Poster M015

UNIVERSITY OF CAMBRIDGE

Active dendrites: adaptation to spike-based communication

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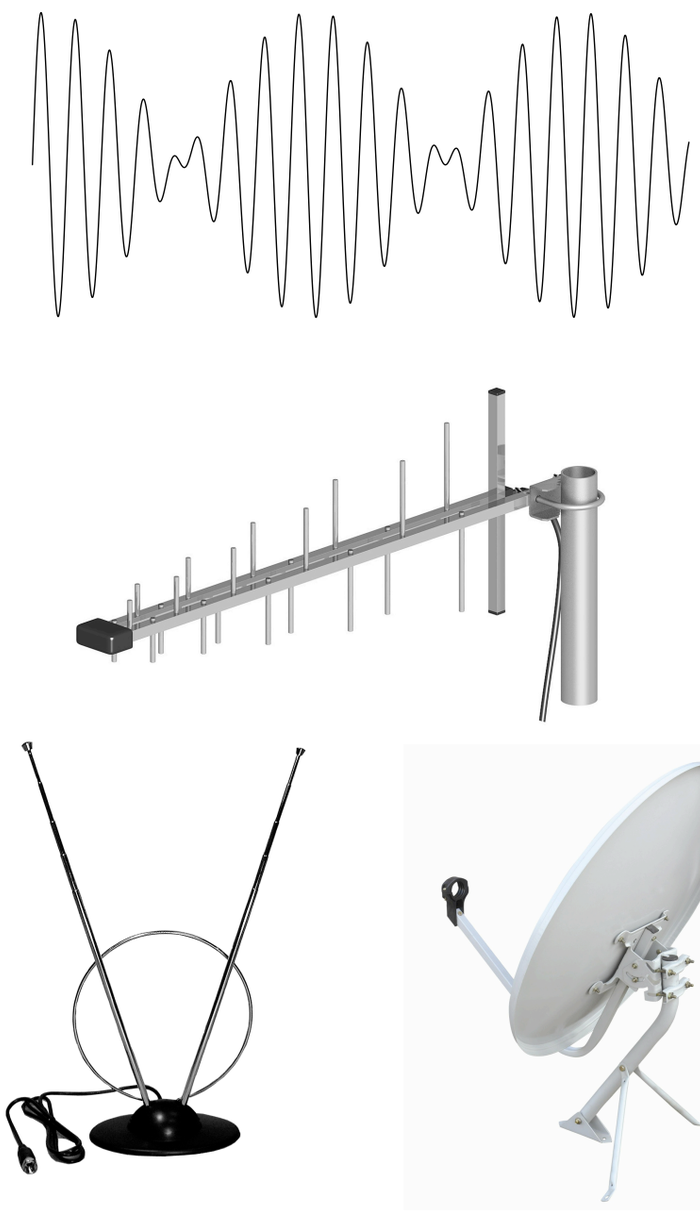
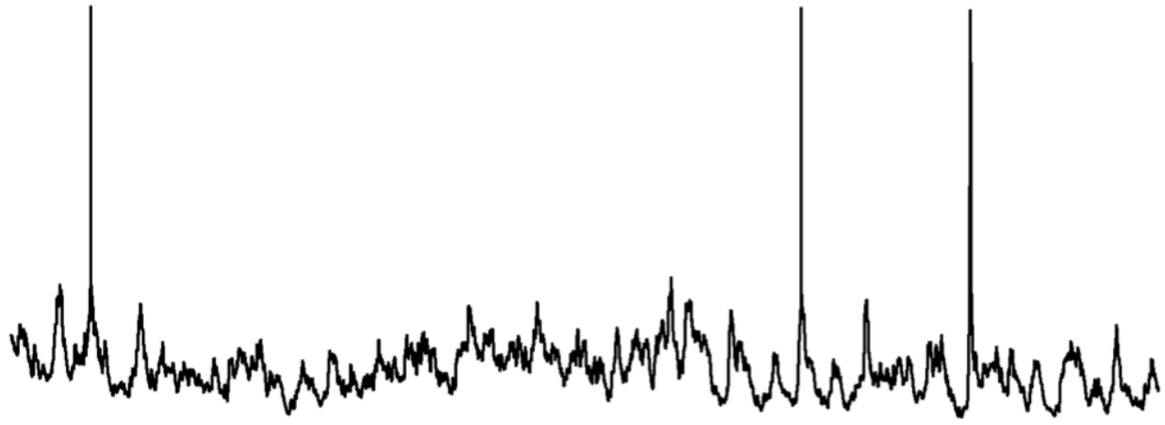
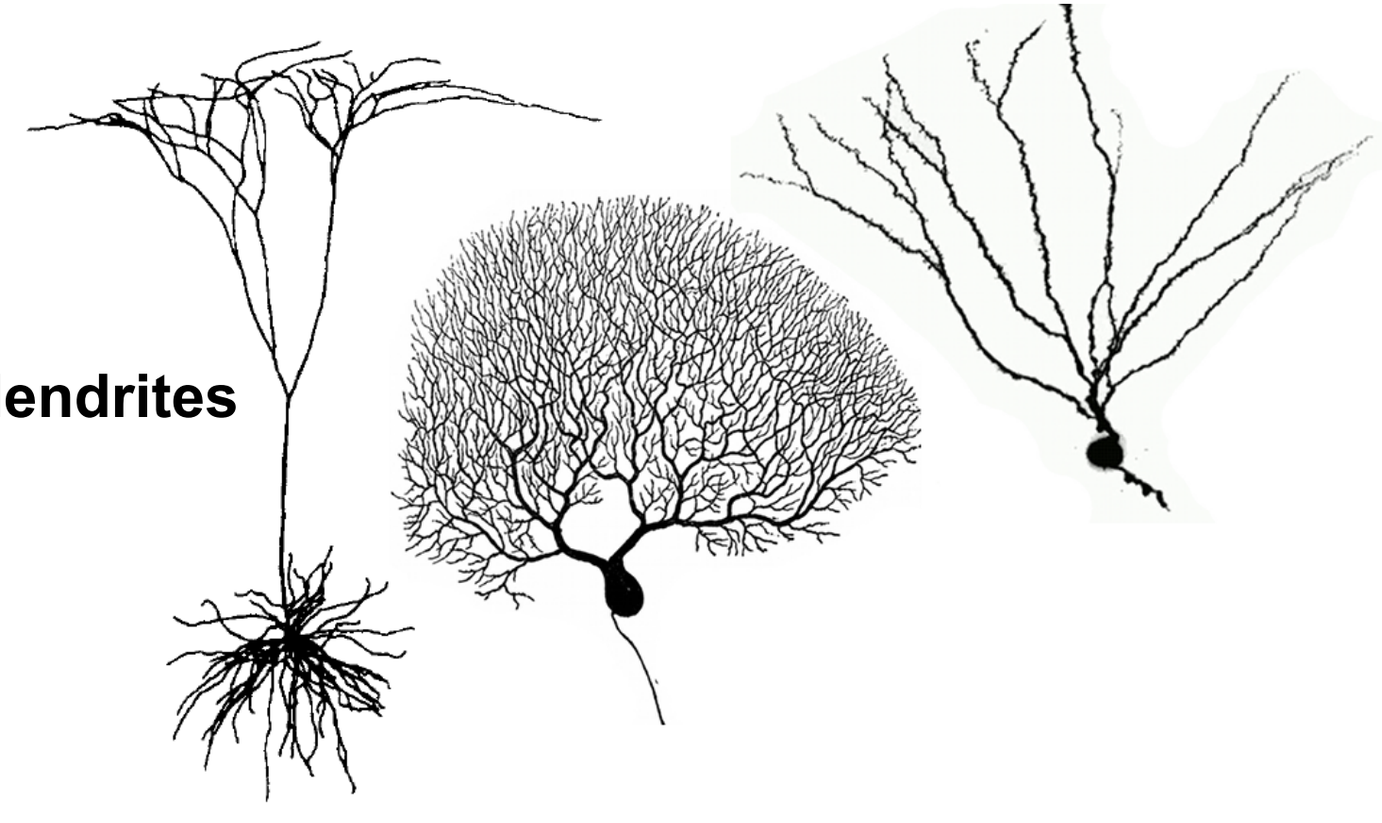


