



Revisiting time discretisation of spiking network models

Bruno Cessac, Thierry Viéville

► **To cite this version:**

Bruno Cessac, Thierry Viéville. Revisiting time discretisation of spiking network models. BMC Neuroscience, BioMed Central, 2007, 8 (Suppl 2), pp.P76. <hal-00784465>

HAL Id: hal-00784465

<https://hal.inria.fr/hal-00784465>

Submitted on 4 Feb 2013

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

Revisiting time discretisation of spiking network models

Bruno Cessac² and Thierry Viéville*¹

Address: ¹Odyssee Lab, INRIA, Sophia, France and ²INLN, Univ. of Nice-Sophia-Antipolis, France

Email: Bruno Cessac - Bruno.Cessac@sophia.inria.fr

* Corresponding author

from Sixteenth Annual Computational Neuroscience Meeting: CNS*2007
Toronto, Canada. 7–12 July 2007

Published: 6 July 2007

BMC Neuroscience 2007, **8**(Suppl 2):P76 doi:10.1186/1471-2202-8-S2-P76

© 2007 Cessac and Viéville; licensee BioMed Central Ltd.

A link is built between a biologically plausible generalized integrate and fire (GIF) neuron model with conductance-based dynamics [1] and a discrete time neural network model with spiking neurons [2], for which rigorous results on the spontaneous dynamics has been obtained. More precisely the following has been shown.

i) Occurrence of periodic orbits is the generic regime of activity, with a bounded period in the presence of spike-time dependence plasticity, and arbitrary large periods at the edge of chaos (such regime is indistinguishable from

chaos in numerical experiments, explaining what is obtained in [2]),

ii) the dynamics of membrane potential has a one to one correspondence with sequences of spikes patterns ("raster plots").

This allows a better insight into the possible neural coding in such a network and provides a deep understanding, at the network level, of the system behavior. Moreover, though the dynamics is generically periodic, it has a weak form of initial conditions sensitivity due to the presence



Figure 1

A view of the numerical experiments software platform raster-plot output, considering either a generic fully connected network or, here, a retinotopic network related to visual functions (top-left: 2D instantaneous spiking activity).

of the sharp spiking threshold [3]. A step further, constructive conditions are derived, allowing to properly implement visual functions on such networks [4].

The time discretisation has been carefully conducted avoiding usual bias induced by e.g. Euler methods and taking into account a rather complex GIF model for which the usual arbitrary discontinuities are discussed in detail. The effects of the discretisation approximation have been analytically and experimentally analyzed, in detail.

Acknowledgements

This work was partially supported by the EC IP project FP6-015879, FAC-ETS.

References

1. Rudolph M, Destexhe A: **Analytical integrate and fire neuron models with conductance-based dynamics for event driven simulation strategies.** *Neural Computation* 2006, **18**:2146-2210.
2. Soula H, Beslon G, Mazet O: **Spontaneous dynamics of asymmetric random recurrent spiking neural networks.** *Neural Computation* 2006, **18**(1):
3. Cessac B: **A discrete time neural network model with spiking neurons. i. rigorous results on the spontaneous dynamics.** [A PRECISER] in press.
4. Viéville T, Kornprobst P: **Modeling cortical maps with feed-backs.** *Int Joint Conf on Neural Networks* 2006.

Publish with **BioMed Central** and every scientist can read your work free of charge

"BioMed Central will be the most significant development for disseminating the results of biomedical research in our lifetime."

Sir Paul Nurse, Cancer Research UK

Your research papers will be:

- available free of charge to the entire biomedical community
- peer reviewed and published immediately upon acceptance
- cited in PubMed and archived on PubMed Central
- yours — you keep the copyright

Submit your manuscript here:
http://www.biomedcentral.com/info/publishing_adv.asp

