Dr. Sergi Valverde

ResearcherID: J-3275-2012
Scopus Author ID: 7006393703
ORCID ID: 0000-0002-2150-9610

Professional situation

Institution: Consejo Superior de Investigaciones Científicas (CSIC)
Department/Section/Unit: Institute of Evolutionary Biology (CSIC-UPF)
Address: Psg. Marítim de la Barceloneta 37-49, 08003, Barcelona
Email: sergi.valverde@ibe.upf-csic.es
Website: http://www.ibe.upf-csic.es/valverde
Speciality (UNESCO codes): 22
Professional category: CSIC Tenured Scientist
Dedication: Full Time

Keywords: Complex Networks, Complex Systems, Cultural Evolution, Ecology.

Curriculum summary

I am a complex systems scientist at the Institute of Evolutionary Biology (IBE-CSIC/UPF), where I lead the Evolution of Networks Lab. My research combines ideas from statistical physics, network science, and evolutionary theory to create a framework that enables us to understand how the structure of networks affects their behavior, development, and creativity in biological, ecological, technological, and cultural systems. A central goal of my work is to identify general principles that explain the emergence of complexity and the organization of real-world systems, from ecosystems and host–pathogen interactions to technological and cultural change.

This research program has led to over 100 peer-reviewed publications across various disciplines, including complex systems, evolutionary biology, and computational science. Notably, my work has been published in esteemed journals like Nature Ecology & Evolution, Trends in Ecology & Evolution, Nature Human Behavior, Philosophical Transactions of the Royal Society B, and Journal of the Royal Society Interface. In my contributions, I have reviewed a range of complex questions, including exploring the origins and breakdowns of modularity, investigating the interplay between nestedness and modularity in ecological networks, studying the macroevolutionary dynamics of cultural and technological systems, analyzing innovation patterns in patent and software ecosystems, and examining the evolution of semantic knowledge networks like the Gene Ontology.

In the past ten years, I have built my own research career by securing competitive funding as the Principal Investigator (PI) for national projects while also leading the Spanish part of the international project BiodivRestore-424/MPA4Sustainability. In 2025, I was additionally awarded an INVESTIGO grant supporting the 12-month hiring of a young researcher to strengthen ongoing research activities and project deliverables. My work is embedded in an active international network, reflected in invited and contributed talks at institutions and conferences such as CCS, CompleNet, and the Santa Fe Institute, as well as regular participation in academic seminar series. In parallel, I contribute to the development of the scientific community through service roles such as EU external evaluator and program committee member for Artificial Life conferences and ECAL, member of the Council of the Complex Systems Society (2016-2018) and the Catalan Network for the Study of Complex Systems (2020-2024), and organization of satellite workshops at ECCS.

Teaching and training have been enduring and integral aspects of my academic pursuits. For 12 years, I have been actively involved in teaching within the Biomedical Engineering program at Universitat Pompeu Fabra (UPF), designing coursework that bridges quantitative modeling, network analysis, and complex systems theory to address practical biological and biomedical challenges. This long-term teaching activity complements my supervision work as co-director of three completed PhD theses (UPC, UPF), as well as supervision of undergraduate and master theses aligned with my research agenda. Former PhD trainees currently hold academic and research positions at institutions such as UPC, the University of Graz, and University College London (UCL).
I also maintain international affiliations as External Fellow of the European Centre for Living Technology (ECLT, Venice) and the Center for the Dynamics of Social Complexity (DySoC, University of Tennessee, Knoxville), supporting long-term collaborations across disciplines. Finally, a key component of my scientific strategy is the development of reusable computational tools and open research infrastructure. I have created and maintained research and educational software, including Netlab, Netlab Online, BiMat, and Chimera, and I actively support open science and reproducibility through public code and data releases, including curated datasets and reproducible pipelines archived through Zenodo and GitHub.

International affiliations

1. **External Fellow**, European Centre for Living Technology (ECLT), Ca' Foscari University of Venice. Venice, Italy. Web: https://www.unive.it/pag/17724/
2. **External Fellow**, Center for the Dynamics of Social Complexity (DySoC), College of Arts and Sciences, University of Tennessee, Knoxville. Knoxville, USA. Web: https://artsci.utk.edu/research-and-creative-activity/research-centers-and-institutes/dysoc/

Education

- Informatics Engineering, Universitat Politècnica de Catalunya (UPC), Barcelona, Spain (1999-07-13).
- PhD in Applied Physics, Universitat Politècnica de Catalunya (UPC), Barcelona, Spain (2006-01-19).

Languages: Spanish, Catalan, English

Experience and job history / Former academic positions

- Científico Titular (CSIC), Consejo Superior de Investigaciones Científicas (CSIC), Spain (2018–present).
- Visiting Professor, Universitat Pompeu Fabra (UPF), Barcelona, Spain (2008–2018).
- Postdoctoral Researcher, Université Paul Sabatier, Toulouse, France (2007–2009).
- Postdoctoral Researcher, Universitat Pompeu Fabra (UPF), Barcelona, Spain (2006–2007).
- PhD Student, Universitat Pompeu Fabra (UPF), Barcelona, Spain (2004–2006).
- Software Engineer, Ubisoft Entertainment (1999–2004).
- R&D Engineer, El Periódico de Catalunya (1996–1999).

Research projects (national and international)

International and transnational projects (participant / consortium member)

DYNAMICALLY EVOLVING, LARGE-SCALE INFORMATION SYSTEMS (DELIS)
Funding: Complex Systems Initiative, 6th Framework Programme (EU).

Participants: Universität Paderborn; University of London; Consorzio Università Industria; Université Paris XI; Politechnika Wroclawska; Univerzita Karlova v Praze; Universitat Pompeu Fabra; Universität Karlsruhe; Max-Planck-Gesellschaft zur Förderung der Wissenschaft.
Duration: 2004-01-01 to 2007-12-31.
Total funding: 4,500,000 €.
Coordinator (PI): Friedhelm Meyer auf der Heide.
Researchers involved: 20.

EMBODIED AND COMMUNICATING AGENTS (ECAGENTS)
Funding: Complex Systems Initiative, 6th Framework Programme (EU).
Participants: Université Libre de Bruxelles; Institute for Advanced Studies; Collegium Budapest; Universitat Pompeu Fabra; University of Göteborg; Humboldt Universität; Università La Sapienza; University of Tokyo.
Duration: 2004-01-01 to 2007-12-31.
Total funding: 4,300,000 €.
Coordinator (PI): Stefano Nolfi.
Researchers involved: 20+.

