Introduction to SNNs

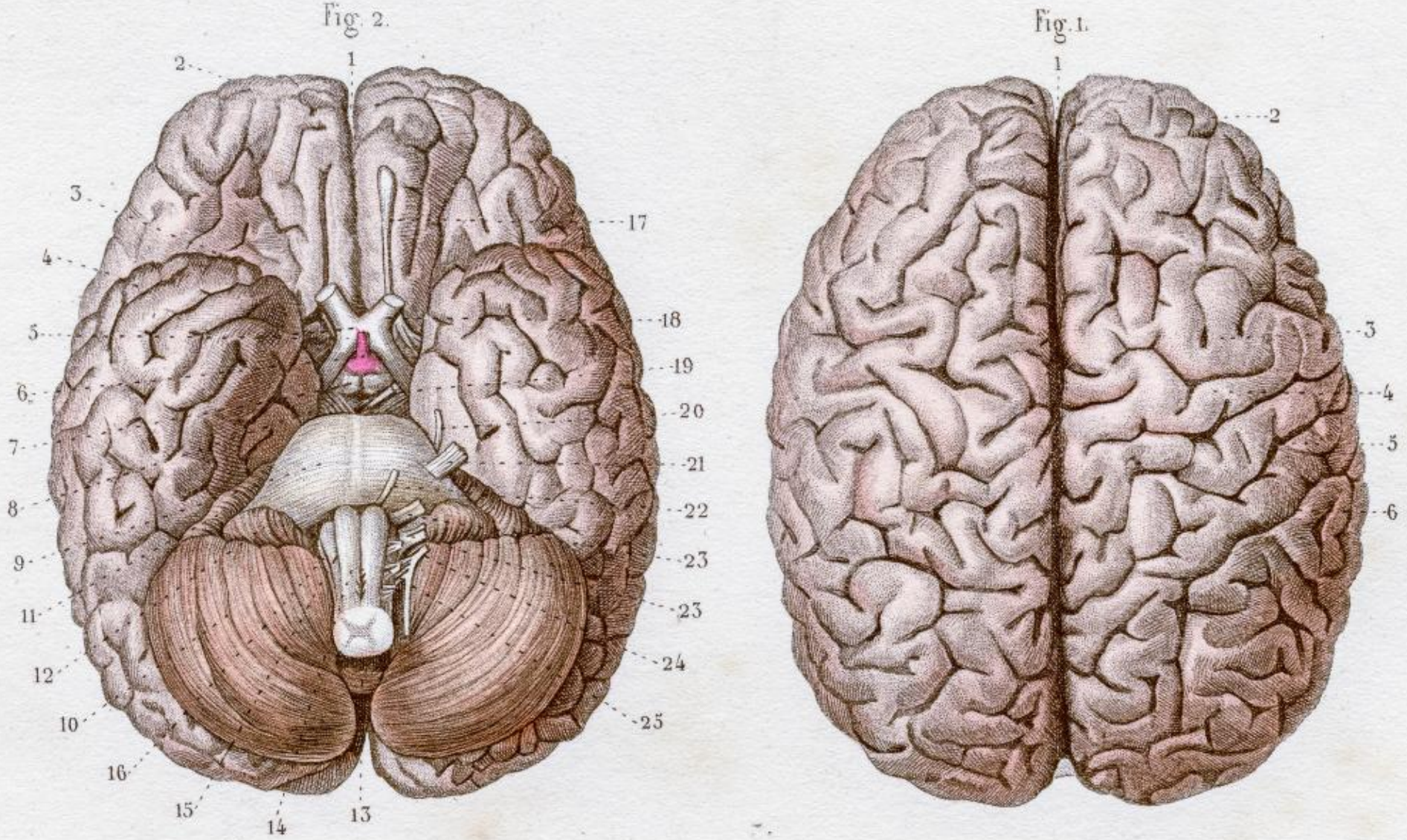
Or: Why spikes?

What's the big deal with spiking neurons?

Time

Photo by Ahmad Odeh on Unsplash

What's the big deal with spiking neurons?



Energy

What's the big deal with spiking neurons?

