Giorgio Nicoletti

Contacts

Room 232, Quantitative Life Sciences
ICTP, Trieste, Italy
gnicolet@ictp.it
giorgionicoletti.github.io
giorgionicoletti

Skills

Programming

Advanced Knowledge

Python | Wolfram Mathematica

Basic Knowledge

C++ | Matlab | Julia | R | Bash

Tools

Latex | Powerpoint & MS Office | HTML | CSS | Inkscape

Languages

native: Italian

fluent: English

intermediate: French

beginner: German, Japanese

Research experience

International Center for Theoretical Physics — *Trieste, Italy*
Postdoctoral researcher — 2024 - present
Quantitative Life Sciences section, with prof. Antonio Celani

École Polytechnique Fédérale de Lausanne — *Lausanne, Switzerland*
Postdoctoral researcher — 2023 - 2024
Laboratory of Ecohydrology, with prof. Andrea Rinaldo

Tübingen University — *Tübingen, Germany*
Visiting Ph.D. student — Sept 2022 - Dec 2022
"Self-organization of neuronal networks" group, with prof. Anna Levina

Max Planck Institute for the Physics of Complex Systems — *Dresden, Germany*
Visiting Ph.D. student — June 2022 - July 2022
Division of Biological Physics, with Dr. Daniel M. Busiello

Education

Ph.D. in Physics *cum laude* — *University of Padova*
Thesis: *Information and Criticality in Complex Stochastic Systems* — 2019 - 2023
Supervisors: prof. Amos Maritan and prof. Samir Suweis

Master's Degree in Physics *cum laude* — *University of Padova*
Thesis: *Scaling and Renormalization Group for models of neural activity* — 2017 - 2019
Final grade: 110/110 *cum laude*, GPA: 29.93/30

Erasmus+ scolarship — *Paris-Sud University*
International Master in Physics of Complex System, ECTS GPA: A/A — 2018 - 2019

Bachelor's Degree in Physics *cum laude* — *University of Padova*
Thesis: *A Bayesian interpretation of quantum probability* — 2014 - 2017
Final grade: 110/110 *cum laude*, GPA: 29.19/30

Invited talks and seminars

Information processing in multiscale biological systems: from transduction mechanisms to decision-making processes — *Tokyo, Japan*, *27th Mar 2026*
Padova Neuroscience Center

Decoding behavior: inference of decision-making processes with interpretable agent models — *Padova, Italy*, *14th Nov 2025*
Padova Neuroscience Center

Information propagation across timescales — *Trieste, Italy*, *4th Apr 2024*
International Center for Theoretical Physics

Tuning transduction from hidden observables to optimize information harvesting — *Trieste, Italy*, *11th Mar 2024*
"Information processing and decision-making in biology" workshop, ICTP

Survival and coexistence in spatially explicit metapopulation models — *Padova, Italy*, *18th Dec 2023*
"Emergent dynamical patterns of disordered systems with applications to natural communities" workshop

Information theory in stochastic processes and complex systems — *Dresden, Germany*, *13th Jul 2022*
Max Planck Institute for the Physics of Complex Systems

What can phase transitions and criticality teach us about brain dynamics? — *Stockholm, Sweden*, *23rd - 24th May 2022*
BrainNet workshop, KTH Royal Institute of Technology

Unfolding complex systems with information theory — *Online*, *10th Mar 2022*
Young Seminars of the Italian Society of Statistical Physics

Publications

Unveiling gene perturbation effects through gene regulatory networks inference from single-cell transcriptomic data — **PLOS Comp. Bio.**, *22 (4), e1014067 (2026)*
C. Corridori, M. Romeike, G. Nicoletti, C. Buecker, S. Suweis, S. Azaele, G. Martello

Information-directed sampling for bandits: a primer
A. Hirling, G. Nicoletti, A. Celani
J. Stat. Mech. *4, 043402 (2026)*