PROGRAMMABLE ARTIFICIAL CELL EVOLUTION (PACE)
Funding: Complex Systems Initiative, 6th Framework Programme (EU).
Participants: Ruhr-Universität Bochum; Ca' Foscari University of Venice; University of Copenhagen; Chalmers University of Technology; Universitat Pompeu Fabra; University of Zurich; Vilnius University; ProtoLife s.r.l.; University of Southern Denmark.
Duration: 2004-01-01 to 2007-12-31.
Coordinator (PI): Stefano Nolfi.
Researchers involved: 20+.

Competitive projects (national/institutional)

ORIGINS OF INNOVATION IN TINKERED NETWORKS
Funding: James McDonnell Foundation.
Host institution: Universitat Pompeu Fabra.
Duration: 2006-01-01 to 2010-12-31.
Total funding: 460,000 €.
PI: Ricard V. Solé.
Researchers involved: 2.

SOCIAL INSECT NESTS AS 3D NETWORKS: MORPHOGENESIS AND STRUCTURAL DESIGNS (MESOMORPH)
Funding: Agence Nationale de la Recherche (ANR), Biologie Systémique programme.
Host institution: Université Paul Sabatier.
Duration: 2007-01-01 to 2009-12-31.
Total funding: 500,000 €.
PI: Guy Theraulaz.
Researchers involved: 8.

FIS2009-12365 – Computación. Replicación y rotura de simetría en sistemas protocelulares
Funding: Ministerio de Ciencia e Innovación.
Host institution: Universitat Pompeu Fabra.
Duration: 2010-01-01 to 2013-12-31.
Total funding: 89,540 €.
PI: Ricard V. Solé.
Researchers involved: 7.

Principal Investigator (PI) projects

FIS2013-44674-P – Detección de tecnologías emergentes en redes de innovación
Funding: Ministerio de Economía y Competitividad.
Host institution: Universitat Pompeu Fabra.
Duration: 2013-01-01 to 2016-12-31.
Total funding: 12,000 €.
PI: Sergi Valverde.
Researchers involved: 1.

FIS2016-77447-R – Predicción de innovación tecnológica en redes de culturómica
Funding: Ministerio de Economía y Competitividad.
Host institution: Universitat Pompeu Fabra.
Duration: 2016-12-30 to 2019-12-01.
Total funding: 34,000 €.
PI: Sergi Valverde.
Researchers involved: 1.

PID2020-117822GB-100 – Estructura y evolución del conectoma tecnológico
Funding: Agencia Estatal de Investigación.
Host institution: Consejo Superior de Investigaciones Científicas (CSIC).
Duration: 2019-09-01 to 2024-08-31.
Total funding: 90,750 €.
PI: Sergi Valverde.
Researchers involved: 1.

PCI2024-162055NB-I00 – Phylogenetic Scaling and Evolutionary Transitions in Mammalian Intelligence
Funding: Agencia Estatal de Investigación.
Host institution: CSIC.
Duration: 2025-09-01 to 2027-08-31.
Total funding: 45,000 €.
PI: Sergi Valverde.
Researchers involved: 8.

INVESTIGO grant (Ministerio de Ciencia, Innovación y Universidades / SEPE)
Call: Proyectos Investigo 2025: public subsidy to finance the 12-month hiring of a young researcher (Grado ≥ 300 ECTS / Máster Universitario) in support of research projects.
Contract code: INV25SEPE_BAR_IBE_M3_2.
Total funding: 38,556 €.
Year awarded: 2025 (contract starts in 2026).

International coordination/node leadership

BiodivRestore-424 / MPA4Sustainability – Enhancing the role of MPAs in restoring biodiversity while maintaining access to ecosystem services
Funding: BiodivRestore Transnational Cofund (Innovation Fund Denmark; ANR; FCT; Agencia Estatal de Investigación; Swedish Environmental Protection Agency).
Participants: Technical University of Denmark; CNRS; Madeira Whale Museum; CSIC; Centre de Recerca Matemàtica / Autonomous University of Barcelona; Swedish University of Agricultural Sciences.
Duration: 2021-04-01 to 2024-03-31.
Total funding: 107,668.80 €.
Overall PI: David Lusseau.

Spanish node lead / Principal researcher (Spain): Sergi Valverde.
Researchers involved: 20+.

Publications

2001

1. Solé, R. V., & Valverde, S. (2001). Information transfer and phase transitions in a model of Internet traffic. Physica A: Statistical Mechanics and its Applications, 289(3–4), 595–605. [Q1 journal]

2002

2. Solé, R. V., Ferrer-i-Cancho, R., Montoya, J. M., & Valverde, S. (2002). Selection, tinkering, and emergence in complex networks. Complexity, 8(1), 20–33. [Q1 journal]

3. Valverde, S., & Solé, R. V. (2002). Self-organized critical traffic in parallel computer networks. Physica A: Statistical Mechanics and its Applications, 312(3–4), 636–648. [Q1 journal]

4. Valverde, S., et al. (2002). Scale-free networks from optimal design. Europhysics Letters, 60(4), 512. [Q2 journal]

2003

5. Valverde, S., & Solé, R. V. (2003). Hierarchical small worlds in software architecture. arXiv, cond-mat/0307278.

2004

6. Buhl, C., et al. (2004). Efficiency and robustness in ant networks of galleries. The European Physical Journal B: Condensed Matter and Complex Systems, 42(1), 123–129 [Q3 journal]

7. Solé, R. V., & Valverde, S. (2004). Information theory of complex networks: On evolution and architectural constraints. In Complex Networks (pp. 189–207). Springer, Berlin, Heidelberg.

8. Valverde, S. (2004). A new science for a connected world. Current Anthropology, 45(4), 565-566. [Q1 journal]

9. Valverde, S., & Solé, R. V. (2004). Internet's critical path horizon. The European Physical Journal B, 38(2), 245–252. [Q3 journal]

2005

10. Valverde, S. (2005). Evolution and dynamics in information networks (PhD thesis). Department of Applied Physics, Technical University of Catalonia, Barcelona, Spain.

