Rodrigo Felipe de Oliveira **Pena**

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Education

USP(University of São Paulo) — *Ribeirão Preto, São Paulo, Brazil*

Ph.D. in Physics — *Feb. 2014 - Dec. 2018*

HUB(Humboldt Universität zu Berlin) — *Berlin, Germany*

Visiting Ph.D. student — *Sept. 2015 - Oct. 2016*

EPFL(École Polytechnique Fédérale de Lausanne) — *Lausanne,Switzerland*

Research Internship and exchange studies — *Mar. 2012 - Feb. 2013*

USP(University of São Paulo) — *Ribeirão Preto, São Paulo, Brazil*

B.S. in Medical Physics — *Mar. 2009 - Dez. 2013*

UNASP(University Center Adventist São Paulo) — *Hortolândia, São Paulo, Brazil*

Technical Education in Computer Science — *Feb. 2005 - Dez. 2007*

Scientific projects & collaborations

Post-Doctoral Research Associate (Supervised by Prof. Horacio G. Rotstein) — *Newark, New Jersey, USA*

New Jersey Institute of Technology — *2019 - PRESENT*

- Theoretical and computational research addressing neuronal mechanisms of generation of network resonance.
- Supported by the National Science Foundation grant DMS-1608077 (HGR).

Ph.D project (Supervised by Prof. Antonio C. Roque) — *Ribeirão Preto, São Paulo*

University of São Paulo — *2014 - 2018*

- Activity propagation in hierarchical and modular networks of spiking neurons.
- Supported by a FAPESP Ph.D. scholarship (grant 2013/25667-8).

Collaboration with the Laboratory of Electrophysiology at the School of Medicine of Ribeirão Preto, University of São Paulo (Dra. Alexandra Cunha and Dr. Ricardo Leão) — *Ribeirão Preto, São Paulo*

University of São Paulo — *2017 - PRESENT*

- Application of computational methods in electrophysiological recordings.

Ph.D exchange project (Supervised by Dr. Michael Zaks) — *Berlin, Germany*

Humboldt Universität zu Berlin — *2015 - 2016*

- Self-sustained activity in hierarchical and modular networks with synaptic noise.
- Supported by a FAPESP Research Internships Abroad (BEPE) fellowship (grant 2015/09916-3).

Ph.D exchange project (Supervised by Prof. Benjamin Lindner) — *Berlin, Germany*

Bernstein Center for Computational Neuroscience — *2015 - 2016*

- Determination of spike-train statistics with an iterative scheme.
- Research under the scope of the International Research Training Group (IRTG) 1740.

Research internship project (Supervised by Dr. Christian Gaumier) — *Lausanne, Switzerland*

École Polytechnique Fédérale de Lausanne — *2012 - 2013*

- Modeling diseases propagation using graph theory.
- Supported by the Science without Borders fellow (CNPq).

Undergraduate scientific project (Supervised by Prof. Antonio C. Roque) — *Ribeirão Preto, São Paulo*

University of São Paulo — *2010 - 2013*

- Self-sustained activity in cortical networks of spiking neurons.
- Supported by a FAPESP scholarship for undergraduate students (grant 2011/06806-1).

Undergraduate scientific project (Supervised by Prof. Lauro Wichert Ana) *Ribeirão Preto, São Paulo*

Clinics Hospital of Ribeirão Preto *2009 - 2010*

- Integration of different institutional databases: acquisition of medical-hospital equipment, confrontation and correction of inconsistencies, and search for clinical evidence for technical-scientific advice.
- Supported by a FAEPA scholarship.

Honors & Awards

2019	**Honorable Mention for Ph.D. Thesis due to its excellent quality,** Graduate Program in Physics Applied to Medicine and Biology (FAMB)	*São Paulo, Brazil*
2018	**Travel Award CNS*2018,** Conference Organization For Computational Neuroscience (2018)	*Seattle, US*
2018	**Best project presented award,** LASCON – Latin American School on Computational Neuroscience (2018)	*São Paulo, Brazil*
2014	**John Roderick Cameron award,** Best student graduating with honors in Medical Physics	*São Paulo, Brazil*
2014	**Second best presentation award,** GCARI-RP meeting	*São Paulo, Brazil*
2012	**Best presentation award,** Brazilian Conference in Medical Physics	*São Paulo, Brazil*
2012	**Science Without Borders,** Brazilian scholarship to pursue one year of studies in Switzerland	*Lausanne*