spikes



dendrites



evolution of neural models

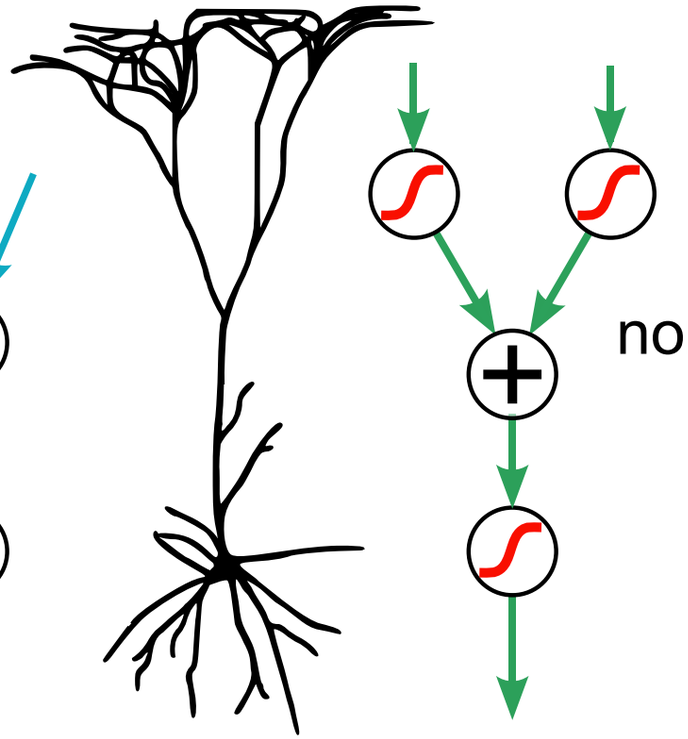
1980s

linear dendrite

$$\dot{v} = f\left(\sum_i w_i u_i\right)$$

dendrites are not considered ✗
spikes are not considered ✗

2000s



nonlinear dendrite

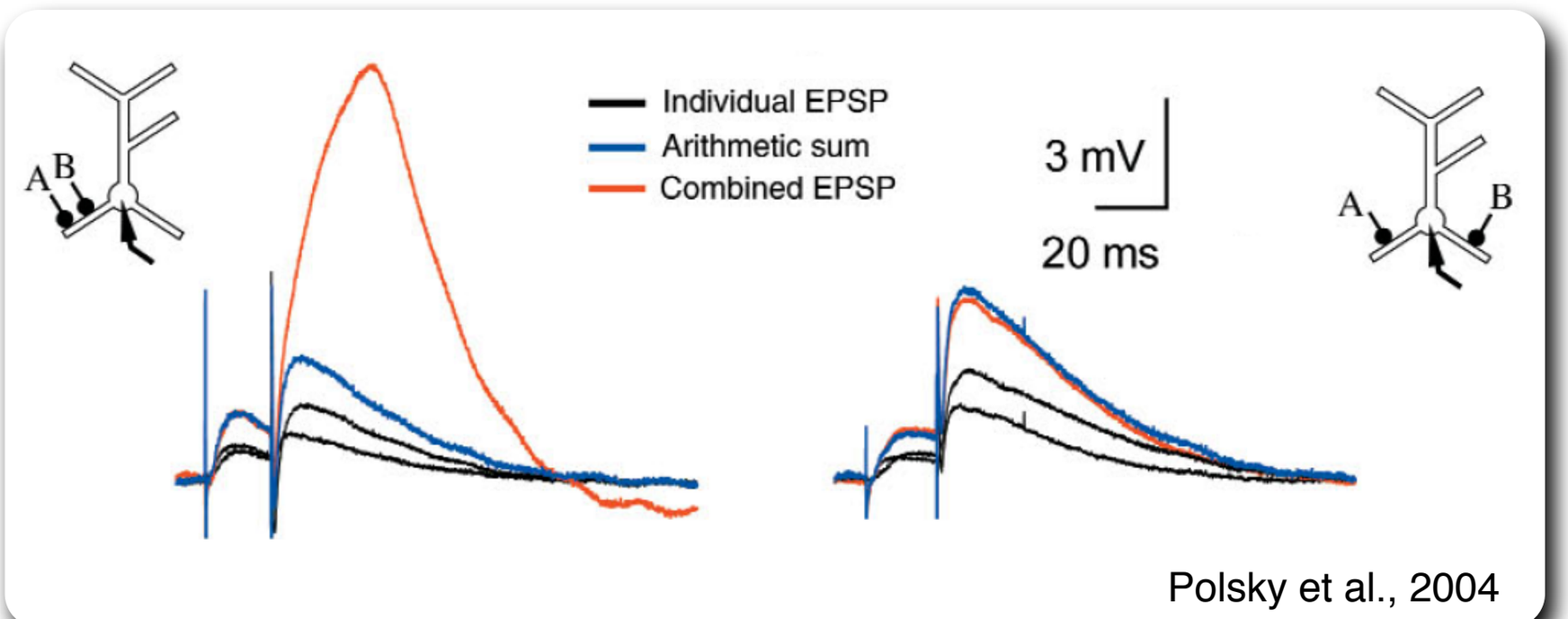