11. Valverde, S., & Solé, R. V. (2005). Logarithmic growth dynamics in software networks. Europhysics Letters, 72(5), 858. [Q2 journal]

12. Valverde, S. (2005). Network motifs in computational graphs: A case study in software architecture. Physical Review E, 72(2), 026107. [Q2 journal]

2006

13. Buhl, C., et al. (2006). Topological patterns in street networks of self-organized urban settlements. The European Physical Journal B: Condensed Matter and Complex Systems, 49(4), 513–522. [Q3 journal]

14. Solé, R. V., & Valverde, S. (2006). Are network motifs the spandrels of cellular complexity? Trends in Ecology & Evolution, 21(8), 419–422. [Q1 journal]

15. Valverde, S., & Solé, R. V. (2006). On the nature of design. In Complex Engineered Systems: Science Meets Technology (pp. 72–100). Springer, Berlin, Heidelberg.

16. Valverde, S., et al. (2006). Self-organization patterns in wasp and open-source communities. IEEE Intelligent Systems, 21(2), 36–40. [Q1 journal]

2007

17. Corominas-Murtra, B., et al. (2007). K-scaffold subgraphs of complex networks. Europhysics Letters, 77(1), 18004. [Q2 journal]

18. Corominas-Murtra, B., et al. (2007). Emergence of scale-free syntax networks. arXiv, arXiv:0709.4344.

19. Perna, A., et al. (2007). The topological fortress of termites. In Workshop on Bio-inspired Design of Networks (pp. 165–173). Springer, Berlin, Heidelberg.

20. Rosas-Casals, M., et al. (2007). Topological vulnerability of the European power grid under errors and attacks. International Journal of Bifurcation and Chaos, 17(7), 2465–2475.

21. Solé, R. V., et al. (2007). Modularity in biological networks. In Biological Networks (pp. 21–40).

22. Valverde, S. (2007). Crossover from endogenous to exogenous activity in open-source software development. Europhysics Letters, 77(2), 20002. [Q2 journal]

23. Valverde, S., & Solé, R. V. (2007). Self-organization versus hierarchy in open-source social networks. Physical Review E, 76(4), 046118. [Q2 journal]

24. Valverde, S., et al. (2007). Topology and evolution of technology innovation networks. Physical Review E, 76(5), 056118. [Q2 journal]

2008

25. Challet, D., & Valverde, S. (2008). Fat tails, long memory, maturity and ageing in open-source software projects. arXiv, arXiv:0802.3170.

26. Mestres, J., et al. (2008). Data completeness—the Achilles heel of drug-target networks. Nature Biotechnology, 26(9), 983–984. [Q1 journal]

27. Perna, A., et al. (2008). The structure of gallery networks in the nests of termite Cubitermes spp. revealed by X-ray tomography. Naturwissenschaften, 95(9), 877–884.

28. Perna, A., et al. (2008). Topological efficiency in three-dimensional gallery networks of termite nests. Physica A: Statistical Mechanics and its Applications, 387(24), 6235–6244. [Q1 journal]

29. Solé, R. V., & Valverde, S. (2008). Spontaneous emergence of modularity in cellular networks. Journal of the Royal Society Interface, 5(18), 129–133. [Q1 journal]

30. Solé, R. V., et al. (2008). Models of protocell replication.

31. Solé, R. V., et al. (2008). Robustness of the European power grids under intentional attack. Physical Review E, 77(2), 026102. [Q2 Journal]

2009

32. Corominas-Murtra, B., et al. (2009). Emergence of scale-free syntax networks. In Evolution of Communication and Language in Embodied Agents (pp. 83–101). Springer, Berlin, Heidelberg.

33. Corominas-Murtra, B., et al. (2009). The ontogeny of scale-free syntax networks: Phase transitions in early language acquisition. Advances in Complex Systems, 12(3), 371–392. [Q2 journal]

34. Mestres, J., et al. (2009). The topology of drug–target interaction networks: Implicit dependence on drug properties and target families. Molecular BioSystems, 5(9), 1051–1057. [Q1 journal]

35. Valverde, S., & Solé, R. V. (2009). Motifs. In Encyclopedia of Complexity and Systems Science (Vol. 13, pp. 5692–5702). Springer.

36. Valverde, S., et al. (2009). Percolation in insect nest networks: Evidence for optimal wiring. Physical Review E, 79(6), 066106. [Q2 Journal]

2010

37. Horta-Bernús, R., et al. (2010). Discerning electricity consumption patterns from urban allometric scaling. In Complexity in Engineering (pp. 49–51). IEEE.

38. Solé, R. V., et al. (2010). Language networks: Their structure, function, and evolution. Complexity, 15(6), 20–26. [Q1 journal]

2011

39. Flores, C. O., et al. (2011). Statistical structure of host–phage interactions. Proceedings of the National Academy of Sciences, 108(28), E288. [Q1 journal]

40. Solé, R. V., et al. (2011). Convergent evolutionary paths in biological and technological networks. Evolution: Education and Outreach, 4(3), 415–426. [Q2 journal]

2012

41. Valverde, S., & Solé, R. V. (2012). Motifs in graphs. In Computational Complexity (pp. 1919–1928). Springer, New York, NY.

42. Valverde, S., et al. (2012). Evolved modular epistasis in artificial organisms. Artificial Life, 13, 111–115. [Q3 journal]

2013

43. Flores, C. O., et al. (2013). Multi-scale structure and geographic drivers of crossinfection within marine bacteria and phages. The ISME Journal, 7(3), 520–532. [Q1 journal]

44. Flores, C. O., et al. (2013). Phage-bacteria infection networks: From nestedness to modularity. In APS March Meeting Abstracts (J44–011).

45. Solé, R. V., & Valverde, S. (2013). Before the endless forms: Embodied model of transition from single cells to aggregates to ecosystem engineering. PLOS ONE, 8(4), e59664. [Q1 journal]

46. Solé, R. V., & Valverde, S. (2013). Macroevolution in silico: Scales, constraints and universals. Palaeontology, 56(6), 1327–1340. [Q1 journal]

47. Solé, R. V., et al. (2013). The evolutionary ecology of technological innovations. Complexity, 18(4), 15–27. [Q1 journal]

48. Valverde, S., & Solé, R. V. (2013). Networks and the city. Architectural Design, 83(4), 112–119. [Q2 journal]

49. Weitz, J. S., et al. (2013). Phage–bacteria infection networks. Trends in Microbiology, 21(2), 82–91. [Q1 journal]

2014

50. Gautrais, J., et al. (2014). The role of colony size on tunnel branching morphogenesis in ant nests. PLOS ONE, 9(10), e109436. [Q1 journal]

51. Hillung, J., et al. (2014). Experimental evolution of an emerging plant virus in host genotypes that differ in their susceptibility to infection. Evolution, 68(9), 2467–2480. [Q1 journal]

52. Solé, R. V., et al. (2014). Can a minimal replicating construct be identified as the embodiment of cancer? BioEssays, 36(5), 503–512. [Q1 journal]

53. Valverde, S. (2014). Evolution of patent citation networks. In Complexity in Engineering (COMPENG) (pp. 1–5). IEEE.

2015

54. Valverde, S., & Solé, R. V. (2015). A cultural diffusion model for the rise and fall of programming languages. Human Biology, 87(3), 224–234.