Publications

Peer reviewed journals

- Lima, V., **Pena, R.F.O.**, Shimoura, R.O., Kamiji, N.L, Ceballos, C.C., Higa, G.S.V., de Pasquale, R., Roque, A.C. (2021). Modeling and characterizing stochastic neurons based on in vitro voltage-dependent spike probability functions. *The European Physical Journal - Special Topics*, doi 10.1140/epjs/s11734-021-00160-7.
- Shimoura, R.O., **Pena, R.F.O.**, Lima, V., Kamiji, N.L., Girardi-Schappo, M., Roque A.C. (2021). Building a model of the brain: from detailed connectivity maps to network organization. *The European Physical Journal - Special Topics*, doi 10.1140/ep js/s11734-021-00152-7
- Ceballos, C.C., **Pena, R.F.O.**, Roque A.C. (2021). Impact of the activation rate of the hyperpolarization-activated current I_h on the neuronal membrane time constant and synaptic potential duration. *The European Physical Journal - Special Topics*, doi 10.1140/ep js/s11734-021-00176-z
- Shimoura, R.O., **Pena, R.F.O.**, Kamiji, N.L., Lima, V., Roque A.C., Models of neocortical neuronal networks and observed emergent phenomena. *Brazilian Journal of Education in Physics*., 43: e20200452. doi 10.1590/1806-9126-RBEF-2020-0452
- Lima, V., Dellajustina, F.F., Shimoura, R.O, Girardi-Schappo, M., Kamiji, N.L., **Pena, R.F.O.**, Roque, A.C. Granger causality in the frequency domain: derivation and applications. *Brazilian Journal of Education in Physics*, 42:e20200007. doi 10.1590/1806-9126-RBEF-2020-0007
- **Pena, R.F.O.**, Ceballos C.C., Deus, J.L., Roque, A.C., Garcia-Cairasco, N., Leão, R.M., Cunha A.O. (2020). Modeling hippocampal CA1 GABAergic synapses of audiogenic rats. *International Journal of Neural Systems*, 30:2050022. doi 10.1142/S0129065720500227
- **Pena, R.F.O.**, Lima., V., Shimoura, R.O., Novato, J.P., Roque, A.C. (2020). Optimal interplay between synaptic strengths and network structure enhances activity fluctuations and information propagation in hierarchical modular networks. *Brain Sciences*, 10:228. doi 10.3390/brainsci10040228
- **Pena, R.F.O.**, Lima., V., Ceballos, C.C., Shimoura, R.O., Rotstein, H.G., Roque, A.C. (2019). Asymmetrical voltage response in resonant neurons shaped by nonlinearities. *Chaos*, 29:103135. doi 10.1063/1.5110033
- Borges, F.S., Protachevicz, P.R., **Pena, R.F.O.**, Lameu, E.L., Higa, G.S.V., Kihara, A.H., Matias, F.S., Antonopoulos, C.G., de Pasquale, R., Roque, A.C., Iarosz, K.C., Ji, P., Batista, A.M. (2020). Low frequency self-sustained activity in balanced networks. *Physica A*, 537:122671. doi 10.1016/j.physa.2019.122671
- **Pena, R.F.O.**, Zaks, M., Roque, A.C. (2018). Spontaneous activity dynamics in random networks of spiking neurons with synaptic noise. *Journal of Computational Neuroscience*, 45:1–28. doi 10.1007/s10827-018-0688-6
- **Pena, R.F.O.**, Ceballos, C.C., Lima., V., Roque, A.C. (2018). Interplay of activation kinetics and the derivative conductance determines resonance properties of neurons. *Physical Review E*, 97:042408. doi 10.1103/PhysRevE.97.042408
- **Pena, R. F.O.**, Vellmer, S., Bernardi, D., Roque, A. C., and Lindner, B. (2018). Self-Consistent Scheme for Spike-Train Power Spectra in Heterogeneous Sparse Networks. *Frontiers in Computational Neuroscience*, 12:9. doi 10.3389/fncom.2018.00009
- Lima, V., **Pena, R.F.O.**, Ceballos, C.C., Shimoura, R.O., Roque, A.C. (2019). Information theory applications in neuroscience. *Brazilian Journal of Education in Physics*, 41:e20180197. doi 10.1590/1806-9126-rbef-2018-0197
- Cunha A.O., Ceballos C.C., Deus, J.L., **Pena, R.F.O.**, Oliveira, J.A.C., Roque, A.C., Garcia-Cairasco, N., Leão, R.M. (2018). Intrinsic and synaptic properties of hippocampal CA1 pyramidal neurons of the Wistar Audiogenic Rat (WAR) strain, a genetic model of epilepsy. *Scientific Reports*, 8:10412. doi 10.1038/s41598-018-28725-y
- Shimoura, R.O., Kamiji, N.L., **Pena, R.F.O.**, Cordeiro, V., Ceballos, C.C., Romaro, C., Roque, A.C. (2018). [Re] The cell-type specific cortical microcircuit: relating structure and activity in a full-scale spiking network model. *The ReScience Journal*, 4:785-806. doi 10.5281/zenodo.1243268
- Ceballos, C. C., **Pena, R. F.**, Roque, A. C., and Leão, R. M. (2018). Non-Decaying postsynaptics potentials and delayed spikes in hippocampal pyramidal neurons generated by a zero slope conductance created by the persistent Na^+ current. *Channels*, 12:81–88. doi 10.1080/19336950.2018.1433940
- Tomov, P., **Pena, R. F.**, Roque, A. C., and Zaks, M. A. (2016). Mechanisms of self-sustained oscillatory states in hierarchical modular networks with mixtures of electrophysiological cell types. *Frontiers in Computational Neuroscience*, 10:23. doi 10.3389/fncom.2016.00023
- Tomov, P., **Pena, R. F.**, Zaks, M. A., and Roque, A. C. (2014). Sustained oscillations, irregular firing, and chaotic dynamics in hierarchical modular networks with mixtures of electrophysiological cell types. *Frontiers in Computational Neuroscience*, 8:103. doi 10.3389/fncom.2014.00103