Dynamics

Photo by Michal Janek on Unsplash

Standard ANN

$$y = \Theta(W \cdot x + b)$$

Output

Transfer function

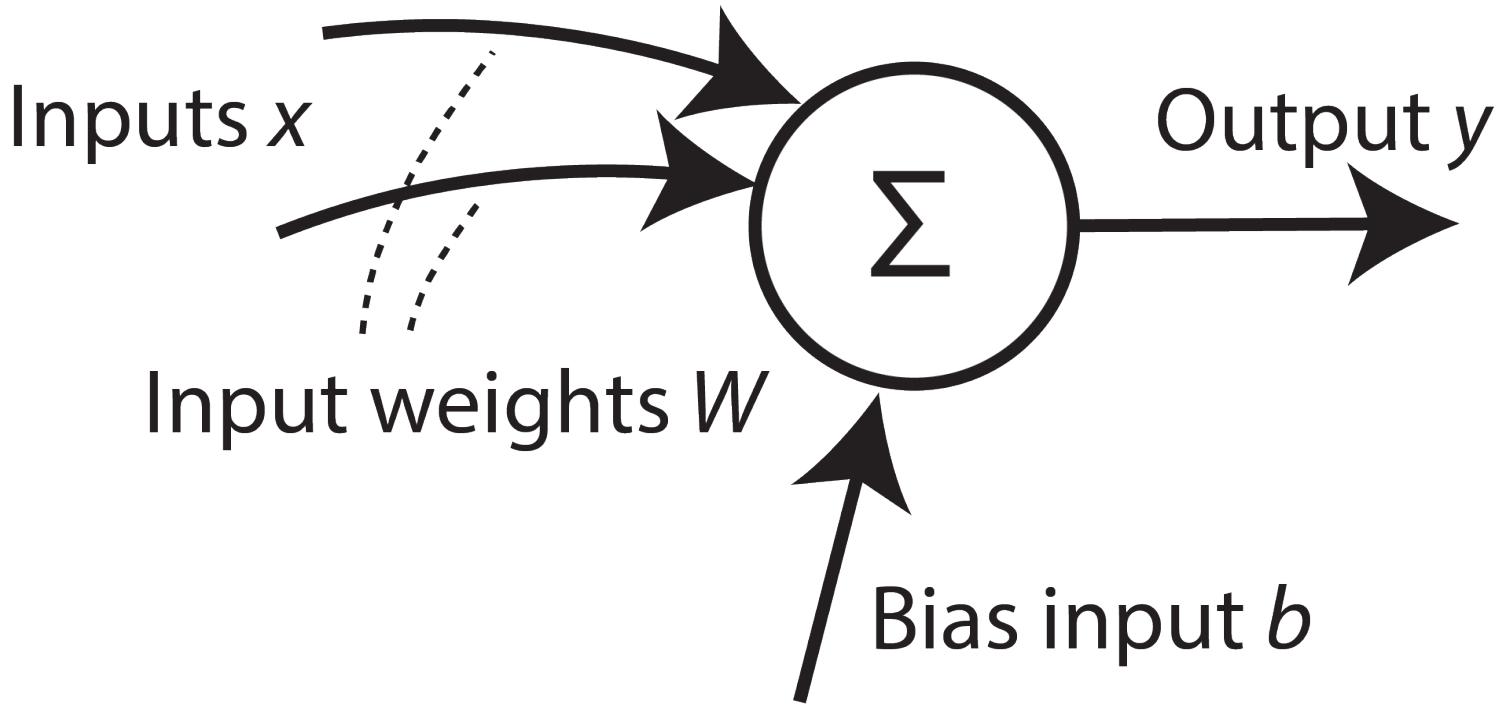
Weights

Input

Bias

Standard ANN

$$y = \Theta(W \cdot x + b)$$



Spiking Neuron

$$z_o(t) = \Theta\left[V_m(t)\right]$$

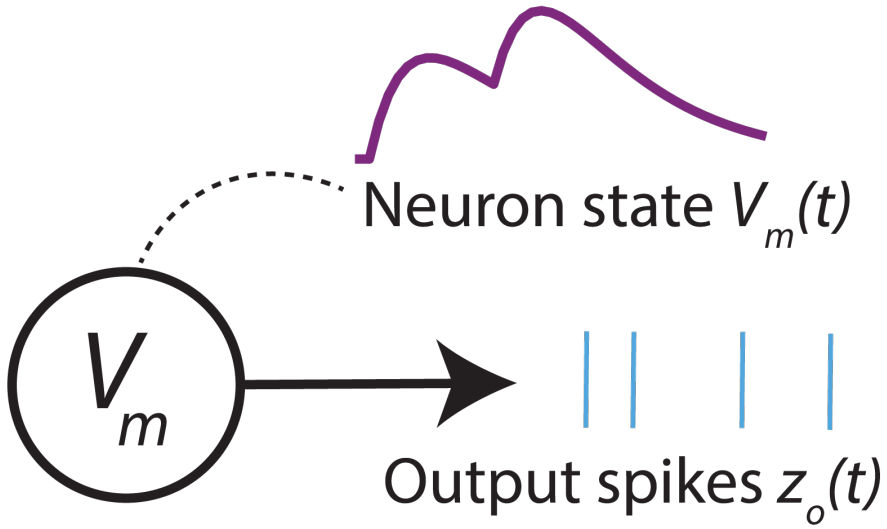
Output (events)