55. Valverde, S., & Solé, R. V. (2015). Punctuated equilibrium in the large-scale evolution of programming languages. Journal of the Royal Society Interface, 12(107), 20150249. [Q1 journal]

56. Valverde, S., et al. (2015). Structural determinants of criticality in biological networks. Frontiers in Physiology, 6, 127. [Q2 journal]

2016

57. Duran-Nebreda, S., et al. (2016). Emergence of proto-organisms from bistable stochastic differentiation and adhesion. Journal of the Royal Society Interface, 13(117), 20160108. [Q1 journal]

58. Flores, C. O., et al. (2016). BiMat: A MATLAB package to facilitate the analysis of bipartite networks. Methods in Ecology and Evolution, 7(1), 127–132. [Q1 journal]

59. Solé, R., et al. (2016). On singularities and black holes in combination-driven models of technological innovation networks. PLOS ONE, 11(1), e0146180. [Q1 journal]

60. Valverde, S. (2016). Major transitions in information technology. Philosophical Transactions of the Royal Society B: Biological Sciences, 371(1701), 20150450.

61. Valverde, S., & García-Ojalvo, J. (2016). Hacia una teoría unificada de la criticalidad biológica. Investigación y Ciencia.

62. Valverde, S., & Solé, R. V. (2016). Correction to “Punctuated equilibrium in the large-scale evolution of programming languages”. Journal of the Royal Society Interface, 13(117), 20160272. [Q1 journal]

63. Valverde, S., et al. (2016). The software crisis of synthetic biology. bioRxiv, 041640.

2017

64. Aguilar, D., et al. (2017). Computational analysis of multimorbidity between asthma, eczema and rhinitis. PLOS ONE, 12(6), e0179125. [Q1 journal]

65. Solé, R., et al. (2017). The paradox of constant oceanic plastic debris: Evidence for evolved microbial biodegradation? bioRxiv, 135582.

66. Valverde, S. (2017). Breakdown of modularity in complex networks. Frontiers in Physiology, 8, 497.

67. Valverde, S. (2017). Visualizing the evolution of programming languages. Leonardo, 50(5), 505–505.

68. Valverde, S., et al. (2017). Spatially induced nestedness in a neutral model of phage-bacteria networks. Virus Evolution, 3(2), vex021. [Q1 journal]

2018

69. Corominas-Murtra, B., et al. (2018). Chromatic transitions in the emergence of syntax networks. Royal Society Open Science, 5(12), 181286. [Q1 journal]

70. Rosas-Casals, M., et al. (2018). A simple spatiotemporal evolution model of a transmission power grid. IEEE Systems Journal, 12(4), 3747–3754. [Q1 journal]

71. Valverde, S., et al. (2018). The architecture of mutualistic networks as an evolutionary spandrel. Nature Ecology & Evolution, 2(1), 94–99. [Q1 journal]

2020

72. Ferrando-Bernal, M., et al. (2020). Mapping co-ancestry connections between the genome of a Medieval individual and modern Europeans. Scientific Reports, 10(1), 6843. [Q1 journal]

73. Solé, R. V., & Valverde, S. (2020). Evolving complexity: How tinkering shapes cells, software and ecological networks. Philosophical Transactions of the Royal Society B: Biological Sciences, 375(1796), 20190325. [Q1 journal]

74. Valverde, S. (2020). The long and winding road: Accidents and tinkering in software standardization. Mètode: Revista de Difusió de la Investigació, 2(105), 68–75.

75. Valverde, S., et al. (2020). Coexistence of nestedness and modularity in host–pathogen infection networks. Nature Ecology & Evolution, 4(4), 568–577. [Q1 journal]

2021

76. Bentley, R. A., et al. (2021). Neutral models are a tool, not a syndrome. Nature Human Behaviour, 5(7), 807–808. [Q1 journal]

77. Gómez-Marín, A., et al. (2021). Cognition, collective behavious and conciousness. White Paper 5: Brain, Mind & Behaviour. Consejo Superior de Investigaciones Científicas.

78. Marco de Lucas, J. E., et al. (2021). In White Paper 2: Origins, (Co)Evolution, Diversity & Synthesis of Life. Consejo Superior de Investigaciones Científicas.

79. Valverde, S., et al. (2021). Evolutionary system biology. In White Paper 2: Origins, (Co)Evolution, Diversity & Synthesis of Life. Consejo Superior de Investigaciones Científicas.

80. Vidiella, B., et al. (2021). Habitat loss causes long extinction transients in small trophic chains. Theoretical Ecology, 14(4), 641–661. [Q2 journal]

81. Vidiella, B., et al. (2021). Structural entropy constrains dynamics in directed networks. Preprints, 2021010565.

2022

82. Duran-Nebreda, S., et al. (2022). Dilution of expertise in the rise and fall of collective innovation. Humanities and Social Sciences Communications, 9(1), 1–10. [Q1 journal]

83. Galiana, N., et al. (2022). Ecological network complexity scales with area. Nature Ecology & Evolution, 6(3), 307–314. [Q1 journal]

84. Toro-Delgado, E., et al. (2022). Butterfly–parasitoid–hostplant interactions in Western Palaearctic Hesperiidae: A DNA barcoding reference library. Zoological Journal of the Linnean Society, 196(2), 757–774. [Q1 journal]

85. Vidiella, B., et al. (2022). A cultural evolutionary theory that explains both gradual and punctuated change. Journal of the Royal Society Interface, 19(196), 20220570. [Q1 journal]

2023

86. Bentley, R. A., et al. (2023). Is disruption decreasing, or is it accelerating? Advances in Complex Systems, 26(2), 2350006. [Q2 journal]

87. Duran-Nebreda, S., & Valverde, S. (2023). Composition, structure and robustness of lichen guilds. Scientific Reports, 13(1), 3295. [Q1 Journal]

88. Duran-Nebreda, S., & Valverde, S. (2023). Rashevsky's dream: A physico-mathematical foundation of history and culture. Mètode Science Studies Journal, 85–90.

