Neuromorphic System with Synaptic Transistors and Neuron Circuits for Spiking Neural Network

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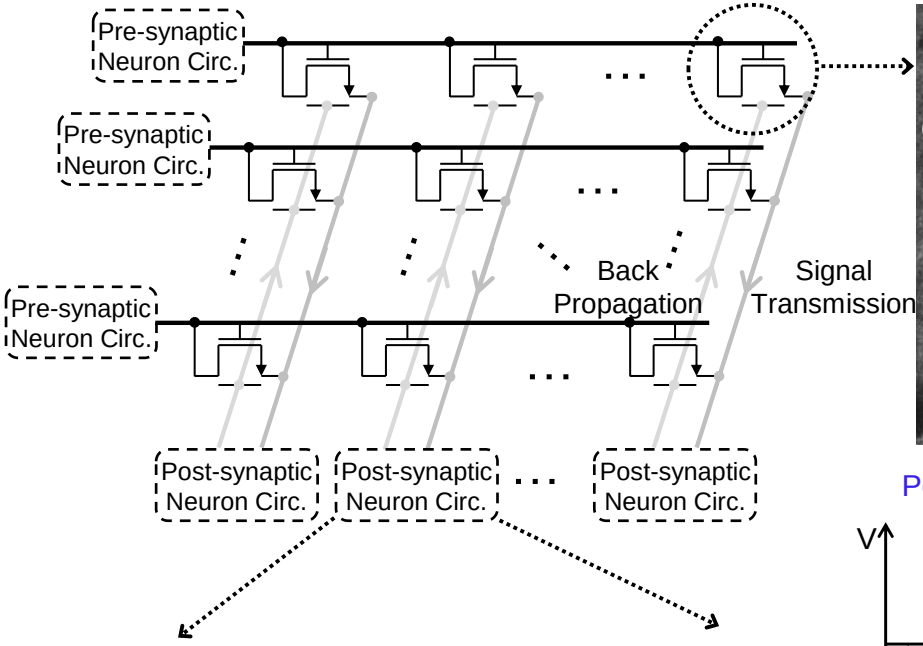
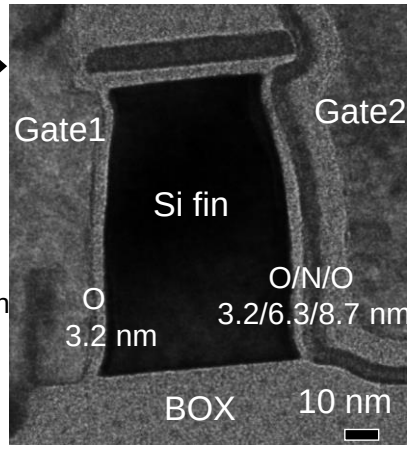
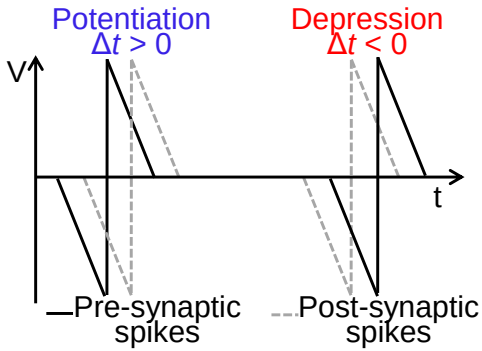
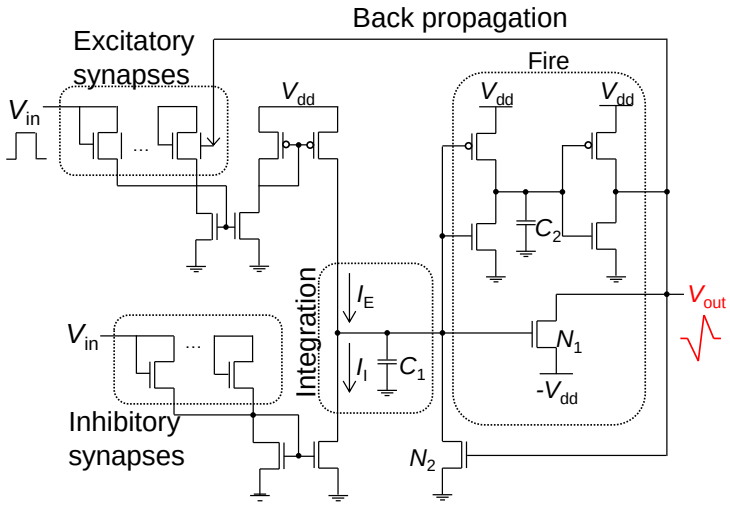
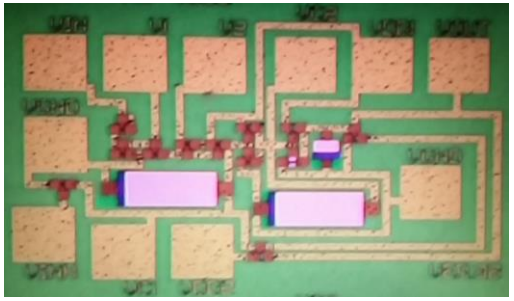
Synaptic Transistors and Neuron Circuits







