Group 2: Problem and results

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Neapolitan proverb:
Dicette 'o pappecio vicino 'a noce: "damme 'o tiempo ca te spertosso"

rough translation:
The flea said to the walnut tree: "give me time, I drill you down!"
Our network(s)
Other Models

- 0

- 4

- 5

I_1 \rightarrow P_1 \rightarrow I_1

I_1 \rightarrow P_2 \rightarrow I_2

I_2 \rightarrow P_1 \rightarrow I_1

I_2 \rightarrow P_2 \rightarrow I_2

Thalamus
Izhikevich neurons

\[ v' = 0.04v^2 + 5v + 140 - u + I \]
\[ u' = a(bv - u) \]

If \( v = 30 \text{ mV} \),
then \( v - c, \quad u - u + d \)
Coupled I neurons only: The Sashi implementation

Voltage (mV)

Low frequency: antiphase

Time (mS)
Coupled I neurons only: The Sashi implementation

High frequency: in phase (synchronous)
Coupled I neurons only: The Sashi implementation

 Begins in-phase goes to antiphase
Coupled I neurons only: The Hermann Implementation

Blue $I_1$
Red $I_2$

Increased drive at 1000, decreased at 1200
To do

- Implement with output of each I to each P
- Implement with only one I with output to both Ps
- Implement synapse with stochastic failure, not simply noisy exponential decay (Brent)
Stochastic synapse model of Lu & Trussell, 2000, Neuron (sans Ca\(^{2+}\))

- Two populations of vesicles: Full and Empty
- Total = \(N = 150\)
- Update \(N_i\) re \(N_{i-1}\) as
  \[
  N_i = N \cdot [N \cdot (1 - P_{f(i-1)}) N_{i-1}] e^{-\frac{t}{\tau_{\text{rec}}}} \quad i=1,2,3,...
  \]
- Number of quanta released from a binomial with probability of success = \(P_{f(i)}\).
- Quantal release has current input effect of
  \[
  I = I_Q \cdot e^{\frac{-t}{\tau_Q}}
  \]
Tsodyks et al 2000 synapse model modified

\[
\frac{dx(t)}{dt} = \frac{z(t)}{\tau_r} - ux(t) \quad \text{(x is recovered)}
\]

\[
\frac{dy(t)}{dt} = -\frac{y(t)}{\tau_p} + ux(t) \quad \text{(y is active)}
\]

\[
\frac{dz(t)}{dt} = \frac{y(t)}{\tau_p} - \frac{z(t)}{\tau_r} \quad \text{(z is inactive)}
\]

take \quad ux(t) \sim \text{Poisson as } n \to \infty??
Stochastic synapse: Hermann Implementation

- Two vesicle site states: Active ($F_t$) and Inactive ($E_t$)
- $N_{tot} = F_t + E_t$
- Number of vesicles released
  $$N_{rt} = \text{binomial} \ (p_r, F_t)$$
- $IPSC_t = Ae^{-t/\tau_1} - Be^{-t/\tau_2}$
- $F_t = F_{t-1} + \text{binomial} \ (p_{rec}, E_t)$

$$p_r = \frac{C}{1 + e^{-\left(\frac{V-V_h}{k}\right)}}$$
$$C = 0.05$$
$$A = f(N_r)$$
$$B = g(N_r)$$
Stochastic synapses: Hermann Implementation

I=4, $p_{\text{rec}}=0.0005$, $\Delta t=0.05$ ms

I=7, $p_{\text{rec}}=0.0005$, $\Delta t=0.05$ ms
Stochastic synapses: Hermann Implementation

$I=10$, $p_{\text{rec}}=0.0005$, $\Delta t=0.05$ ms
Stochastic synapses: Hermann Implementation

I=10, p_{rec}=0.0005, \Delta t=0.05 \text{ ms}
Stochastic synapses: Sashi Implementation
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Hermann: l=4, pool = 5
I=4, pool = 20
l=4, pool=100
I=7, pool=5
I=7, pool=20
$l=7$, pool=40