

Curriculum Vitae: Luis F Seoane, PhD

Employer: Spanish National Centre for Biotechnology (CNB) at the Spanish National Research Council (CSIC).

Address: Darwin Street 3, 28049 Madrid, Spain. **Cell phone:** +34 631 56 9873

Web site: <http://lf-seoane.wikidot.com> **e-mails:** lf.seoane@cnb.csic.es, brigan@gmail.com

Tenured (since 2022) junior scientist at CSIC. Work on Complex Systems (CCSS), quantitative systems biology, and computational neuroscience. Solo author of two *Phys. Rev. X* papers (IF: 14.417). First (shared) author of a *Nat. Com.* paper (IF: 16.6). Over 500 citations. h-index 14. Over 40 research papers, 28 as first, last, or solo author.

Research Highlights:

- Computational Neuroscience—brain (a)symmetry, plasticity, and evolution:
 - [Mathematical proof that increased cognitive complexity favors brain lateralization](#) (PRX, IF: 14.417).
 - [Modeling brain reorganization after hemispherectomy](#) and [phase transitions mediate plasticity after stroke](#).
 - Envision and development of a Brain-Computer Interface to [reconstruct images with the mind](#).
- Systems Biology—mathematical models and empirical studies of Darwinian evolution:
 - Ongoing: Developed algorithm for empirical reconstruction of massive genotype-genotype networks. Insights on SARS-CoV-2, Q β phage, and general viral evolution.
 - [Why does complex life exist at all?](#) A Darwinian trade-off between fast replication and computation yields complex life. [Parasites](#) can boost the evolution of complexity.
- Social Systems:
 - [Games in Rigged Economies: From coordination to collapse in rigged economies](#) (PRX, IF: 14.417).
 - Social complexity [slows down dynamics](#) (Nat. Com., IF: 16.6), revealing [jumps in social organization](#).
- Computational Linguistics:
 - [A morphospace of communication codes](#) to map the optimality of human language.

Skills:

- **Extremely original thinking** to unveil theoretical principles, for problem solving, and insightful modeling.
- Broad, deep knowledge of analytical and conceptual tools from Physics, Neuroscience, and CCSS:
 - **Network theory:** dynamics on and of networks, computational and analytical modeling, etc.
 - Advanced **agent-based modeling**.
 - **Information and complexity theory** for evolutionary dynamics, neuroscience (large data sets), etc.
 - Solid background in physics theory: **statistical physics, dynamical and stochastic processes**, etc.
 - **Advanced mathematical methods:** differential equations, real and complex analysis, statistics, etc.
- Computational and numerical skills (C++, Python, Matlab, etc.):
 - Broad theoretical and applied knowledge of **machine learning** and **artificial intelligence** techniques:
 - Recurrent and **Deep Neural Networks**, Reservoir Computing, Spiking Neurons.
 - Genetic algorithms; single-, **multi-objective optimization**; in-depth theoretical and hands-on experience.
- Working with empirical data:
 - Advanced **analysis of ECoG data** and **EEG** for **Brain-Computer Interfaces**.
 - Advanced analysis of **genetic sequences data**.
 - Extended experience with **network science data**.
- English (TOEFL 108/120, 2008), German (DSH-2, 2007), Spanish (native), Galician (native), Catalan (basic).

Postdoctoral research appointments:

Postdoctoral fellowships:

- **‘Juan de la Cierva’** fellow at CNB-CSIC: 2020 – 2022
 - Topological, computational, and optimality constraints to **neural circuitry evolution and reorganization**.
 - **Statistical mechanics of viral quasispecies** evolution grounded on empirical data.
- **Excellence program María de Maeztu** fellow at IFISC: 2019 – 2020
 - **Stability of rigged economies**; network and information **morphospace of language development and pathology**; neural circuitry evolution and reorganization.

Postdoc at the Complex Systems Lab at the Pompeu Fabra University:

- Evolutionary aspects of **Intelligence** (artificial and biological) **across CCSS**.
- Information theory principles in evolutionary dynamics.

2018 – 2019

Postdoctoral research appointments:

Postdoc Affiliate at **MIT, Physics Departments** and Center for Brains, Minds and Machines: 2016 – 2018

- **Physics of intelligence and consciousness**; AI-assisted sleep staging, spike sorting; advancing recurrent neural nets.
- Supervision of research summer program with 8 students ranging from undergrad to PhD levels.
- Organization of group meetings, review and interview postdoc candidates, writing successful grant proposals.

Funding:

Principal Investigator in Fundación Jesús Serra's **grant for emergent groups** (awarded **15,000 €**). 2022

Co-Principal Investigator in PREDICO research project #COV20_00617 funded by the Spanish Institute of Health Carlos III as part of the COVID-19 relief effort (awarded **30,718.00 €**). 2020

Wrote ~25% of NSF grant #1734870 (Ground-Truth Analysis and Modeling of Entire Individual *C. elegans* Nervous Systems, led by Prof. Edward Boyden, awarded **\$707,296.00**). 2017

Hired by Prof. Ricard Solé with funding from Fundación Botín and through the **European Research Council Advanced Grant** project #294294 (Distributed Computation in Synthetic Cellular Consortia). 2018 – 2019
2011 – 2016

Pedro Barrié de la Maza Scholarship for MSc in Computational Neuroscience (awarded **32,400 €**). 2009 – 2011

Education:

PhD Cum Laude & Research Assistant in **CCSS** supervised by Prof. **Ricard Solé**: 2011 – 2016

- Universitat Pompeu Fabra, ICREA-Complex Systems Lab.
- Research topics on CCSS: **Pareto optimization, Statistical Mechanics**, phase transitions, theoretical linguistics, **Darwinian evolutionary dynamics**, complex networks.
- Teaching: Introductory Statistics course at the Bioengineering degree.
- Science popularization: main author at the group's blog, <http://cslabupf.wordpress.com/> 2013 – 2014
- Referee for several journals in neuro- or multidisciplinary science.

