



HAL
open science

Two-dimensional patterns in neural fields subject to finite transmission speed

Eric Nichols, Kevin Green, Axel Hutt, Lennaert van Veen

► **To cite this version:**

Eric Nichols, Kevin Green, Axel Hutt, Lennaert van Veen. Two-dimensional patterns in neural fields subject to finite transmission speed. Twenty Third Annual Computational Neuroscience Meeting, Jul 2014, Quebec City, Canada. BMC Neuroscience, 15, pp.16, 2014, 10.1186/1471-2202-15-S1-P16 . hal-01064153

HAL Id: hal-01064153

<https://inria.hal.science/hal-01064153>

Submitted on 15 Sep 2014

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

POSTER PRESENTATION

Open Access

Two-dimensional patterns in neural fields subject to finite transmission speed

Eric Nichols^{1*}, Kevin Green^{1,2}, Axel Hutt¹, Lennaert van Veen²

From The Twenty Third Annual Computational Neuroscience Meeting: CNS*2014
Québec City, Canada. 26-31 July 2014

This work analyzes and implements finite axonal transmission speeds in two-dimensional neural populations. The biological significance of this is found in the rate of spatiotemporal change in voltage across neuronal tissue, which can be attributed to phenomena such as delays in spike propagation within axons, neurotransmitter activation and the time courses of neuron polarization and refraction. The authors build upon the finite transmission speed work in [1].

Linear analysis about a spatially homogeneous resting state of the neural population dynamics is performed. The analyses of the resulting analytical expressions guide the parameter selection for simulations. For simulation, computation of the transmission-delayed convolution between the kernel and firing rates is performed with a fast Fourier transform as in [1].

The Neural Field Simulator [2] is used to simulate the activity of the field. We extended the simulator by the implementation of a large class of kernels reflecting

global excitation, global inhibition, local excitation-lateral inhibition and local inhibition-lateral excitation. Moreover, we extended the tools by an automatic root finder to compute stationary states and an automatic root finder of the characteristic equation of the linear dynamics. These latter features facilitate the user to perform the linear analysis. Further adjustments to the simulator include a provision to modify neural field variables online while simulations are ongoing and three-dimensional displays of disparate parts of the neural field, such as the external input, kernel and firing rate.

We find Turing patterns appear when starting the simulations with the derived conditions for stationary instability. This is shown in Figure 1(A,B,C). Simulations with travelling wave patterns are also performed using parameter sets for the non-stationary instabilities, and the effects of finite transmission speeds are analyzed and visualized. The software tool provides a large set of analysis and visualization tools, that promises to speed up

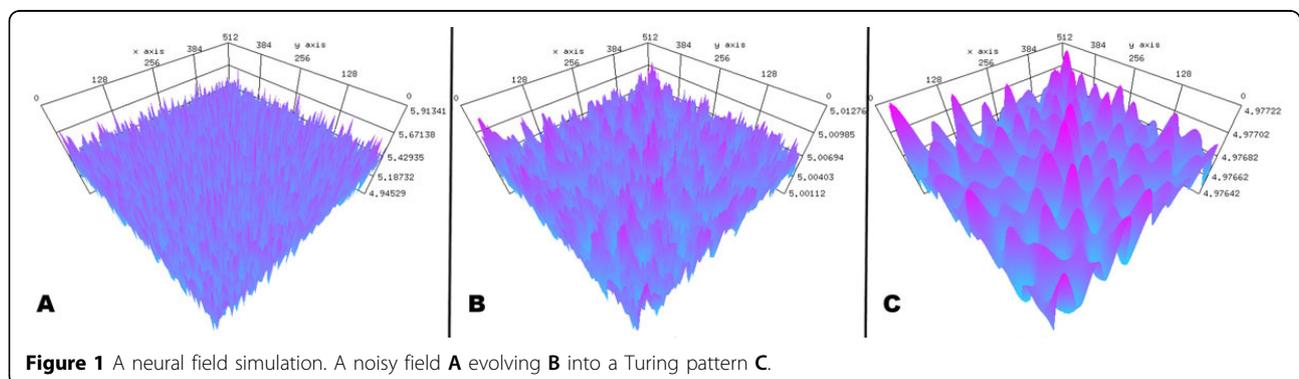


Figure 1 A neural field simulation. A noisy field **A** evolving **B** into a Turing pattern **C**.

* Correspondence: eric.nichols@inria.fr

¹INRIA Nancy, Team NeuroSys, 615 rue du Jardin Botanique, 54600 Villers-lès-Nancy, France

Full list of author information is available at the end of the article

the analysis of two-dimensional neural field dynamics and hence accelerates research on neural population dynamics.

Acknowledgements

This work is funded by the European Research Council for support under the European Union's Seventh Framework Programme (FP7/2007-2013), ERC grant agreement No. 257253 (MATHANA project).

Authors' details

¹INRIA Nancy, Team NeuroSys, 615 rue du Jardin Botanique, 54600 Villers-lès-Nancy, France. ²Faculty of Science, University of Ontario Institute of Technology, 2000 Simcoe Street North, Oshawa, L1H 7K4 Ontario, Canada.

Published: 21 July 2014

References

1. Hutt A, Rougier N: **Activity spread and breathers induced by finite transmission speeds in two-dimensional neural fields.** *Physical Review E: Statistical, Nonlinear, and Soft Matter Physics* 2010, **82**(5):R055701.
2. Nichols EJ, Hutt A: **Neural field simulator: fast computation and 3D-visualization.** *Twenty Second Annual Computational Neuroscience Meeting, Paris, France* 2013, **14**:179.

doi:10.1186/1471-2202-15-S1-P16

Cite this article as: Nichols *et al.*: Two-dimensional patterns in neural fields subject to finite transmission speed. *BMC Neuroscience* 2014 **15**(Suppl 1):P16.

Submit your next manuscript to BioMed Central and take full advantage of:

- Convenient online submission
- Thorough peer review
- No space constraints or color figure charges
- Immediate publication on acceptance
- Inclusion in PubMed, CAS, Scopus and Google Scholar
- Research which is freely available for redistribution

Submit your manuscript at
www.biomedcentral.com/submit

