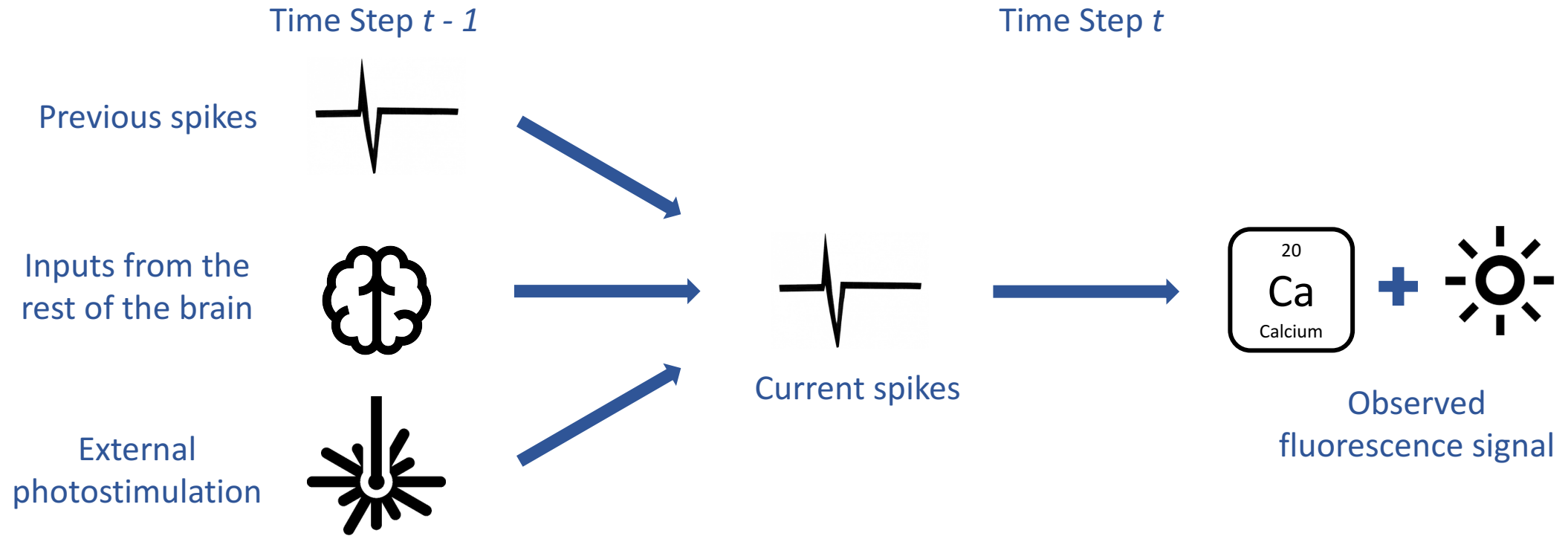


Broad Overview of Generative Model

Part 1: Generate spikes at
time step t

Part 2: Generate calcium
fluorescence signals from the spikes



Key Equations

Generative Model

$$P(f(t)) = N(f(t); r(t), \Sigma^f)$$

Fluorescence
signals at time t

Reconstruction with
Gaussian noise

Learned, diagonal
covariance matrix

Reconstruction

$$r(t) = W^{re}e(t) + A \sum_{t'=0}^t \underbrace{k(t-t')}_{\text{Convolution kernel (cell-specific)}} \odot \underbrace{s(t')}_{\text{Spikes}} + \underbrace{b^r}_{\text{Additive offset}}$$

Optogenetic stimulation

Diagonal scaling matrix

Convolution Kernel (unique to each cell)

$$k_c(t) = e^{-t/\tau_c^{decay}} - e^{-t/\tau_c^{rise}}$$

Spiking Depends on the Input

$$P(s(t)|u(t)) = \text{Bernoulli}(s(t); \sigma(u(t)))$$

Input

$$u(t) = \underbrace{W^{se}}_{\text{Weighted matrices}} e(t) + W^{ss} \sum_{t'=t-4}^{t-1} \underbrace{k^s(t-t')}_{\text{Normalized, exponentially decaying kernel}} s(t') + \underbrace{W^{sl}}_{\text{Low-dimensional latents}} l(t) + \underbrace{b^s}_{\text{Learned offset}}$$

External photostimulation

Dynamical System Generates Low-Dimensional Input
Representing Activity in the Rest of the Brain

$$P(l(t)|l(t-1)) = N(l(t); W^{ll}l(t-1), \Sigma^l)$$