Stochastic processes with multiple temporal scales: timescale separation and information
G. Nicoletti, D. M. Busiello
J. Stat. Mech. *12, 124004 (2025)*

Fast nonlinear integration drives accurate encoding of input information in large multiscale systems
G. Nicoletti, D. M. Busiello
Comm. Physics *8, 437 (2025)*

Optimal information gain at the onset of habituation to repeated stimuli
G. Nicoletti, M. Bruzzone, S. Suweis, M. Dal Maschio, D. M. Busiello
eLife *13:RP99767 (2025)*

Finite size scaling of survival statistics in metapopulation models
A. Doimo, G. Nicoletti, D. Bernardi, P. Padmanabha
Phys. Rev. E *111 (6), 064415 (2025)*

Excitation-inhibition balance controls information encoding in neural populations
G. Barzon, D. M. Busiello, G. Nicoletti
Phys. Rev. Lett. *134 (6), 068403 (2025)*

Information interference driven by environmental activity
G. Nicoletti, D. M. Busiello
Phys. Rev. Research *6 (4), 043275 (2024)*

Landscape and environmental heterogeneity support coexistence in competitive metacommunities
P. Padmanabha*, G. Nicoletti*, D. Bernardi*, S. Suweis, S. Azaele, A. Rinaldo, A. Maritan (*equal contribution)
PNAS *121 (44) 2410932121 (2024)*

Information propagation in Gaussian processes on multilayer networks
G. Nicoletti, D. M. Busiello
J. Phys. Complex. *5, 045004 (2024)*

Tuning transduction from hidden observables to optimize information harvesting
G. Nicoletti, D. M. Busiello
Physical Review Letters Editors' Suggestion and viewpoint in the APS "Physics" magazine
Phys. Rev. Lett. *133, 158401 (2024)*

Information propagation in multilayer systems with higher-order interactions across timescales
G. Nicoletti, D. M. Busiello
Phys. Rev. X *14 (2) 021007 (2024)*

Prenatal experience with language shapes the brain
B. Mariani, G. Nicoletti, G. Barzon, M. C. O. Barajas, M. Shukla, R. Guevara, S. Suweis, J. Gervain
Science Advances *9 (47), eadj3524 (2023)*

Emergent encoding of dispersal network topologies in spatial metapopulation models
G. Nicoletti*, P. Padmanabha*, S. Azaele, S. Suweis, A. Rinaldo, A. Maritan (*equal contribution)
PNAS *120 (46) 2311548120 (2023)*

The emergence of scale-free fire outbreaks in Australia
G. Nicoletti, L. Saravia, F. Momo, A. Maritan, S. Suweis
Best poster award at the conference "Stochastic Models and Experiments in Ecology and Biology 2021" Venice, Italy
iScience *26 (3) 106181 (2023)*

Mutual information in changing environments: Nonlinear interactions, out-of-equilibrium systems, and continuously varying diffusivities
G. Nicoletti, D. M. Busiello
Phys. Rev. E *106, 014153 (2022)*

Information-driven transitions in projections of underdamped dynamics
G. Nicoletti, A. Maritan, D. M. Busiello
Phys. Rev. E *106, 014118 (2022)*

Criticality and network structure drive emergent oscillations in a stochastic whole-brain model
G. Nicoletti*, G. Barzon*, B. Mariani, M. Formentin, S. Suweis (*equal contribution)
J. Phys. Complex. *3, 025010 (2022)*

Disentangling the critical signatures of neural activity
B. Mariani, G. Nicoletti, M. Bisio, M. Maschietto, S. Vassanelli, S. Suweis
Featured in the "Top 100 papers in Neuroscience" published by Scientific Reports in 2022
Sci. Rep. *12, 10770 (2022)*

Mutual information disentangles interactions from changing environments
G. Nicoletti, D. M. Busiello
Physical Review Letters Editors' Suggestion, viewpoint in the APS "Physics" magazine and highlight in PRL's weekly tip sheet for reporters
Phys. Rev. Lett. *127, 228301 (2021)*

