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2019-02-03

3 Spiking Neurons

3.1 Synapse

$$i(t) = w\alpha(t - t^f) \tag{1}$$

- $i(t)$: **analog current signal received by post-synaptic neuron**; linear and time-invariant
- $w\alpha(t)$: transfer function
- w:
  - synaptic weight representing conductance across a synapse connecting two neurons
  - also known as the scaling factor
  - varies from synapse to synapse
  - can be positve or negative depending on "**which the synapse** is said to be excitatory or inhibitory respectively"
- $\alpha(t)$: post-synaptic current kernel; independent of synapse
- t^f: time at which pre-synaptic neuron issues a spike; firing time
- assume synaptic currents are independent of membrane or reversal potential of post-synaptic neuron

$$\alpha(t) = [\exp(-t/\tau_1) - \exp(-t/\tau_2)]u(t) \tag{2}$$

- $\tau_1 > \tau_2$
- τ_1 and τ_2: **unspecified in document**
- $u(t)$: Heaviside function; models the incoming spike

$$c_i(t) = \sum_f \alpha(t - t_f^i) = \sum_i \delta(t - t_f^i) * [e^{-t/\tau_1} - e^{-t/\tau_2}] \tag{3}$$

- i: represents specific synapse
- t_f^i: (*most likely*) pre-synaptic firing time of individual spikes across the specified synapse
- t: