Synaptic Integration in Single Neurons

### Dr Tiago Branco, February 13, 2018

# outline

Input-output functions of single neurons

Synaptic conductance and currents

Equivalent electrical circuit of the membrane

Membrane potential in response to step current

Membrane potential in response to synaptic current

Integration allows for computation

How is synaptic input integrated?

Membrane constant sets summation time window

Basic input-output function

Voltage-gated conductances change IO function

Dendritic trees add a spatial dimension to integration

Current flow in neuron with dendrites

Voltage attenuation in cables

Compartmental modeling of neurons

EPSP attenuation by dendrites

Effects of location, Rm and Ri on EPSP attenuation

Input-output function in dendrites

Computation of input direction

Voltage gated conductances change IO function

Dendritic spikes

Dendritic patch-clamp recording

Backpropagating action potentials

Active properties in dendrites

Input-output function varies with dendritic location

Dendritic computation of input sequences

Near-perfect integration

Ideal experiment: discussion

# Resources

Neuron simulation environment: <https://www.neuron.yale.edu/neuron/what_is_neuron>

‘The Theoretical Foundation of Dendritic Function’ The Collected Papers of Wilfrid Rall with Commentaries by Segev, Rinzel, Cambridge, Mass ; London : MIT Press  c1995 (available at UCL Science library at MEDICAL SCIENCES JN 43 SEG)