MSc in Computational Neuroscience: 2009 – 2012

- Technische Universität Berlin, Bernstein Center for Computational Neuroscience.
- Research topics: Brain-Computer Interfaces, neural cryptography, emergent cortical rhythms, AI applied to gaming.

Licentiate (former Spanish degree+master program) in **Physics with Outstanding Award**: 2003 – 2009

- Universidade de Santiago de Compostela, Spain – home University.
- Ru-Ka Heidelberg Universität, Germany – Erasmus (European exchange program).
- Universidad de Granada, Spain – Séneca (Spanish national exchange program).

Internships, Summer Schools, Workshops, Seminars, and Research Stages:

Talks at international conferences or research institutions:

- “(A)symmetry and complexity in neural systems”: 2022, -23
 - Barcelona Collaboratorium, MPI-PKS (Dresden), U. Graz, U. Granada; etc.
 - Work presented at national and international physics and computational neuroscience conferences.
- Oral presentations and posters at the Conference on Complex Systems. 2013, -15, -17, -19, -21, -22
- “Information theory, predictability, and the emergence of complex life”: 2019
 - [Invited seminar](#) at the **Santa Fe Institute (SFI)**.
 - Invited seminar at Simon Levin's group in **Princeton University**. 2019
- **SFI Working groups**: contributed, Liquid Brains Solid Brains (2017); attended, Major synthetic transitions in evolution (2015). 2015, -17
- Oral presentation at NecSci Conference 2015. 2015

Research stages & internships:

- **Santa Fe Institute**, more than three months accumulated in research stages during PhD: 2013-2016
 - Invited by Prof. Ricard Solé, Prof. Steve Lansing, and Dr. Simon DeDeo.
 - Research topics: **Major transitions in evolution**, non-equilibrium social systems, Pareto optimality, gene regulatory networks.
- University of Granada, Spain, four-month Research Stage invited by Prof. Miguel Ángel Muñoz: 2011
 - Research Topics: **Emergent neural rhythms in the neocortex**, criticality in the brain.
- GSI particle accelerator, Germany, internship supervised by Dr. Giuliano Franchetti: 2008
 - Research Topics: Theory of particle accelerators.
- Max Plank Institut für Astronomie, Germany, internship by Prof. Cornelis Dullemond: 2007
 - Research Topics: Interstellar dissipative systems.

Summer schools:

- Center for Brains, Minds and Machines, USA: Brains, Minds, and Machines summer course. 2016
- Santa Fe Institute Complex Systems Summer School: 2013
 - Internal papers on: Social networks, written history as a complex adaptive system.

Advising experience:

Samuel Martínez, PhD thesis:	2022 – today
<ul style="list-style-type: none">• Co-supervised with Susanna Manrubia.• Statistical physics of viral evolution.	
Alex Gwyn O'hare, MSc thesis:	2023 – today
<ul style="list-style-type: none">• Topological communities in human connectomes.	
Gabriel Mallku Guzman Schiller, MSc Thesis:	2023 – today
<ul style="list-style-type: none">• Constraints on neural circuit structure from spike-timing dependent plasticity constraints and neural symmetry.	
Paula Rodríguez Sánchez, MSc Thesis:	2023 – today
<ul style="list-style-type: none">• Measuring topological (a)symmetry in human brain connectomes.	
Nerea Hidalgo Antúnez, JAE Intro:	2023 – today
<ul style="list-style-type: none">• Modeling energetic landscapes for neural plasticity.	
Alba Carballo, JAE Intro:	2021 – 2022
<ul style="list-style-type: none">• Introduction to research program for excellent degree students.• This work qualified the student to the Arquímedes national research award for undergrads (resolution pending).	2023
Juan Soria, MSc Thesis:	2021 – 2022
<ul style="list-style-type: none">• Topological communities in syntax networks.	
Henry Secaira, MSc Thesis, Outstanding and undergrad research stage:	2020 – 2022
<ul style="list-style-type: none">• Co-supervised with Susanna Manrubia.• Topology of a viral quasispecies.	
Marcos Martínez Jiménez, undergrad research stage:	2021
<ul style="list-style-type: none">• Renormalization approaches to study genotype-genotype networks.	
Miguel Ángel Casal, MSc Thesis, Outstanding Award:	2018 – 2019
<ul style="list-style-type: none">• Optimality tradeoffs in human language.	
Summer research program at MIT:	2016
<ul style="list-style-type: none">• Supervision of 8 students ranging from high school to PhD levels.• Projects on computational neuroscience, machine learning, and AI.	

Intellectual property:

Software for predicting epidemic dynamics, license being processed as “software of public interest”.	2021
Software for a Brain-Computer Interface to reconstruct images with the mind , copyleft license.	2011 – 2012

Awards and Honors:

Nominated to the PhD extraordinary award of the Pompeu Fabra University.	2016
Best poster in Foundations of Complex Systems at the Conference in Complex Systems 2015, AZ, USA.	2015
Honorable Mention in the Investigation Award of the Galician Royal Academy of Sciences.	2011
Galician Critics Award to my paper “The Importance of interlinguistic similarity and stable bilingualism when two languages compete”.	2011
Extraordinary Prize within the Spanish Arquímedes National Contest for Young Researchers.	2009
Licentiate degree with outstanding award.	2009
Work on language dynamics awarded by the Dean of the Faculty of Physics.	2009
Designated Valedictorian by my undergraduate colleagues.	2008