerns (Creative Commons license).
- Data collection/extraction: Utilizing GitHub repositories for efficient downloading, formatting, and cropping of sound files.
- Assessing resource usage and parallelization impact.
- Uncertainties about data quality: Contextual issues, multi-labeling, Weak and Strong Label annotations.

Feasibility

- Addressing uncertainties related to dynamic audio signals, varying acoustic environments, and challenges in modeling temporal aspects.
- Discussing potential challenges in training SNNs, considering non-linearity and sparsity of spikes.
- Highlighting potential data uncertainties, such as varied audio formats and unavailability of certain samples.
- Estimating computation time for data import and training.

ANNs Used for Audio Classification

- Overview of existing ANNs for audio classification.
- Mentioning pre-trained models on Google AudioSet, rearranged Resnet, inception, densenet, and LSTM-based models.
- Providing references to relevant GitHub repositories and research papers.

SNNs Used for Audio Classification

- Overview of existing SNNs for audio classification.
- Highlighting spiking convolutional neural networks (SCNN), multi-layer SNN using SpiNNaker, shadow training, and SNN simulators (BindsNET, NEST).
- Referencing GitHub repositories and documentation for each model.

Pre-processing

- Collecting the data
- Adaptation of the data
- Checking that there are no errors / repetitions

Outline

Spectrograms

- Spectrograms

MEL

- MEL

MFCC

- MFCC

Outline

Spiking Neural Networks - First results

- First results

Outline

Conclusion

- Summary
- Future Work