$$\dot{v} = f(\mathbf{u})$$

dendrites are considered ✓
spikes are not considered ✗

2010s

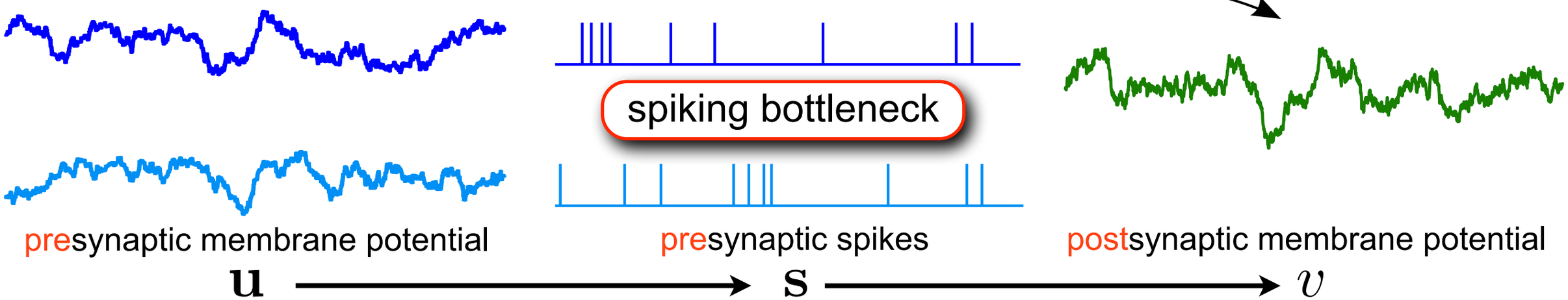
?

dendrites are considered ✓
spikes are considered ✓



Polsky et al., 2004

computation $\dot{v} = F(\mathbf{u})$



implementation

?

