Sparse Spiking Neural Networks

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Encoding

- Use temporal coding
- Use intensity to delay encoding
- Allow only the first n of m spikes to pass through (N of M encoding)
- Alternativly use Rank Order Coding or N of M Rank Order
- Alternativly use a dynamic N. This could be a thresold per region of an image use relative threshold so that dark spots still get their information trough
- For images, divide the input into spatial chunks and apply n-of-m coding within each chunk to preserve spatial information.
- For sequences like text, audio, or video, apply n-of-m coding to time frames. For video, combine n-of-m coding across both spatial chunks and temporal frames. Can be linked to brain waves.

Theoretical Foundations

- Prove that the network satisties the universal approximation theorem
- learn how visiontransformers work and how they differ from CNNs
- ressonator neurons and integrator neurons ???
- Design a critical system lookup *Critical Brain Theory* https://www.youtube.com/watch?v=vwLb3XlPCB4 This will make shure signal does not grow out of proportions or shrink to a halt

Network

- use inhibitory connections—but more importantly figure out how
- Adress event representaion (AER)
- Binary weights, only check if there is and outgoing/incomming spike or not

Neuron Models

- Integrate-and-Fire Neurons (IF): Output neurons accumulate spikes from their connected synapses within a short time window. If the accumulated input exceeds a threshold (e.g., 4/4 synapses fire), the neuron fires. This process ensures that only significant patterns propagate further. They need to reset after, either leaky or instant, also dependng on wether they fired or not

Learning

- Use lateral inhibition
- Use Homeostatic Plasticity

- Use Synaptic Competition
- Grow Synapses: If a neuron is close to firing (e.g., 3/4 synapses activate), connect its final synapse to the most recent active input neuron. This mimics biological synapse growth
- Move Synapses: Adjust existing synapses toward frequently active input neurons to refine connections.
- Prune Synapses: Remove inactive synapses over time to maintain efficiency and sparsity.

Experiment 1

Bibliography