Activity simulations in random networks subject to neurodegradation

Sylvain Casteilla[1], Samuel Bottani[1]

[1] Laboratoire Matières et Systèmes Complexes UMR CNRS 7057, Université de Paris

Email: samuel.bottani@u-paris.fr

- In Neuroscience, in vitro cultures of neurons play a particular role; they provide systems where neurons can be reproducibly stimulated, with controlled parameters. These setups make it possible, by reducing the complexity of the system, to investigate the properties of a neuronal network and how computation may occur in these structures. In our case, we study the activity of a neuronal network in culture under the attack of a neurodegenerative process which progressively destroys links or nodes.

- Theoretical deductions from experiments and simulations show complex spiking avalanches and large scale activity bursts [1]. Additionally, the activity of the network can exhibit phase transitions from an asynchronous state to one displaying synchronous bursting, which is connected to the topological features of the network.

- We simulate using NEST the evolution of the activity in random networks of adaptative integrate and fire neurons while the network is progressively degraded. We considered two different strategies to perform the simulations over attacked networks.

- In the first approach, a new simulation is restarted for each network modification. In the second strategy, the NEST disconnect function is used to modify the network while the simulation of activity is running. Additionally, modifications of the network are made with different strategies as: a uniform random removal of the neurons, a selective targeted removal depending on their out- or in-degree, or a specific targeting of nodes identified among initiators of synchronous bursting states.

- We monitor different properties for the same topological neuronal network modified with these two approaches, and observe that the post transitory state of the network dynamics is only topology-dependent.

Acknowledgements

We would like to thank Tanguy Fardet, and Stephane Metens for their helpful discussions .

References

1. Tanguy Fardet, Mathieu Ballandras, Samuel Bottani, Stéphane Métens and Pascal Monceau, Front. Neurosci. (Jan. 2018). *Understanding the Generation of Network Bursts by Adaptive Oscillatory Neurons.* doi: 10.3389/fnins.2018.00041 https://www.frontiersin.org/article...