NeuroField

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Abstract

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1. Introduction

Motivation behind neural field theory: large-scale neural dynamics.

$$
\begin{aligned}
D_{ab}V_{ab}(\mathbf{r},t) &= \nu_{ab}\phi_{ab}(\mathbf{r},t),\\
Q_a(\mathbf{r},t) &= S_a\big[\sum_b V_{ab}(\mathbf{r},t)\big],\\
\mathcal{D}_{ab}\phi_{ab}(\mathbf{r},t) &= Q_b(\mathbf{r},t-\tau_{ab}).
\end{aligned}
$$

NeuroField: a general code to solve the neural field theory by allowing users to:

1. Specify an arbitrary number of populations and connections between populations;
2. Specify the parameters for any objects, including populations, dendritic responses, firing responses, propagators, synapses, and stimulus pattern.
3. Choose alternative wave propagation types, i.e. choose different forms of $\mathcal{D}_{ab}$;
4. Uses plastic synapses, i.e. $\nu_{ab} = \nu_{ab}(\mathbf{r},t)$.
5. Use different firing responses, i.e. change S_a.

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2. Method and Results

NeuroField solves each equation within the Robinson et al. model with an object:

$$P = \nu_{ab}\phi_{ab}, \qquad \texttt{Couple}$$

$$D_{ab}V_{ab} = P, \qquad \texttt{Dendrite}$$

$$Q_a = S_a\big[\sum_b V_{ab}\big], \qquad \texttt{QResponse}$$

$$\mathcal{D}_{ab}\phi_{ab} = Q_b, \qquad \texttt{Propag}$$

with an arbitrary number of these objects, with each object may be a different type (e.g. constant synaptic coupling vs plastic synaptic coupling), and all parameter values may be tailored.

- Populations, can have as many as required, different customizable firing responses, bursting. Stimulus populations, different noise processes, pulsed stimulus, TMS
- Propagators, wave propagator, spherical geometry
- Couples, incorporate different types of plasticity
- MATLAB helper scripts for visualization, power spectrum calculation, processing

Examples for single excitatory population, cortical population, corticothalamic model. Each example has a population diagram, and related results. All examples should preferably be published result?

- Plasticity results (Felix)
- Corticothalamic model, compare analytic and neurofield result (Romesh)
- Bursting populations (XL)
- Seizures (XL, Romesh)

3. Discussion

Overview of any tricky issues with the problem being solved (for example, the EEGLAB code paper mentions limitations of time/frequency decomposition). Discuss limitations or qualifiers on the usage of the code.

- Discussion regarding spatial components, grid size, noise amplitude with regard to approximations
- CFL condition, automatically checked for. Also limitations on Δx depending on r_e
- Incorporating volume conduction

4. Acknowledgements

To add.

5. References