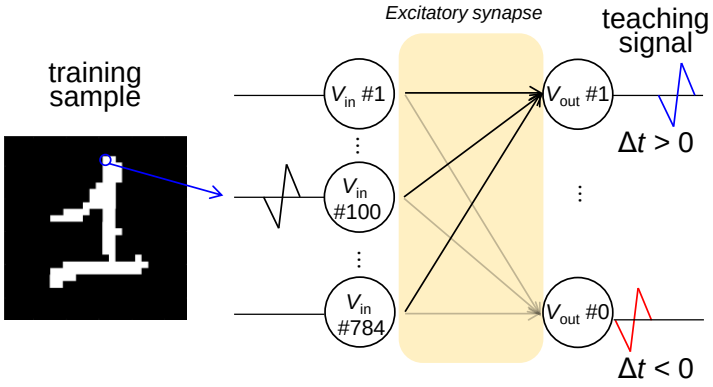




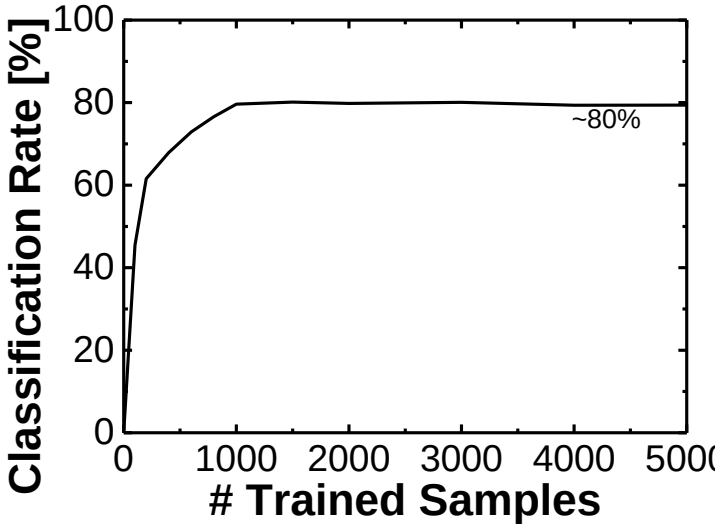
- Independent dual-gate synaptic transistors
- Receive pre- & post-synaptic spikes directly from G1 and G2, respectively.

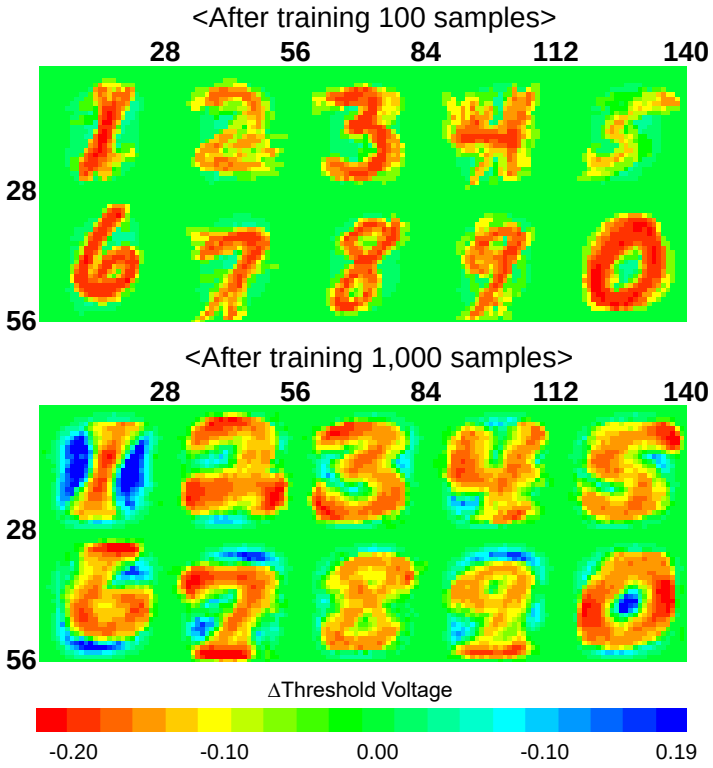
- Neuron circuit for generating triangular spike
- Both excitatory and inhibitory postsynaptic potentials are generated through dual current mirrors.