Manuscripts submitted or in preparation

- **Pena, R.F.O.**, Rotstein, H.G.R. Oscillations and variability in neuronal systems: the role of autonomous transient dynamics in the presence of fast deterministic fluctuations. **in review**. doi 10.1101/2021.06.14.448371
- **Pena, R.F.O.**, Rotstein, H.G.R. The voltage and spiking responses of subthreshold resonant neurons to structured and fluctuating inputs: resonance, loss of resonance and variability. **in review**. doi 10.1101/2021.06.14.448368
- Mondal, Y., **Pena, R.F.O.**, Rotstein, H.G.R. Temporal filters in response to presynaptic spike trains: Interplay of cellular, synaptic and short-term plasticity time scales. **in review**. doi 10.1101/2021.09.16.460719

Other Publications

- My Career in the Midst of a Pandemic: Overcoming the Limitations of COVID-19. *Journal of Stories in Science*. link
- The publication "Modeling hippocampal CA1 GABAergic synapses of audiogenic rats" was in covered by the media in many important national Brazilian newspapers including UOL VivaBem which is a web newspaper content and the fifth most visited website in Brazil (data from 2012). link
- **Pena, R.F.O.**, Lima., V., Ceballos, C.C., Shimoura, R.O., Roque, A.C. (2019). A new measure to evaluate subthreshold resonance in neurons. Book Chapter at *The Production of Knowledge in Biomedical Engineering*, doi 10.22533/at.ed.8281901069

Programming Languages & Environments

- Fluent in C/C++, Matlab, Python.
- Simulation tools for neuroscience including Brian, Brian2 and NEURON.
- Machine learning and Deep learning python packages such as scikit-lean and PyTorch.
- Experience with parallel programming (joblib and multiprocessing libraries for Python).
- Good experience with LaTeX and UNIX-based systems.

Teaching experience & organization of scientific events

Satellite workshop at the Bernstein Conference 2021 — *2021*

- Responsible for the organization and selection of speakers of the satellite workshop "Frequency-preference responses to external perturbations: from neurons to networks" at the Bernstein Conference 2021.