many local estimates

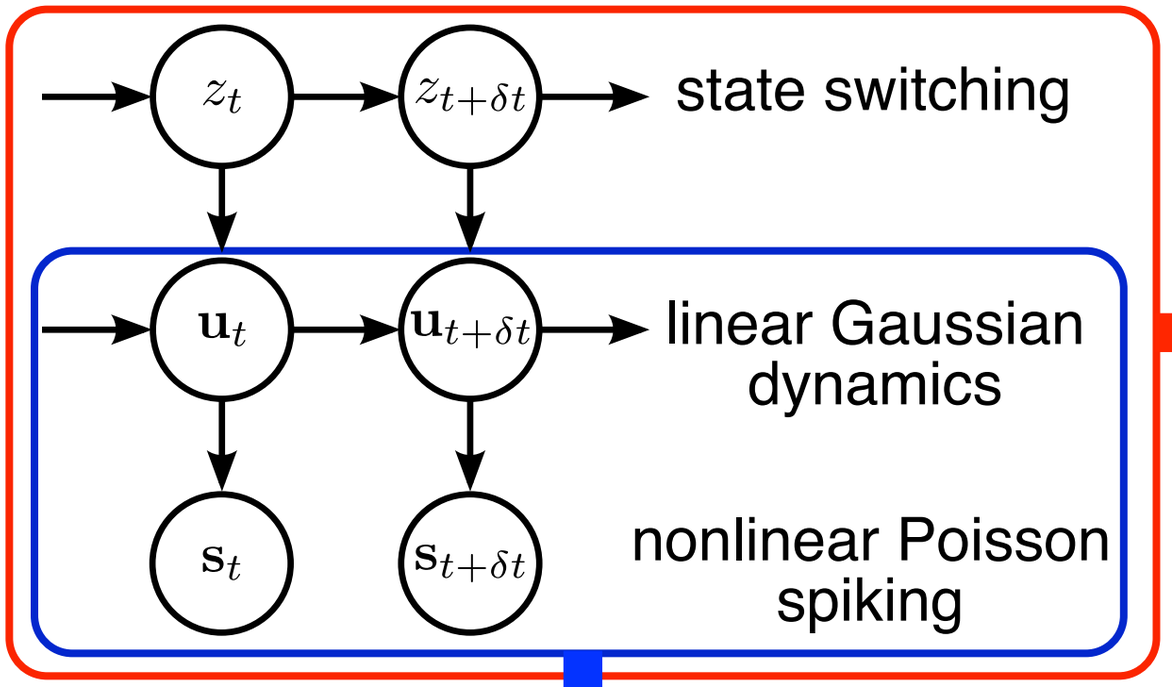
$$\dot{v} \simeq F\left(\left\{\int u_i \, \mathrm{P}(u_i|s_{i,0:t}) \, du_i\right\}\right)$$

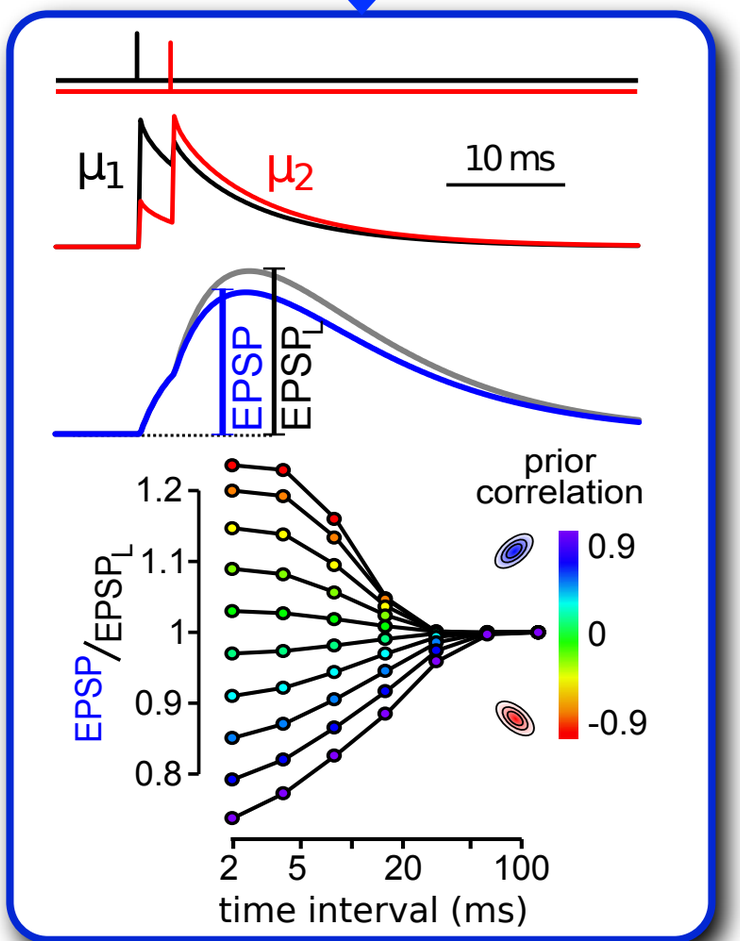
suboptimal if
- presynaptic cells are *correlated*
- $F(\mathbf{u})$ is nonlinear