89. Koppl, R., et al. (2023). Explaining technology. Elements in Evolutionary Economics. Cambridge University Press.

2024

90. Bentley, R. A., et al. (2024). Cultural evolution, disinformation, and social division. Adaptive Behavior, 32(2), 189–203. [Q1 Journal]

91. Duran-Nebreda, S., et al. (2024). On the multiscale dynamics of punctuated evolution. Trends in Ecology & Evolution, 39(8), 734–744. [Q1 Journal]

92. Duran-Nebreda, S., et al. (2024). The many ways toward punctuated evolution. Palaeontology, 67(5), e12731. [Q1 Journal]

93. O'Brien, M. J., et al. (2024). Punctuated equilibrium at 50: Anything there for evolutionary anthropology? Yes; definitely. Evolutionary Anthropology: Issues, News, and Reviews, 33(1), e22009. [Q1 Journal]

2025

94. Duran-Nebreda, S., & Valverde, S. (2025). The natural evolution of computing. In Oxford Handbook of Cultural Evolution (Vol. 104, p. 459).

95. Duran-Nebreda, S., et al. (2025). Fractal clusters and urban scaling shape spatial inequality in US patenting. npj Complexity, 2(1), 30.

96. O'Brien, M. J., et al. (2025). Archaeology and the construction of artifact lineages: From culture history to phylogenetics. Biological Theory, 1–23. [Q1 Journal]

97. Valverde, S., et al. (2025). Structural changes in Gene Ontology reveal modular and complex representations of biological function. Molecular Biology and Evolution, 42(6), msaf148. [Q1 Journal]

98. Valverde, S., et al. (2025). The cultural macroevolution of arcade video games: Innovation, collaboration, and collapse. Evolutionary Human Sciences, 7, e30. [Q1 Journal]

99. Vidiella, B., et al. (2025). Networks: The visual language of complexity. In Nonlinear Dynamics for Biological Systems (pp. 135–162). Springer Nature Switzerland, Cham.

2026

100. Vidiella, B., et al. (2026). The Evolutionary Ecology of Software: Constraints, Innovation and the AI Disruption. In The Economy as an Evolving Complex Systems: IV (pp. 908-936) Santa Fe Institute Press, NM, USA.

Stays abroad

(continuous stays exceeding one month)

Institution: Santa Fe Institute
Place: Santa Fe **Country:** USA **Date:** 01/09/2006 - 20/11/2006
Duration (weeks): 11
Type: Research Collaboration

Institution: Université Paul Sabatier
Place: Toulouse **Country:** France **Date:** 01/01/2007 - 01/06/2009
Duration (weeks): 125
Subject: Swarm Intelligence
Type: Postdoc

Institution: Santa Fe Institute
Place: Santa Fe **Country:** USA **Date:** 01/03/2007 - 17/05/2007
Duration (weeks): 10
Type: Research Collaboration

Talks & Presentations

1. (2000). Complexity in computer networks. The Global Internet: Measurement, Modeling & Analysis. Leiden, Netherlands.

2. (2004). Origins of software complexity. Software Complexity Workshop Conference (IST2004). The Hague, Netherlands.

3. (2004). Universal properties of bipartite software graphs. Workshop on Software and Complex Systems, 9th IEEE International Conference on Engineering of Complex Computer Systems. Florence, Italy.

4. (2004). Network motifs in computational networks: A case study in software architecture. Nordic Workshop on Networks. Copenhagen, Denmark.

5. (2005). Information theory of class graphs: On evolution and architectural constraints. Workshop on Complexity and Self-Properties. Brussels, Belgium.

6. (2005). Xarxes tecnològiques: del software a Internet. Curs “Evolució de Xarxes Complexes”. Barcelona, Spain.

7. (2005). Noise and reliable computation: Von Neumann revisited. Workshop on Evolution, Information and Computation: From Living to Non-Living Matter. Venice, Italy.

8. (2007). Complejidad tecnológica. Maratón Científico: Sistemas Complejos, Virus, Hormigas y Cerebros. Madrid, Spain.

9. (2008). Hierarchy and emergence in open-source networks. DELIS Final Workshop and Review Meeting. Barcelona, Spain.

10. (2008). Into the Turing’s nest. Selection, Tinkering and Emergence in Complex Networks (Santa Fe Business Meeting). Googleplex, California, USA.

11. (2009). Complex networks: The architecture of life. Festival Punto y Raya (2nd edition). Barcelona, Spain.

12. (2009). Evolution of technology innovation networks. “Changing Cultures: Cultures of Change” (ATACD Project). Barcelona, Spain.

13. (2009). Percolation and modularity in insect nest networks. Workshop on Principles of Innovation in Swarm-made Architectures. Venice, Italy.

14. (2011-01-26). Community structure in a patient–phenotype network. MeDALL Kick-off Meeting. Barcelona, Spain.

15. (2011-05-02). Networks of innovation: From patents to open-source software. I Jornada Complexitat.CAT. Barcelona, Spain.

16. (2011-09-15). Hierarchy vs. self-organization in open-source networks. European Conference on Complex Systems (ECCS 2011). Vienna, Austria.

17. (2011-10-05). Hierarchy vs. self-organization in open-source networks. Spanish node meeting (FuturICT). Barcelona, Spain.

18. (2012-05-17 to 2012-05-19). SFI Workshop: Power Grids as Complex Networks. Santa Fe, New Mexico, USA.

19. (2012-06-06). Hierarchy vs. self-organisation in complex networks. Emergent Technologies & Design (Architectural Association, AA). London, UK.

20. (2012-11-29). Networks of innovation. BioDesign Research Lab Lectures. Barcelona, Spain.