Transfer function

Internal state

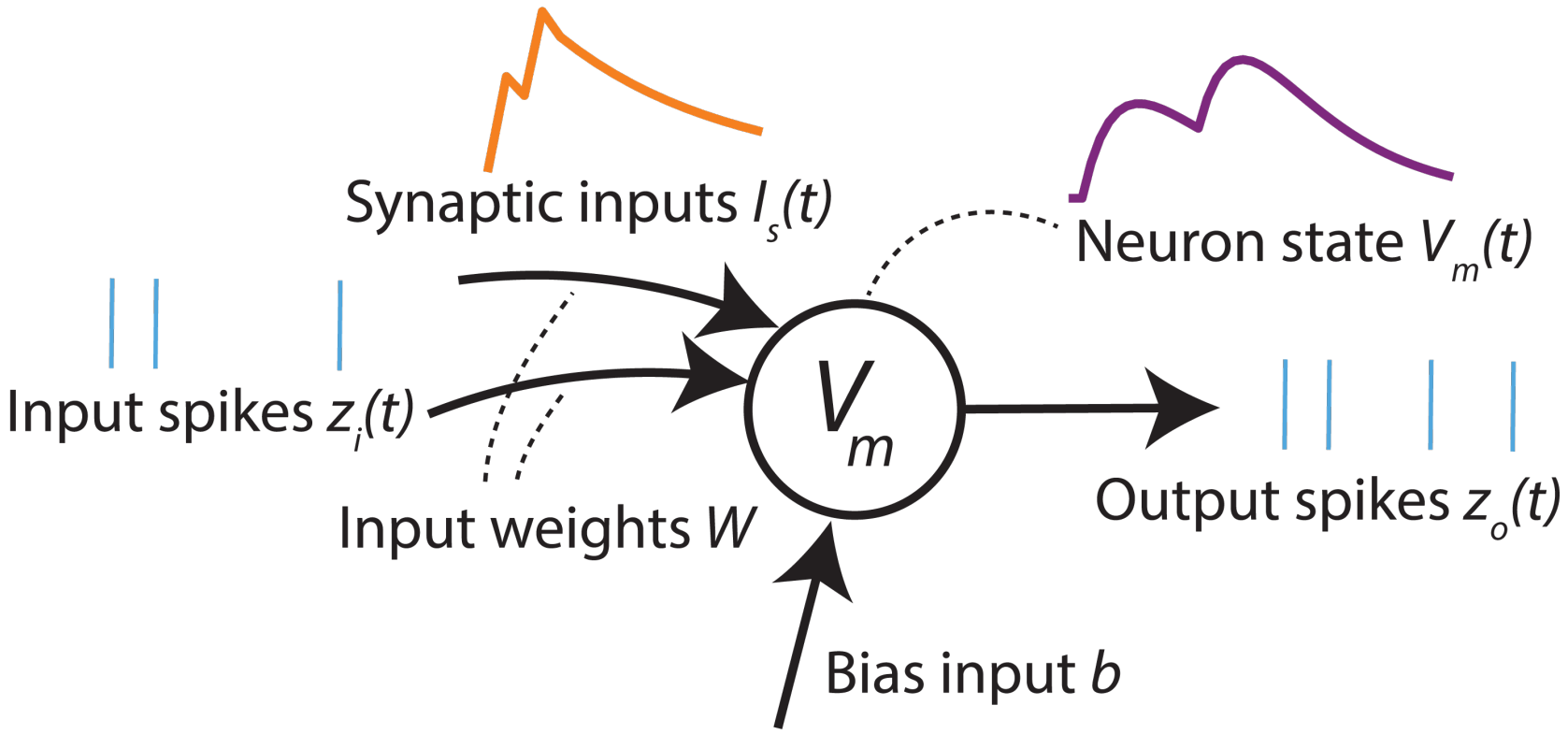
Spiking Neuron

$$z_o(t) = \Theta\left[V_m(t)\right]$$



Spiking Neuron

$$z_o(t) = \Theta\left[V_m(t)\right]$$



Spiking Neuron — “Leaky integrate and fire”

Neuron internal state (“Membrane potential”)

$$\tau_m \cdot dV_m/dt + V_m(t) = I_s(t) + b$$

Synaptic state (“Synaptic current”)

$$\tau_s \cdot dI_s/dt + I_s(t) = \sum_i w_i \cdot \sum_j \delta(t - t_j^i)$$

Output spikes

$$z_o(t) = \Theta(V_m(t)) = H(V_m(t) - V_{th})$$

$$V_m(t) = V_m(t) - z_o(t)$$