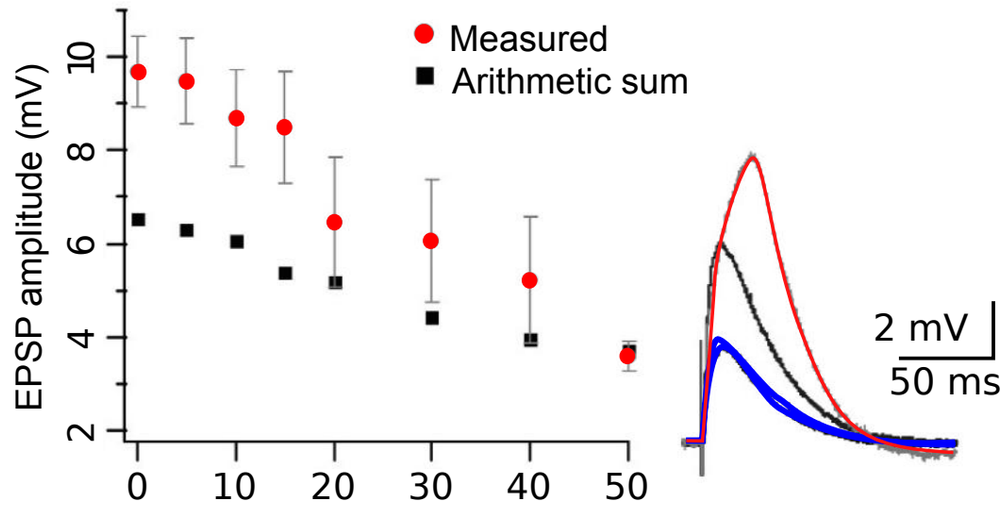
one global estimate

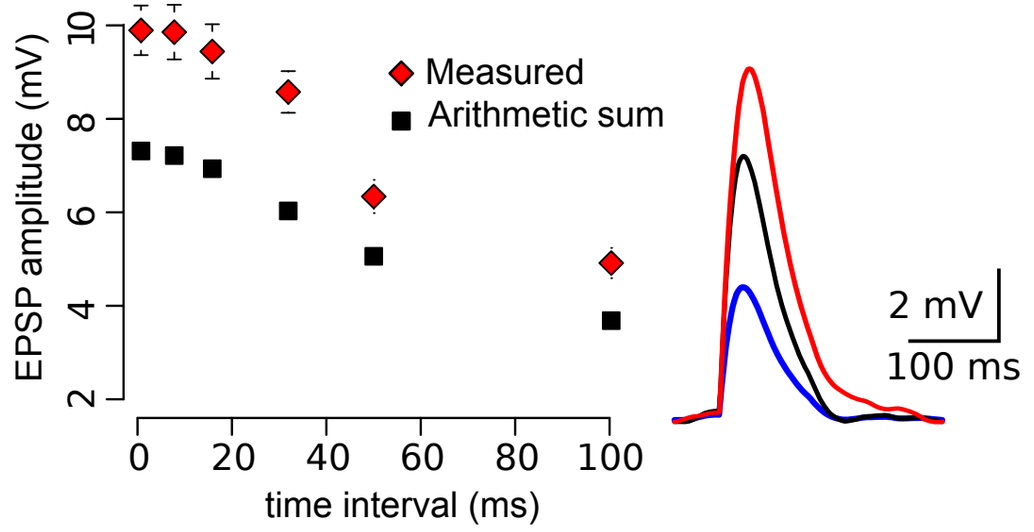
$$\dot{v} \simeq \int F(\mathbf{u}) \, \mathrm{P}(\mathbf{u}|\mathbf{s}_{0:t}) \, d\mathbf{u}$$