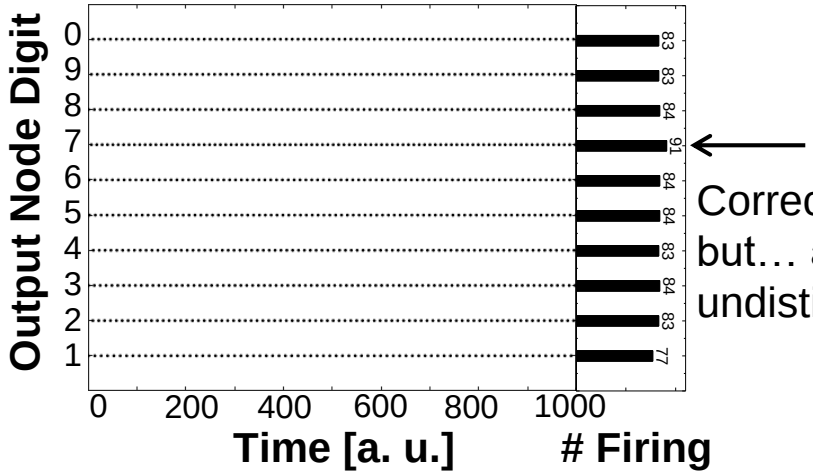
Spiking Neural Netowkr with Excitatory Synapses



