

Mario Figueira Pereira

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Presentation

My name is Mario Figueira Pereira, and I am post-doctoral researcher at Vogelwarte (Swiss Ornithological Institute), in Sempach, Switzerland. During my PhD I have carried out research in statistical and computational statistical methods, applying them to ecological data (species distribution models) and compositional data (land use).

My strongest expertise lies in spatial and spatio-temporal statistics within the Bayesian paradigm. In particular, I have extensive knowledge of the INLA approach, as well as experience with sampling-based methods such as MCMC and Monte Carlo. Regarding MCMC and MC methods, I am capable of programming algorithms and samplers from scratch, typically in C/C++ and integrating them into R via the Rcpp and RcppArmadillo libraries. That said, in practice it is often more convenient to rely on probabilistic programming languages (PPLs), among which I have experience with nimble, Stan, and JAGS—particularly in nimble, where I implemented the SPDE approach developed by the INLA team. My main strengths, however, lie in deterministic approximate Bayesian computation, particularly through the use of INLA through the R-INLA package.

Although I have broad experience using R-INLA, in the final stage of my PhD—work that, due to time constraints, could not yet be formalized into a paper for inclusion in the dissertation—I have reimplemented part of the INLA framework in Julia. This has involved integrating automatic differentiation via the Zygote library, along with modifications to strategies and algorithms for hyperparameter exploration. This effort was motivated both by the goal of developing or improving deterministic approximate Bayesian computational methods and by a collaboration on implementing Stochastic Frontier models under this framework. The results achieved are highly substantial: with the INLA-based approach I implemented in Julia, computations run in the range of 600-1500 milliseconds, whereas with JAGS, nimble, or Stan, convergence requires 3-5 hours.

I also have experience in Python, using libraries such as Keras and Pyro—Keras for deep learning analyses, and Pyro for variational Bayes and MCMC methods.

In the ecological domain, my main expertise lies in the analysis of ecological data through species distribution models (abundance, presence-only, and presence/absence). I have worked on combining data through classical models such as geostatistical models under preferential sampling and integrated models in general. I have also developed new algorithms during my PhD—such as sequential consensus, and distributed and recursive strategies with INLA—to integrate diverse sources of information. Although I have not directly worked with ecological population models, I have studied the related literature and am familiar with implementations using nimble and inlabru (a wrapper for INLA that provides greater modeling flexibility).

Work history

16/02/2026 – 15/02/2028

📌 **Post-doctoral researcher**, Swiss Ornithological Institute (Vogelwarte), Sempach, Switzerland.

Development of spatio-temporal models based on SPDE-FEM methods for species distributions models, assesment of source-sink dynamics and derived quantities, e.g. directional derivatives, flux or curvature.

Work history (continued)

- 03/2023 – 01/2026  **Predoctoral fellow**, Universitat de València Estudi General, Spain.
Space-time analysis of land use at the European level, using hierarchical Bayesian models implemented with the R-INLA software. Member of the European project LAMASUS (LAnd Management for SUStainability) as a young researcher.
- 25/10/2022 – 08/03/2023  **Predoctoral fellow**, Universitat de València Estudi General, Spain.
Space-time analysis of the distribution of the *Ceratitis Capitata*, implementing hierarchical space-time Bayesian models.
- 11/2021 – 02/2022  **External Curricular Internship**, Consultancy Promedio, S.L.
During the internship, I have conducted space-time simulation and modeling of species distribution, Bayesian inference with INLA, and geostatistical analysis using INLA-SPDE methodologies.

Education

- 10/2022 – present  **PhD in Statistics and Optimization, Universitat de València Estudi General.**
Main research line in space-time Bayesian modeling.
- 09/2020 – 07/2022  **Master in Biostatistics, Universitat de València Estudi General.**
Master's Thesis: *Methodology for Feedback between Independent Spatial Models and Preferential Models*.
- 09/2014 – 09/2019  **Degree in Physics, Universidade de Santiago de Compostela.**
Undergraduate Thesis: *Simulation of Multi-junction Photovoltaic Cells*.

Congresses, workshops and symposia

- 1 Participation in the XVIII Congress of Biometry CEBMADRID with a poster titled *Estimating essential habitats combining fishery-dependent and -independent data applying Bayesian learning* (Madrid, Spain, 05/2022).
- 2 Participation in the 5th General Meeting of BIOSTATNET in Santiago de Compostela, with the presentation of a poster titled *Combining different kinds of ecological data using Bayesian feedback* (Santiago de Compostela, Spain, 19/01/2023 - 20/01/2023).
- 3 International communication titled *Improving essential habitats estimation applying Bayesian feedback*, participating as an invited speaker in the *Advanced Species Distribution Modeling* workshop held at the *Universidade do Minho*. Awarded as one of the best oral presentations in the *Student Session* (Guimarães, Portugal, 23/01/2023).
- 4 Participation in the *Workshop on Bayesian Modeling for Complex Correlated Data* as an invited speaker, with an oral presentation titled *Improving Species Distribution Models using Bayesian feedback* (Valencia, Spain, 16/05/2023-18/05/2023).
- 5 Participation in the workshop *13th Bayesian Inference for Stochastic Processes* with an oral presentation titled *Improving ecological modeling using Bayesian feedback* (Madrid, 22/05/2023-24/05/2023).
- 6 Participation in the *XIX Spanish Conference and VIII Ibero-American Biometrics Meeting* with an oral exposition titled *A Shiny App for spatial species distribution modeling* (Vigo, Spain, 27/06/2023-30/06/2023).