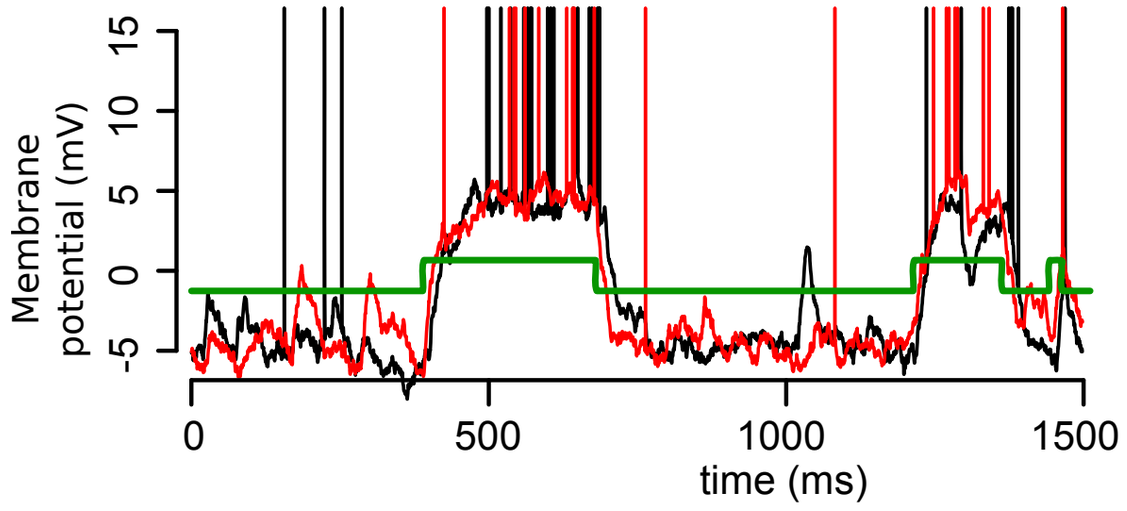
requires nonlinear implementation
- if cells are correlated
- even if $F(\mathbf{u})$ is linear


z_t
$z_{t+\delta t}$
state switching
$\mathbf{u}_t$
$\mathbf{u}_{t+\delta t}$
linear Gaussian dynamics
$\mathbf{s}_t$
$\mathbf{s}_{t+\delta t}$
nonlinear Poisson spiking


μ_1
μ_2
10 ms
EPSP
$EPSP_L$
prior correlation
0.9
0
-0.9
$EPSP/EPSP_L$
1.2
1.1
1
0.9
0.8
2
5
20
100
time interval (ms)


Measured
Arithmetic sum
EPSP amplitude (mV)
2
4
6
8
10
0
10
20
30
40
50
2 mV
50 ms


Measured
Arithmetic sum
EPSP amplitude (mV)
2
4
6
8
10
0
20
40
60
80
100
time interval (ms)
2 mV
100 ms


Membrane potential (mV)
-5
0
5
10
15
0
500
1000
1500
time (ms)