Neuronal avalanches across the rat somatosensory barrel cortex and the effect of single whisker stimulation
B. Mariani, G. Nicoletti, M. Bisio, M. Maschietto, R. Oboe, A. Leparulo, S. Suweis, S. Vassanelli
Front. Syst. Neur. *15:709677 (2021)*

Scaling and criticality in a phenomenological renormalization group
G. Nicoletti, S. Suweis, A. Maritan
Phys. Rev. Research *2, 023144 (2020)*

Preprints

Pulse desynchronization of neural populations by targeting the centroid of the limit cycle in phase space
R. Guevara, M. Zenari, G. Nicoletti, E. Marini, S. Suweis, S. Azaele, M. Formentin
arXiv
arXiv:2603.12878 (2026)

Habitat heterogeneity and dispersal network structure as drivers of metacommunity dynamics
D. Bernardi, A. Doimo, G. Nicoletti, P. Padmanabha, A. Rinaldo, S. Suweis, S. Azaele, A. Maritan
arXiv
2602.06640 (2026)

Decoding behavior with minimal and interpretable agent models
G. Nicoletti, A. Celani
bioRxiv
2026.01.20.700580 (2026)

Balancing information and dissipation with partially observed fluctuating signals
G. Nicoletti, I. Di Terlizzi, D. M. Busiello
arXiv
2512.04877 (2025)

Plasticity-induced multistability on fast and slow timescales enables optimal information encoding and spontaneous sequence discrimination
G. Barzon, D. M. Busiello, G. Nicoletti
arXiv
2509.13867 (2025)

The somatosensory barrel cortex controls the spindle thalamocortical oscillation by frequency locking
R. Guevara, M. Tambaro, M. Maschietto, A. Leparulo, C. Checchetto, G. Nicoletti, B. Mariani, S. Suweis, S. Vassanelli
bioRxiv
2025.07.09.662963 (2025)

A novel metric for species vulnerability and coexistence in spatially-extended ecosystems
D. Bernardi, G. Nicoletti, P. Padmanabha, S. Suweis, S. Azaele, A. Rinaldo, A. Maritan
arXiv
2503.10288 (2025)

A network-based method for extracting the organization of brain-wide circuits from reconstructed connectome datasets
K. K. H. Manjunatha, M. Bruzzone, G. Nicoletti, S. Suweis, M. Dal Maschio
bioRxiv
2023.05.21.541471 (2023)

Contributed talks and posters

From Biological Complexity to Evolutionary Principles (EPIC Assembly Symposium 2026)
Tokyo, Japan
14th - 16th Mar 2026
Poster: Processing information from partially observed signals in biological systems with energetic constraints

Neurophysics of Active Sensing, KITP
Santa-Barbara, USA
10th - 16th Aug 2025
Talk: Inference of decision-making strategies with finite memory states

International Physics of Living Systems (iPoLS) Annual Meeting
Urbana-Champaign, USA
28th Jul - 1st Aug 2025
Talk: Optimizing transduction of information from hidden observables in biological systems with a limited energy budget

29th International Conference on Statistical Physics
Firenze, Italy
13th - 18th Jul 2025
Talk: Tuning transduction from hidden observables to optimize information harvesting with a limited energy budget

ENAC Research Day 2024
Lausanne, Switzerland
9th Sept 2024
Poster: Landscape and habitat heterogeneity drive niche coexistence in dispersing ecological metacommunities

Stochastic Models and Experiments in Ecology and Biology 2024
L'Aquila, Italy
28th - 31st May 2024
Talk: Spatially disordered environments stabilize competitive metacommunities

SIGNAL24: Information Processing, Noise, and Adaptation in Living Systems
Dresden, Germany
15th - 19th Apr 2024
Talk: Information propagation across timescales in multiscale systems