- 7 Participation in the *XL National Congress of Statistics and Operations Research* with an oral presentation titled *A Shiny App for spatial species distribution modeling* (Elche, Spain, 7/11/2023-10/11/2023).
- 8 Participation in the *II R Conference and XIII R Users' Meeting* with an oral presentation titled *BAYSPINS: A Shiny app for spatial modelling* (Barcelona, Spain, 15/11/2023-17/11/2023).
- 9 International communication as an invited oral presentation at the *16th International Conference of the ERCIM WG on Computational and Methodological Statistics*, with an oral presentation titled *Modelling independent and preferential data jointly* (Berlin, Germany, 16/12/2023-18/12/2023).
- 10 Participation in the workshop on *Hierarchical Bayesian spatio-temporal modelling* with an oral presentation titled *Combining diverse information sources through integrated models and distributed Bayesian inference* (Valencia, Spain, 16/04/2024-18/04/2024).
- 11 Participation in the *Workshop on Spatio Temporal Modelling* at the Public University of Navarre, with an oral presentation titled *A comparison between different approaches to combine diverse information sources* (Pamplona, Spain, 25/06/2024 - 27/06/2024).
- 12 Participation in the *2024 World Meeting of the Society for Bayesian Analysis* at the Ca' Foscari University of Venice, with a poster titled *Expert prior elicitation with INLA* (Venice, Italy, 01/07/2024 - 07/07/2024).
- 13 Participation in the *International Statistic Ecology Conference (ISEC)* at the Swansea University, with an oral presentation titled *Combining diverse information sources through integrated models and consensus approaches* (Swansea, UK, 15/07/2024 - 19/07/2024).
- 14 Participation in the *2024 Edition of the KAUST Workshop on Statistics* at the King Abdullah University of Science and Technology (KAUST), with a poster titled *Distributed inference with INLA* (Thuwal, Saudi Arabia, 17/11/2024 - 21/11/2024).
- 15 Participation in the *6th General Meeting of BIOSTATNET* in Valencia, with an oral presentation titled *Analysing the behaviour of spatial models for disease mapping: Leroux and BYM* (Valencia, Spain, 15/01/2025 - 17/01/2025).
- 16 Participation in the *2nd Edition Workshop on Hierarchical Bayesian Spatio-Temporal modelling* held in Valencia, with two oral presentations: (1) *A hybrid inferential framework: Combining INLA and Random Forest for enhanced modeling* and (2) *Several strategies for recursive and distributed inference within the INLA framework* (Valencia, Spain, 03/04/2025 - 04/04/2025).
- 17 Participation in the workshop *INLA: past, present, and future* at the University of Galsgow, with a poster titled *Scalable Bayesian Inference: Recursive and Distributed Methods with INLA* (Glasgow, UK, 21/05/2025 - 23/05/2025).
- 18 Participation in the *SIAM Conference on Parallel Processing for Scientific Computing (PP26)* held in Berlin, with an oral presentations: *Distributed and Recursive Bayesian Inference for Complex Spatio-Temporal and Big Data Models* (Berlin, Germany, 03/03/2026).
- 19 Participation in the *3rd Edition Workshop on Hierarchical Bayesian Spatio-Temporal modelling* held in Valencia, with an oral presentation: *Modeling Dynamical Species Distributions: Reaction-Diffusion Dynamics, Velocities, and Level-Set Methods in Species Distribution Models* (Valencia, Spain, 12/05/2026 - 13/05/2026).

Published papers

- 1 Marta González-Warleta, José Antonio Castro-Hermida, **Mario Figueira**, Jesús López, David Conesa, Antonio López-Quílez, Florencio M. Ubeira & Mercedes Mezo, *Bayesian hierarchical modelling of the geospatial distribution of fasciolosis in dairy cattle and the impact on production: Application to the main*

milk-producing region (Galicia) in Spain, Veterinary Parasitology, Volume 325, 2024, 110091, ISSN 0304-4017, <https://doi.org/10.1016/j.vetpar.2023.110091>.