Satellite workshop at the Bernstein Conference 2018 — *2018*

- Responsible for the organization and selection of speakers of the satellite workshop "Resonance in neurons and neural networks: theoretical and experimental approaches" at the Bernstein Conference 2018.

Introduction to Computational Neuroscience — *2018*

- Responsible for a lecture in a 3 days Introduction to Computational Neuroscience course in the XLI Annual Meeting of the Brazilian Society for Neuroscience (SBNeC).

Numerical Methods for Differential Equations — *Autumn 2018*

- Teaching Assistant.

Tutorial course in Computational Neuroscience — *2018*

- Responsible for a 2 days hands-on Computational Neuroscience course Satellite of the XLI Annual Meeting of the Brazilian Society for Neuroscience (SBNeC).
- Course available at sisne.org/eventos/pcn2

Tutorial course in Computational Neuroscience — *2017*

- Responsible for a 2 days hands-on Computational Neuroscience course Satellite of the XL Annual Meeting of the Brazilian Society for Neuroscience (SBNeC).
- Course available at sisne.org/eventos/praticoneuro

Tutorial course in Computational Neuroscience — *2017*

- Responsible for a 5 days hands-on laboratory entitled "Neuro Mathematics" during the 4th Summer School on Intelligent signal processing for Frontier Research and Industry.

Physics II – Waves, Fluids and Thermodynamics — *Autumn 2017*

- Teaching Assistant.
- Helped prepare lecture material and answered student questions for office hours.

Computational Physics — *Spring 2015*

- Teaching Assistant.
- Helped prepare lecture material, graded students exercises, and answered student questions for office hours.

Biophysics II — *Spring 2011*

- Teaching Assistant.
- Answered student questions for office hours.

Physics I – Classical Mechanics — *Spring 2010*

- Teaching Assistant.
- Answered student questions for office hours.

Experience as a reviewer

- IEEE Access (reviewed 6 papers)
- Cognitive Neurodynamics (reviewed 2 papers)
- Entropy (reviewed 3 papers)
- Frontiers in Computational Neuroscience (reviewed 2 papers)
- Frontiers in Neural Circuits (reviewed 1 paper)
- Frontiers in Applied Mathematics and Statistics (reviewed 1 paper)
- Frontiers in Cellular Neuroscience (reviewed 1 paper)
- Applied Sciences (reviewed 1 paper)
- European Physical Journal - Special Topics (reviewed 1 paper)
- Review of Scientific Instruments (reviewed 1 paper)
- Chaos: An Interdisciplinary Journal of Nonlinear Science (reviewed 1 paper)
- Big Data and Cognitive Computing (reviewed 2 papers)
- Processes (reviewed 1 paper)