21. (2013-09-16 to 2013-09-20). Evolution of patent citation networks. European Conference on Complex Systems (ECCS 2013). Barcelona, Spain. Web: http://barabasilab.neu.edu/success_eccs2013

22. (2014-06-12). Networks in action: Communication, computation and evolution. UPF-DTIC Research Seminars. Barcelona, Spain. Web: http://www.dtic.upf.edu/~afaridi/DTIC_Seminars/Abstracts.html#Jun12

23. (2014-06-16 to 2014-06-17). Evolution of patent citation networks. Workshop on Complexity in Engineering (COMPENG 2014). Barcelona, Spain.
Web: http://www.compeng2014.org

24. (2014-07-04). Phage-bacteria infection networks: From nestedness to modularity. Workshop on Virus Dynamics and Evolution. Barcelona, Spain. Web:
http://www.crm.cat/en/Activities/Pages/ActivityFoldersAndPages/Curs%202013-2014/WKVirusDynamics/WKVirusDynamics.aspx

25. (2014). Innovation as a complex system: Technological evolution and emergence of computational creativity. Interactivos?14 (Medialab-Prado). Madrid, Spain. Web:
http://medialab-prado.es/article/lainnovacioncomounsistemacomplejoevoluciontecnologicayemergenciadelacreatividadcomputacional

26. (2014-12-09). Major transitions in technological evolution. Workshop: Major Transitions in Natural, Synthetic and Artificial Evolution. Santa Fe Institute, USA.
Web: http://www.santafe.edu/gevent/detail/science/1917/

27. (2015-03-06). Modelling the evolution of programming languages: Network methods in cultural evolution. Complexity and Socio-Ecological Dynamics Research Group (UPF, Dept. of Humanities). Barcelona, Spain.
Web: http://www.upf.edu/cases/actualitat/150306.html

28. (2015-04-12). Complex networks: The architecture of life. II Jornades Breyting. Vidreres, Spain.
Web: http://www.jornadesbreyting.com/project/xarxes-complexes-larquitectura-de-la-vida/

29. (2015-06-01). Visualising the evolution of programming languages. 6th Leonardo Satellite Symposium at NetSci 2015. Zaragoza, Spain. Web: http://artshumanities.netsci2015.net

30. (2015-10-08). Leyes universales de los ecosistemas complejos. V Jornada UX/UOC (#juxuoc). Barcelona, Spain. Web: http://mosaic.uoc.edu/jornadaux/

31. (2015-10-15). Mapping the space of programming languages. Innovation as Search on a Landscape of Possibilities. Santa Fe Institute, USA. Web: http://www.santafe.edu/gevent/detail/science/2024/

32. (2016-05-30). Major transitions in information technology. NetSci 2016. Seoul, South Korea.

33. (2017-04-19). Major transitions in information technology. Tempe, Arizona, USA.
Web: https://campus.asu.edu/content/major-transitions-information-technology

34. (2017-04-19). Evolution of mutualistic networks by speciation-divergence dynamics. CCS'17 (Conference on Complex Systems). Cancún, Mexico. Web: http://ccs17.unam.mx

35. (2018). 2001: A vision of the future technology. CCCB (Centre de Cultura Contemporània de Barcelona). Barcelona, Spain. Web:
http://www.cccb.org/es/actividades/ficha/2001-una-odisea-en-el-espacio-una-mirada-desde-la-ciencia-actual/230318

36. (2018-01-28 to 2018-02-02). Major transitions in information technology. Workshop: Genetic Improvement of Software (Dagstuhl Seminar 18052). Dagstuhl, Germany.
Web: https://www.dagstuhl.de/de/seminars/seminar-calendar/seminar-details/18052

37. (2018-02-08). Uncovering universal properties of evolutionary landscapes. Biosciences Seminar Series. University of Birmingham, UK.

38. (2019-02-11). The architecture of collective intelligence. Round table "Collective Intelligence" (Biennal Ciutat i Ciència). Barcelona, Spain.
Web: https://www.biennalciutaticiencia.barcelona/ca/intelligencia-collectiva

39. (2019-03-06). Culturomics. Workshop (Biennal Ciutat i Ciència). Barcelona, Spain.
Web: https://www.biennalciutaticiencia.barcelona/ca/programa

40. (2019-03-18 to 2019-03-21). Architecture of mutualistic networks as spandrel. 10th International Conference on Complex Networks (Complenet 2019). Tarragona, Spain.
Web: https://complenet19.weebly.com

41. (2019-05-21). Emergence of intelligence in natural and artificial complex systems. Moderator, round table (Complexitat.cat / IEC). Barcelona, Spain.
Web: http://jornada.complexitat.cat/2019/

42. (2019-05-25 to 2019-05-26). The brain and the computer. Brainhack Networks. Burlington, Vermont, USA.

43. (2020-02-24). The neuroscience of videogames. Presenter (lecture by Diego Redolar Ripoll: "The Playful Brain"), CCCB lecture series "Gameplay, The Permanent Game". Barcelona, Spain.
Web: https://www.cccb.org/en/activities/file/lecture-by-diego-redolar-ripoll/232806

44. (2020-02-26). Major transitions in information technology. INET Complexity Economics Seminar, Oxford Martin School (University of Oxford). Oxford, UK. Web:
https://www.oxfordmartin.ox.ac.uk/events/major-transitions-in-information-technology-with-dr-sergi-valverde/

45. (2020-09-18). Valverde, S., & Vidiella, B. Hidden dimensions: Coexistence of nestedness and modularity reveals the hypergraph nature of ecological architecture. TOPONETS 2020 Satellite @ NetSci 2020. Rome, Italy.

Web: https://sites.google.com/view/toponets2020/home-page

46. (2020). Duran-Nebreda, S., & Valverde, S. Colapso de Atari: El ataque de los clones. Charlas Culturales de Arcade Vintage. Ibi, Spain. Web: https://www.youtube.com/watch?v=myDzDkTwtKs

47. (2021-10-21). Complexitat i tecnologia: promeses i trampes del desenvolupament tecnològic. Casa de la Cultura de Girona. Girona, Spain.
Web: https://www.emporda.info/oci/agenda/complexitat-i-tecnologia-promeses-i-58625195.html

48. (2021-10-27). Evolving complex networks: How tinkering shapes structure. Invited speaker, ReACT Satellite of CCS'21. Lyon, France.
Web: https://liphlab.github.io/REACT2021/

49. (2021-10). The social perception of reality. Roundtable "¿Qué es la realidad?" (Palau Macaya). Barcelona, Spain. Web: https://www.youtube.com/watch?v=AQj0q4hTS_s