Italian Conference on Complex Systems 2023
Naples, Italy
9th - 11th Oct 2023
Poster: Emergent encoding of dispersal network topologies in spatial metapopulation models

28th International Conference on Statistical Physics
Tokyo, Japan
7th - 11th Aug 2023
Talk: The architecture of information processing in biological systems

Brain Criticality Meeting 2022
Online
7th - 9th Nov 2022
Poster: Criticality and network structure drive emergent oscillations in a stochastic whole-brain model

Conference on Complex Systems 2022
Palma de Mallorca, Spain
17th - 21st Oct 2022
Talk: Criticality and network structure drive emergent oscillations in a stochastic whole-brain model
Talk: Information-driven transitions in optimal projections of underdamped dynamics

Bernstein Conference 2022
Berlin, Germany
14th - 16th Sept 2022
Poster: Disentangling the critical signatures of neural activity: avalanches, spatial correlations and information

Conference on Complex Systems 2021
Lyon, France
25th - 29th Oct 2021
Talk: Disentangling the role of external and intrinsic dynamics on the critical signatures of neural activity
Talk: Modeling the emergence of scale-free fire outbreaks in Australia
Poster: Disentangling internal interactions from noisy environments through mutual information

Stochastic Models and Experiments in Ecology and Biology 2021 — *Venice, Italy*
POSTER: MODELING THE EMERGENCE OF SCALE-FREE FIRE OUTBREAKS IN AUSTRALIA — *22nd - 25th June 2021*

Brain Criticality Virtual Meeting — *Online*
POSTER: WHAT CAN A PHENOMENOLOGICAL RENORMALIZATION GROUP TEACH US ABOUT CRITICALITY IN A NETWORK OF NEURONS? — *6th - 9th Oct 2020*

Bernstein Conference 2020 — *Online*
POSTER: SCALING AND CRITICALITY IN A PHENOMENOLOGICAL RENORMALIZATION GROUP — *29th Sept - 1st Oct 2020*

Italian Conference on Complex Systems — *Trento, Italy*
POSTER: SCALING AND RENORMALIZATION GROUP FOR THE ACTIVITY OF NEURONS — *1st - 3rd July 2019*

ATTENDED SCHOOLS AND WORKSHOPS

Emergence of Information in Molecular Systems (MOLINFO) — *Munich, Germany*
WORKSHOP — *22nd Jul - 2nd Aug 2024*

Winter Workshop on Complex Systems 2022 — *Arc-et-Senans, France*
WORKSHOP — *24th - 28th Jan 2022*

Beg Rohu Summer School on "Statistical Mechanics and Emergent Phenomena in Biology" — *St. P. Quiberon, France*
SCHOOL — *30th May - 12th June 2021*

Computational and Theoretical Models in Neuroscience — *Venice, Italy*
SCHOOL — *9th - 16th Sept 2019*

ORGANIZED CONFERENCES

Information and Decisions Across Scales: Constraints and Optimality in Neural and Biological Networks (IDEAS) — *Dresden, Germany*
18th - 22nd May 2026
MAIN ORGANIZER
Conference at the Max Planck Institute for the Physics of Complex Systems

Robustness, Adaptability and Critical Transitions in Living Systems — *Lyon, France*
MAIN ORGANIZER — *27th Oct 2021*
Satellite of the Conference on Complex Systems 2021

