Description of the code for simulating gamma oscillations

The code is driven by the script in `gamma_simulator.m`. To run the program, go to the directory containing `gamma_simulator.m` on your computer, and type `gamma_simulator` at the Matlab prompt.

Input parameters are defined in `params.m`, which is the only file that a user will likely want to modify. Six sample files `params.m`, corresponding to the six panels of Figure 1, can be found in the directory EXAMPLES. The version of `params.m` that you want to use must be placed in the directory containing `gamma_simulator.m`.

A Matlab script `generate_Figure_1.m` that generates the entire Figure 1 is also included.

List of parameters defined in params.m:

- `num_e` and `num_i` are the numbers of pyramidal cells (E-cells) and basket cells (I-cells), respectively (N_E and N_I in Appendix 2).
- `p_ee`, `p_ei`, `p_ie`, and `p_ii` are parameters defining the density of synaptic connectivity (p_{EE}, p_{EI}, p_{IE}, and p_{II} in Appendix 2).
- `tau_r_e`, `tau_d_e`, `tau_r_i`, and `tau_d_i` are the rise and decay time constants (τ_R and τ_D in the notation of Appendix 1) of excitatory and inhibitory synapses, respectively, measured in ms. These constants are allowed to depend on the presynaptic neuron; therefore `tau_r_e` and `tau_d_e` are vectors of length `num_e`, and similarly `tau_r_i` and `tau_d_i` are vectors of length `num_i`.
- `v_rev_e`, `v_rev_i` are the reversal potentials (V_{rev} in Appendix 1) of excitatory and inhibitory synapses, respectively, measured in mV.
- The simulated time interval is $[0, \texttt{t\_final}]$.
- The differential equations are solved using the midpoint method with time step `dt` (Δt in Appendix 2).
- `g_hat_ie` is the expected value of the total inhibitory synaptic conductance affecting each E-cell ($\hat{g}_{IE}$ in the notation of Appendix 2). `g_hat_ei`, `g_hat_ii`, and `g_hat_ee` are defined similarly ($\hat{g}_{EI}$, $\hat{g}_{II}$, and $\hat{g}_{EE}$ in Appendix 2).
- `I_e` and `I_i` are deterministic external drives to the E- and I-cells, respectively (I_E and I_I in Appendix 2). These are functions of time `t`, and they are vectors of lengths `num_e` and `num_i`; thus heterogeneity in deterministic external drives is allowed.

- In addition to the deterministic external drives `I_e` and `I_i`, each cell also receives stochastic external excitatory synaptic drive of the form

$$-s(t)v \times \begin{cases} \texttt{g\_stoch\_e} & \text{for E-cells,} \\ \texttt{g\_stoch\_i} & \text{for I-cells.} \end{cases}$$

  Here `g_stoch_e` and `g_stoch_i` are the maximal conductances associated with the stochastic synaptic input (g_{stoch} in Appendix 2), and the gating variable $s(t)$ decays exponentially with time constant `tau_d_stoch_e` for the E-cells and `tau_d_stoch_i` for the I-cells ($\tau_{D,stoch}$ in Appendix 2) during each time step. At the end of each time step, s jumps to 1 with probability

$$\texttt{dt}/1000 \times \begin{cases} \texttt{f\_stoch\_e} & \text{for E-cells,} \\ \texttt{f\_stoch\_i} & \text{for I-cells.} \end{cases}$$

  This simulates the arrival of external synaptic input pulses. The expected number of input pulses per second is `f_stoch_e` for E-cells, and `f_stoch_i` for I-cells (f_{stoch} in Appendix 2). Different cells receive independent stochastic input.