50. (2021-11-22 to 2021-11-24). Biocreator: A distributed simulation for learning ecology and evolution. Selected workshop, EvoKE 2021 meeting. Barcelona, Spain.
Web: https://evokeproject.org/evoke-2021/

51. (2021-12-3). The Ascent of Computer. ECTL Youtube Channel. European Center for Living Technology, Venice, Italy. Web: https://www.youtube.com/watch?v=6KWByQPcAXo

52. (2022-06-09). Evolving networks: Optimization vs. tinkering. Third Workshop on Nonlinear Dynamics in Biological Systems. Madrid, Spain. Web:
https://eventos.urjc.es/79221/detail/third-workshop-on-nonlinear-dynamics-in-biological-systems.html

53. (2022-06-14 to 2022-06-16). The evolution of computing. SFI Workshop "The Structure of Technology". Santa Fe Institute, New Mexico, USA.
Web: https://www.santafe.edu/events/structure-technology

54. (2022-10-07). Hidden dimensions in ecology: From bipartite networks to hypergraphs. CBGP Seminars. Madrid, Spain. Web:
https://www.etsiaab.upm.es/Centro?id=a73f654250e83810VgnVCM10000009c7648a____&prefmt=articulo&fmt=detail

55. (2023-02-18). PONG: Vida y muerte del arcade. Charlas Culturales de Arcade Vintage. Ibi, Spain.

56. (2024-09). Is disruption decreasing, or is it accelerating? Conference on Complex Systems (CCS 2024). Exeter, UK.

57. (2024-03). A complexity approach to the dark proteome. Lifehub Meeting. La Cristalera, Spain.

58. (2024-04-04). Measuring diversity in complex systems (is not enough!). Biodiversity Seminar, Institute of Evolutionary Biology (IBE-CSIC). Barcelona, Spain.

59. (2024-09-05). La vida al borde del abismo: la gran mortandad del Pérmico. Evolución puntuada: cambios abruptos e innovación. Radio interview, "La Mecánica del Caracol" (EITB Radio Euskadi). Spain. Web:
https://www.eitb.eus/es/radio/radio-euskadi/programas/la-mecanica-del-caracol/detalle/9573970/la-vida-al-borde-del-abismo-gran-mortandad-del-permico-evolucion-puntuada-cambios-abruptos-e-innovacion/

60. (2024-09-18). Quemando el Mando (programa 142) – Ciencia y videojuegos. Radio/podcast interview (iVoox). Alicante. Spain. Web: https://www.ivoox.com/en/quemando-mando-programa-142-ciencia-y-audios-mp3_rf_133911414_1.html

61. (2024-02-22). From complexity to simplicity: The rise and fall of technological innovation. Institut d'Estudis Catalans (IEC). Barcelona, Spain.

62. (2025-05-23). Nestedness, modularity and the architecture of ecological systems: From neutral models to hypergraphs. HESCOR Workshop on Network Analysis and Graph Databases. Cologne, Germany.

63. (2025-04). The evolving Gene Ontology: How network structure shapes functional annotations and computational biology. Biodiversity Seminars, Institute of Evolutionary Biology (IBE-CSIC). Barcelona, Spain.

64. (2025). (Invited talk) A multi-scale approach to punctuated evolution and human evolutionary synthesis. Opening Symposium of HEIRS (Hub for Human Evolution Research Synthesis). Faro, Portugal.

65. (2025-07-14). (Invited seminar) A multiscale approach to punctuated evolution in nature and society. Institute for Integrative Systems Biology (I2SysBio). Valencia, Spain.
Web: https://www.i2sysbio.es/communication/1717/

66. (2025-10-09). (Invited seminar) A multiscale approach to punctuated evolution in nature and society. Theoretical and Experimental Ecology Station (SETE-CNRS). France.

67. (2026-01-14). (Invited talk) A multiscale approach to punctuated evolution in nature and society. Workshop on Mathematical Perspectives on Extinction Dynamics. International Centre for Theoretical Physics (ICTP). Trieste, Italy.

68. (2026). (Accepted contribution; presenter) Fractal clusters and urban scaling shape spatial inequality in U.S. patenting. International Conference on Complex Networks (CompleNet 2026). Zaragoza, Spain.

Teaching experience

Universitat Pompeu Fabra (UPF)—undergraduate & master teaching

Bachelor's Degree in Biomedical Engineering (UPF) (2011–2019)
Courses taught:

- 22106 Mathematical Biomodelling I
- 22123 Evolutionary Algorithms
- 22107 Introduction to the University and Biomedical Engineering
- 22117 Principles of Biological Design
- 22150 Modelling Complex Diseases

Bachelor's Degree in Human Biology (UPF) (2008–2016)
Courses taught:

- 20332 Basic Sciences 1

Computational Biomedical Engineering Master (UPF) (2014–2019)
Course taught:

- 32217 Complexity Science

Web: https://sites.google.com/site/complexsci/

University of Valencia—graduate teaching

Master's Degree in Bioinformatics (University of Valencia) (2013–2026)
Invited Professor—Introduction to Complex Networks: Patterns & Models

Supervision of students and theses

I co-directed three completed PhD theses from 2009 to 2019, with former trainees currently holding academic positions at UPC, University of Graz, and UCL.

PhD thesis supervision (completed)

1. Rosas-Casals, M. (2009). Topological complexity of the electricity transmission network: Implications in the sustainability paradigm. PhD Thesis, Universitat Politècnica de Catalunya (UPC). (Completed).
Current position: Profesor Titular de Universidad, Universitat Politècnica de Catalunya (UPC), Terrassa, Spain.

2. Corominas-Murtra, B. (2011). A unified approach to the emergence of complex communication. PhD Thesis, Universitat Pompeu Fabra (UPF). (Completed).
Current position: Assistant Professor (tenure track), Institute of Biology, University of Graz; Head of the research group Statistical Physics of Living Systems (Field of Excellence "Complexity of Life in Basic Research and Innovation"), Austria.

3. Carrignon, S. (2019-11-15). Content-dependent biases in social learning strategies: A multiscale approach. PhD Thesis, Universitat Pompeu Fabra (UPF). (Completed).
Current position: Research Associate (COREX project), Molecular and Cultural Evolution Laboratory (MACE Lab), Department of Genetics, Evolution and Environment (GEE), University College London (UCL), UK.
Web: https://repositori.upf.edu/items/27d50684-1181-48df-808c-b0107c9d38cf?locale=en

Bachelor thesis supervision

1. Ortiz Sánchez, I. D. (2020–2021). Mode and tempo of cultural evolution in video games. Bachelor Thesis, Universitat Pompeu Fabra (UPF).