Selected abstracts & presentations

- **Pena, R.F.O.**, Revealing the Link between Spiking Cross-Correlation Patterns and the Underlying Subthreshold Neuronal Dynamics, Conference on Dynamical Systems at SIAM Society for Industrial and Applied Mathematics, 2021.
- **Pena, R.F.O.**, Rotstein, H.G., Modeling theta-band resonance in a neocortical circuit, NeuroMatch 2.0, 2020.
- **Pena, R.F.O.**, Rotstein, H.G., Biophysics and dynamics shape the cross-correlation properties of monosynaptic connections, 29th Annual Computational Neuroscience Meeting (CNS), 2020.
- Y. Mondal, **Pena, R.F.O.**, Rotstein, H.G., Synaptic short-term plasticity and temporal filters: interplay of synaptic and postsynaptic dynamics, 29th Annual Computational Neuroscience Meeting (CNS), 2020.
- **Pena, R.F.O.**, Rotstein, H.G., Modeling theta-band resonance in a neocortical circuit, 29th Annual Computational Neuroscience Meeting (CNS), 2020.
- **Pena, R.F.O.**, Chialva, U., Rotstein, H.G., Neuronal resonance may not be apparent, but still present, for realistic input signals using standard impedance measurements, 29th Annual Computational Neuroscience Meeting (CNS), 2020.
- **Pena, R.F.O.**, Revealing the Link between Spiking Cross-Correlation Patterns and the Underlying Subthreshold Neuronal Dynamics,Dynamics Days D 2020, 2020.
- **Pena, R.F.O.**, Emergence of activity fluctuations in cortical network models with heterogeneous neural populations, Biomathematics / Computational Biology Colloquium at Courant Department of Mathematics at New York University (NYU), 2019.
- **Pena, R.F.O.**, Roque, A.C., Zaks, M.A., Lifetime of self-sustained activity in random networks of two-dimensional integrate-and-fire neurons: role of input strength, Bernstein Conference, 2018. doi 10.12751/nncn.bc2018.0146
- **Pena, R.F.O.**, Zaks, M.A., Roque, A.C., Spontaneous activity patterns in networks of two-dimensional integrate and fire neurons with synaptic noise, Bernstein Conference, 2018. doi 10.12751/nncn.bc2018.0147
- **Pena, R.F.O.**, Lima, V., Celis, C.C., Roque, A.C., On the subthreshold resonance properties of neurons, 27th Annual Computational Neuroscience Meeting (CNS), 2018.
- **Pena, R.F.O.**, Bernardi D., Roque A.C., Lindner B., Determination of the spike-train power spectrum statistics in modular networks with mixtures of different excitatory and inhibitory populations, BMC Neuroscience (Online) doi 10.1186/s12868-017-0371-2, 2017.
- **Pena, R.F.**, Zaks, Michael A., Roque A.C., Noise-enhanced transition from synchronized to desynchronized states in a cortical network model, 2017, Washington. SfN 2017.
- **Pena, R.F.O.**, Bernardi, D., Roque A.C., Lindner, B., Self-consistency in the second-order correlation statistics: from network to a single-neuron scheme, PNLD 2016.
- **Pena, R.F.O.**, Tomov, P., Roque A.C., Zaks, M., Up-down states in a neural network model and their relation with the individual neurons, PNLD 2016.
- **Pena, R.F.O.**, Tomov, P., Roque A.C., Zaks, M.A., Mechanisms of oscillatory self-sustained activity in a cortical model. ICMNS 2016.
- **Pena, R.F.O.**, Tomov, P., Roque A.C., Zaks, M.A., Breakdown and resumption of oscillatory self-sustained activity in hierarchical modular networks, FENS 2016, Copenhagen.
- Shimoura, R.O., **Pena, R.F.O.**, Roque A.C., Effect of synaptic plasticity on functional connectivity and global activity of a neocortical network model. BMC Neuroscience (Online), doi 10.1186/1471-2202-16-S1-P210, 2015.
- **Pena, R.F.O.**, Shimoura, R.O., Roque A.C., A cortical multi-layered model and the properties of its internally-generated activity. BMC Neuroscience (Online), doi 10.1186/1471-2202-16-S1-P209, 2015.
- **Pena, R.F.O.**, Tomov, P., Zaks, M.A., Roque A.C., Self-sustained Activity Lifetime in a Cortical Network Model, 9th World Congress International Brain Research Organization, 2015.
- Petar, Tomov, **Rodrigo, Pena.**, Michael, Zaks, Antonio, Roque, Self-sustained activity in cortical network models. Frontiers in Neuroinformatics, doi 10.3389/conf.fninf.2014.18.00007, 2014.
- **Pena, Rodrigo F.O.**, Roque A.C., A bio-inspired computational model to study cortical dynamics, SBNeC anual meeting, 2014.
- Vieira, Diogo PC, **Pena, F.O.**, Roque, Antonio C., Self-sustained activity in neural networks: influence of network topology and cell types. BMC Neuroscience (Online), doi 10.1186/1471-2202-14-S1-P411, 2013.
- Vieira, D. P. C.,**Pena, R.F.O.**, Roque A.C., A study of spontaneous activity in modular neural networks made of neurons of different intrinsic dynamics, Dynamics Days Madrid, 2013.
- **Pena, R. F. O.**, Vieira, D. P. C., Roque A.C., Effect of topology and neuronal composition of a computational cortical model on self-sustained activity, SBNeC annual meeting, 2013.
- **Pena, R.F.O.**, Gaumier, C., Modeling diseases propagation using graph theory, Brazilian Conference in Medical Physics 2013.
- Tomov, P., Roque A.C., **Pena, R. F. O.**, Zaks, M., Modeling of self-sustained activity in neural networks, Dynamics Days BB, TU Berlin, 2013.