- Pattern recognition with supervised learning

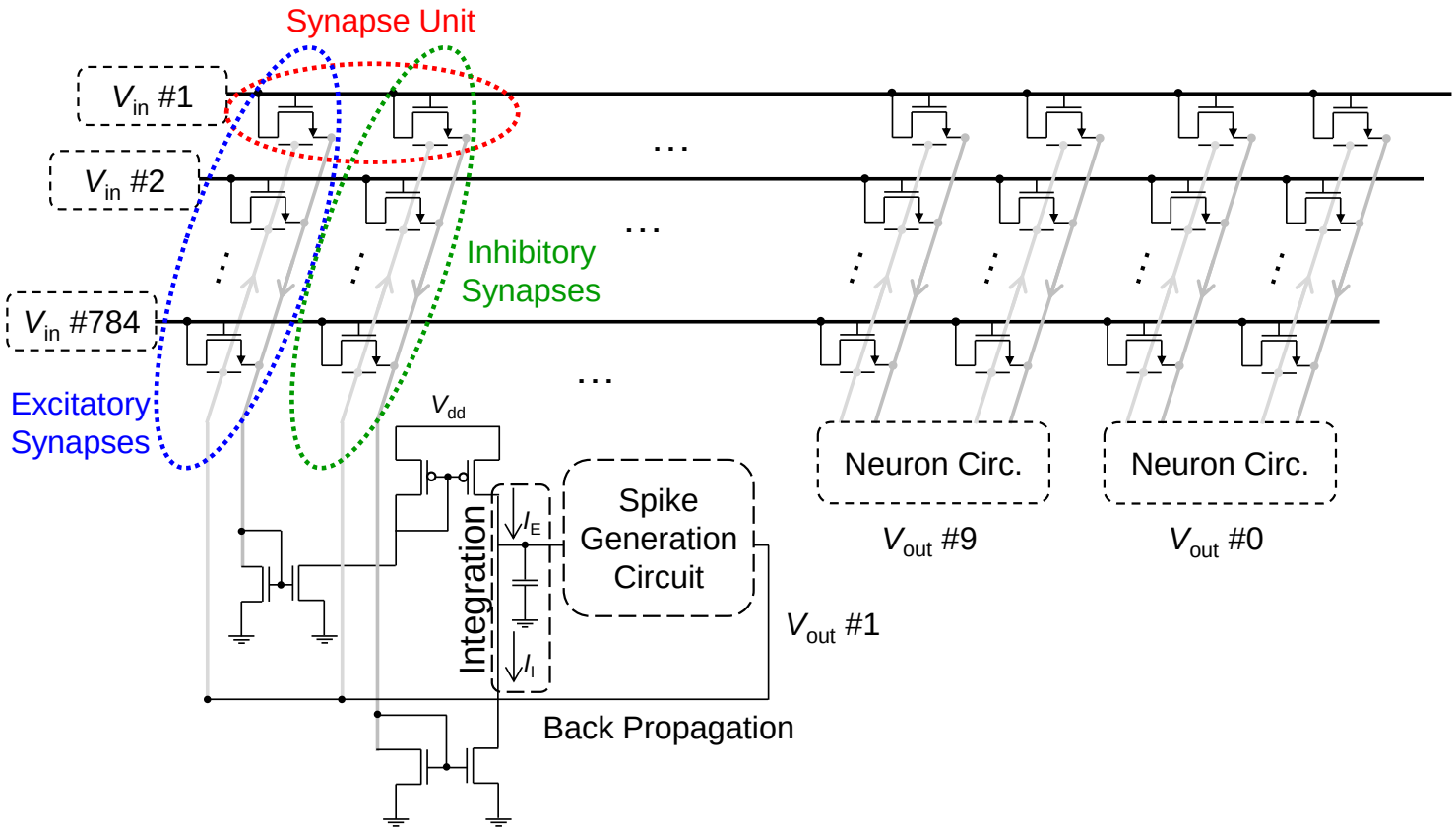






Correct answer but… almost undistinguishable

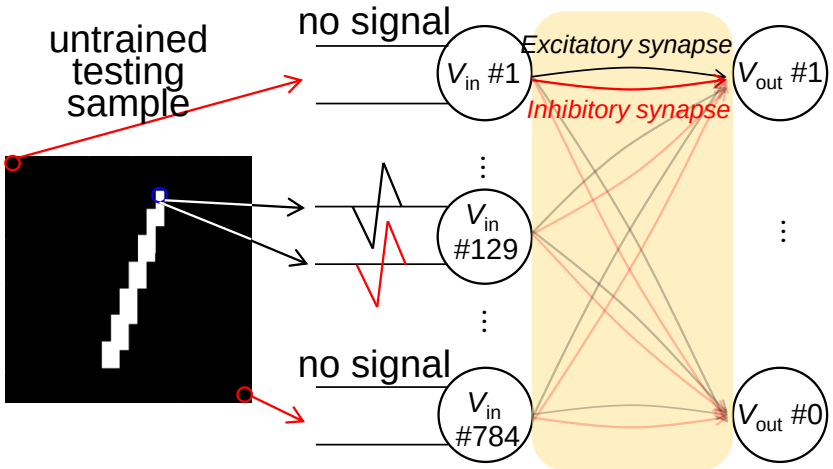
Additiona of Inhibitory Synapses

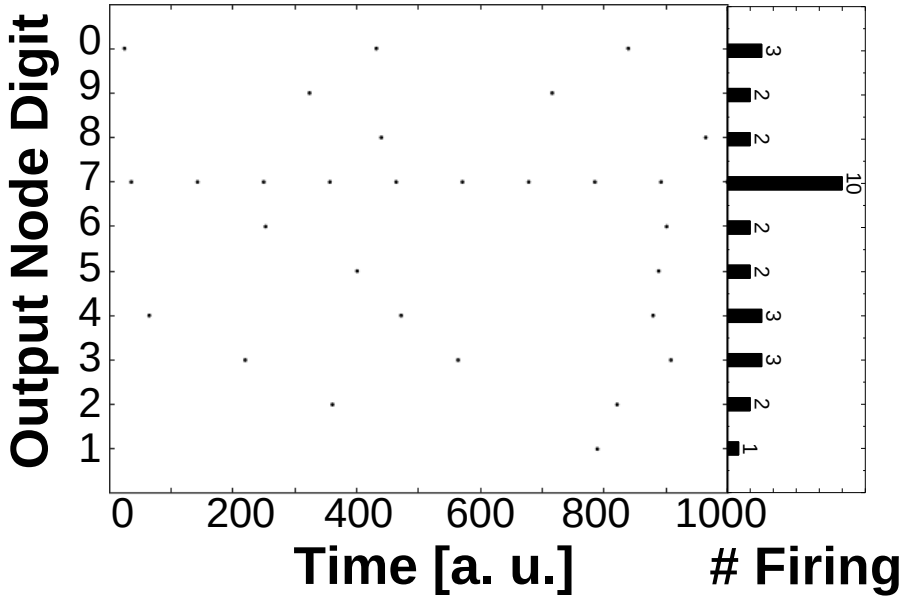


- In order to reduce the excessive firing characteristics discussed above, the inhibitory synaptic transistors are added to the circuit .

- Negative values of the synaptic weight are implemented to suppress the firings at the output nodes by using two synaptic transistors, excitatory one and inhibitory one, as one synapse unit and dual current mirrors.

Improved Firing Characteristics and Performance





- The input signals are applied to both of the excitatory synapse and inhibitory synapses simultaneously.

- The addition of inhibitory part
  → suppression of the excessive firings.
  → much better firing rate ratio
  (when the same sample is tested)

Improved Firing Characteristics and Performance