Master's thesis supervision

1. Roman, M. (2020–2021). The ontogeny of miRNA regulatory networks: Major structural transitions in Blattella germanica. Master's Thesis, Institut de Biologia Evolutiva (IBE-CSIC).
Current position: PhD student (Bascompte Lab), applying quantitative genetics and computational methods to indirect effects in multi-species, multi-trait coevolutionary models.

Scientific service: committees, societies, and event organization

Evaluation panels

- External evaluator, European Project FOC (Forecasting Financial Crises). European Union (EU). 2011–2012.

Program committees (international conferences)

- Program Committee member, Artificial Life XIII (13th Artificial Life Conference). International Society for Artificial Life. 2012.
- Program Committee member, Artificial Life XIV (14th Artificial Life Conference). International Society for Artificial Life. 2014.
- Program Committee member, ECAL 2015 (13th European Conference on Artificial Life). International Society for Artificial Life. 2015.
- Program Committee member, Artificial Life XV (15th Artificial Life Conference). International Society for Artificial Life. 2016.

Governance/scientific societies

- Council member, Complex Systems Society (CSS). 2016–2018.
- Council member, Complexitat.cat (Catalan Network for the Study of Complex Systems). 2020–2024.

Event organization (workshops/satellite meetings)

- Organizer, Workshop on Complexity in Energy Infrastructures: Models, Metrics, Metaphors (ECCS 2011 Satellite Meeting). 2011-09-15.
- Organizer, Workshop on the Cultural Evolution of Technology: Evidence, Hypothesis and Theory (ECCS 2015 Satellite Meeting). 2015-09-30. Web: http://www.ccs2015.org/satellite-the-cultural-evolution-of-technology-evidence-hypothesis-andtheory/

Software (research tools, educational tools, and professional development)

Gene Ontology evolution networks (code + data)

Role: Lead developer/maintainer
Associated publication: Valverde, S., et al. (2025). Structural Changes in Gene Ontology Reveal Modular and Complex Representations of Biological Function. Molecular Biology and Evolution.
Description: Open repository containing Gene Ontology network snapshots and analysis scripts used to study 15 years of Gene Ontology structural evolution, including curator-driven semantic restructuring events and modularization dynamics.
GitHub: https://github.com/svalver/go-evolution-networks
Zenodo (archived release): https://zenodo.org/records/17079600

Fractal patenting (code + data)

Role: Lead developer/maintainer
Associated publication: Duran-Nebreda, S., Vidiella, B., Bentley, R. A., & Valverde, S. (2025). Fractal clusters and urban scaling shape spatial inequality in U.S. patenting. npj Complexity.
Description: Reproducible research repository including (i) a generative model of spatial innovation dynamics, (ii) code to compute spatial inequality across scales, (iii) analytical derivation of the “inequality horizon,” and (iv) processed empirical data from geolocated U.S. patents (1905–2024).
GitHub: https://github.com/svalver/fractal-patenting
Zenodo (archived release, DOI): https://doi.org/10.5281/zenodo.17079686

Arcade macroevolution (code + data)

Role: Lead developer/maintainer

Associated publication: The Cultural Macroevolution of Arcade Video Games: Innovation, Collaboration, and Collapse (Evolutionary Human Sciences).
Description: Full reproducibility package including curated dataset (7,205 arcade machines, traits, genre structure, and collaboration labels), data processing scripts, analysis notebooks, and figure-generation code. Dataset derived from metadata collected through the MAME project.
GitHub: https://github.com/svalver/arcade-macroevolution
Zenodo (archived release, DOI): https://doi.org/10.5281/zenodo.17079589

Netlab

Role: Lead developer/maintainer
Type: Research software toolkit (complex networks)
Availability: Research software (internal distribution)
Description: Software suite for the analysis, modelling, and visualization of complex networks. The toolkit has been reused across multiple Complex Systems Lab publications over the last decade. Impact/dissemination: Visualizations generated with Netlab have been featured in popular media, including The New York Times Magazine (March 12th, 2006) and a special Nature issue on Ecological Complexity (Nature, Vol. 442, No. 7100, July 20th, 2006).
Link: http://www.nature.com/nature/journal/v442/n7100/edsumm/e060720-01.html

Netlab Online

Role: Developer/instructor (courseware design)
Type: Educational software (online applications)
Availability: Public (web-based)
Description: Collection of online applications developed for teaching activities and coursework on Complex Networks.
Link: https://sites.google.com/site/introcomplexnetworks/

BiMat

Role: Co-developer (collaboration with C. Flores, T. Poisot, J. Weitz)
Type: Open-source research software (MATLAB library)
Availability: Open-source
Description: Open-source MATLAB library for the analysis of modularity and nestedness in bipartite ecological networks.
Main features: modularity and nestedness computation; Shannon and Simpson diversity indices; random bipartite network generation via multiple null models; and network statistics utilities.
Link: http://bimat.github.io

Chimera

Role: Lead developer / research platform designer
Type: Research simulation platform (evolutionary + embodied systems)
Availability: Research software (internal distribution)
Description: Simulation platform for “programmable life systems” combining evolutionary dynamics with realistic physical embodiment. This platform facilitates the creation and evaluation of novel functions, built upon a computational model that incorporates emergent properties.
Applications: Adaptable to simulate microfluidic experiments and test hypotheses related to tumor growth and angiogenesis.

Pro Rally 2002

Organization: Ubisoft Entertainment
Role: Physics engine developer; software architecture supervisor
Type: Commercial software/videogame development (PlayStation 2, Nintendo GameCube)
Availability: Commercial release
Description: Racing video game developed for the PlayStation 2 and Nintendo GameCube consoles. My contributions included designing and implementing the physics engine and supervising the overall software architecture according to best engineering practices.

Red1 (El Periódico de Catalunya)

Organization: Ediciones Primera Plana
Role: Developer (desktop publishing + workflow integration)
Type: Professional software (desktop publishing)
Availability: Internal production tool
Description: Desktop publishing software used in the production of El Periódico de Catalunya. Automatic machine translation was incorporated in the production of the Catalan edition of the newspaper (first in Spain).