TEACHING EXPERIENCE AND SUPERVISION

2026	**Reinforcement Learning**, ICTP Diploma Program and University of Trieste	*Main lecturer*
2025	**Ecology and Evolution**, ICTP Diploma Program, SISSA, and University of Trieste	*Invited lecturer*
2025	**An Introduction to Information Theory for Stochastic Biological Systems**, PhD course in Physics, University of Padova	*Main lecturer*
2025	**Co-supervision of one Master's thesis**, EPFL-ICTP	*Co-supervision*
2023	**Fundamental of Information Systems**, Master's Degree in Data Science, University of Padova	*Teaching assistant*
2022 - 23	**Advanced Statistical Mechanics**, PhD course in Physics, University of Padova	*Invited lecturer*
2022 - 23	**Physics with applications to biological systems**, Bachelor's Degree in Biology of Human and Environmental Health, University of Padova	*Teaching assistant*
2021 - 23	**Co-supervision of two Master's thesis and two Bachelor's thesis**, Department of Physics and Astronomy, University of Padova	*Co-supervision*
2021 - 22	**Models of Theoretical Physics**, Master's Degree in Physics of Data, University of Padova	*Teaching assistant*
2020 - 22	**IT and Bioinformatics**, Bachelor's Degree in Biology and Molecular Biology, University of Padova	*Teaching assistant*

AWARDS, HONORS AND MEDIA COVERAGE

13th Jul 2025 **"Giovanni Paladin" prize** for the best PhD thesis on topics in statistical physics and complex systems for the years 2022-2024. Awarded at the inaugural ceremony of the 29th International Conference on Statistical Physics by the Italian Association for Statistical Physics (SIFS)

3rd Apr 2025 ***Entropy* Outstanding Reviewer Award** awarded to five outstanding reviewers of the journal *Entropy* in 2024

9th Mar 2025 **Phys.org feature article** for the paper *Excitation-Inhibition balance controls information encoding in neural populations*, Phys. Rev. Lett. 134, 068403 (2025)

7th Oct 2024 **Physical Review Letters Editors' Suggestion, viewpoint in the magazine "Physics", and Phys.org feature article** for the paper *Tuning transduction from hidden observables to optimize information harvesting*, Phys. Rev. Lett. 133, 158401 (2024)

22nd Nov 2023 **Press release by the American Association for the Advancement of Science, coverage by international news outlets (The Times, Daily Mail, El Pais, Le Figaro, Corriere della Sera, and more), and popular science publications (New Scientists, Nature Italy, PsyPost, Science Alert, and more)** for the paper *Prenatal experience with language shapes the brain*, Science Advances 9 (47), eadj3524 (2023)

12th Mar 2023 **Featuring in the "Top 100 papers in Neuroscience" published by Scientific Reports in 2022** for the paper *Disentangling the critical signatures of neural activity*, Sci. Rep. 127, 12, 10770 (2022)

29th Nov 2022 **Graduate Alumni Award** awarded to the best graduate student of the School of Science of the University of Padova

22nd Nov 2021 **Physical Review Letters Editors' Suggestion, viewpoint in "Physics"magazine and highlight in PRL's weekly tip sheet for reporters** for the paper *Mutual information disentangles interactions from changing environments*, Phys. Rev. Lett. 127, 228301 (2021)

25th Jun 2021 **Best Poster Award** for "Modeling the emergence of scale-free fire outbreaks in Australia" at *Stochastic Models and Experiments in Ecology and Biology 2021*, ECLT, Venice, Italy. Sponsored by MDPI

Feb 2017 **Student grant** for the best students enrolled in scientific degrees, granted by University of Padova

10th Oct 2014 **Best student award** for the best high school students in Italy, awarded by the Italian Ministry for Education

SERVICE AND MEMBERSHIPS

Reviewer for **Nature Reviews Physics**, **Nature Communications**, **PNAS**, **Physical Review X**, **Physical Review Letters**, **PRX Life**, **Communications Physics**, **Physical Review Research**, **Physical Review E**, **Journal of Statistical Mechanics**, **New Journal of Physics**, **iScience**, **Entropy**, and **PLOS Computational Biology**.

2021 - 2024 Member of the **Complex Systems Society**

2021 - 2023 Member of the **Italian Society of Physics**

2021 - 2023 **Elected representative** in the PhD Program Committee and the Academic Board of the PhD program, Department of Physics and Astronomy, University of Padova