- 2 **Mario Figueira**, David Conesa & Antonio López-Quílez, *A Shiny R app for spatial analysis of Species Distribution Models*, Ecological Informatics, Volume 80, 2024, 102542, ISSN 1574-9541, <https://doi.org/10.1016/j.ecoinf.2024.102542>.
- 3 **Mario Figueira**, Xavier Barber, David Conesa, Antonio López-Quílez, Joaquín Martínez-Minaya, Iosu Paradinas & Maria Grazia Pennino, *Bayesian feedback in the framework of ecological sciences*, Ecological Informatics, Volume 84, 2024, 102858, ISSN 1574-9541, <https://doi.org/10.1016/j.ecoinf.2024.102858>.
- 4 **Mario Figueira**, Carmen Guarner, David Conesa, Antonio López-Quílez & Tamás Krisztin, *Unveiling Land Use Dynamics: Insights from a Hierarchical Bayesian Spatio-Temporal Modelling of Compositional Data*, JABES (2025). <https://doi.org/10.1007/s13253-025-00678-6>.
- 5 **Mario Figueira**, David Conesa, Antonio López-Quílez & Iosu Paradinas, *A computationally efficient procedure for combining ecological datasets by means of sequential consensus inference*, Environ Ecol Stat (2025). <https://doi.org/10.1007/s10651-025-00653-x>.

Preprint papers

- 1 **Mario Figueira**, David Conesa, Antonio López-Quílez and Iosu Paradinas, *How to perform modeling with independent and preferential data jointly?*. Authorea. July 17, 2023. <https://www.authorea.com/users/640234/articles/655188-how-to-perform-modeling-with-independent-and-preferential-data-jointly>
- 2 Iosu Paradinas and **Mario Figueira**, *Length-based spatially explicit species distribution model*. Authorea. February 13, 2025. <https://doi.org/10.22541/au.173946297.77881647/v1>.
- 3 **Mario Figueira**, David Conesa, Antonio López-Quílez and Håvard Rue *Integrating Expert Knowledge and Recursive Bayesian Inference: A Framework for Spatial and Spatio-Temporal Data Challenges*. arXiv [stat.ME], 2506.00221. May 30, 2025. <https://arxiv.org/abs/2506.00221>.
- 4 **Mario Figueira**, Michela Cameletti and Luca Patelli *INLA-RF: A Hybrid Modeling Strategy for Spatio-Temporal Environmental Data*. arXiv [stat.ME], 2506.00221. July 24, 2025. <https://arxiv.org/abs/2507.18488>.
- 5 **Mario Figueira**, David Conesa, Antonio López-Quílez and Håvard Rue, *Distributed and recursive Bayesian inference for Big Data and complex spatio-temporal models*. arXiv [stat.ME], 2607.23396. July 25, 2026. <https://arxiv.org/abs/2607.23396>.

Courses

- 1 Attendance at the course *Bayesian spatial and spatio-temporal models with R-INLA* taught by Håvard Rue and Elias T. Krainski, and hold at the Public University of Navarre (Pamplona, Spain, 25/01/2023-27/01/2023).
- 2 Attendance at the seminar *Spatio Temporal Modelling*, held during the *Workshop INAMAT2 on Spatio-Temporal Modelling* at the Public University of Navarre (Pamplona, Spain, 25–27 June 2024). The seminar, taught by Alexandra Schmidt, comprised 21.5 hours of intensive training in spatial statistics.

Stays

- 1 A one-month research stay (01/09/2024–01/10/2024) at the Public University of Navarre (UPNA) to work on the analysis of the behavior of widely used distributions in disease mapping (Leroux and BYM), under the supervision of Associate Professor Aritz Adin Urtasun.
- 2 A 90-day research stay (01/10/2024–29/12/2024) at King Abdullah University of Science and Technology (KAUST) to work on the design of distributed and recursive inference methods within the INLA methodology, under the supervision of Professor Håvard Rue.

Collaborations

- 03/2022 - 01/2024  Collaboration in the spatial analysis of the distribution of *Fasciola hepatica* and productive variables in livestock farms in Galicia. Development of geostatistical models for the presence/absence of *Fasciola hepatica* on farms and for continuous data of productive variables.
- 01/01/24 - Present  Collaboration as part of the research team in the Spanish national project “MÁS ALLÁ DE LA MODELIZACIÓN HABITUAL DE DATOS ESPACIALES Y TEMPORALES: UNA APROXIMACIÓN JERÁRQUICA BAYESIANA” (*Beyond the Usual Modeling of Spatial and Temporal Data: A Bayesian Hierarchical Approach*). The project aims to advance methods, models, and computational algorithms for hierarchical spatial and spatio-temporal modeling in Bayesian statistics.

Contributions on GitHub

-   [SpatialModeling ShinyApp](#). An application developed with Shiny that implements the **R-INLA** environment to solve geostatistical and preferential models. In addition to allowing configuration of arguments related to the operation of INLA, it also enables feedback processes.
-   [Transformation to sp/sf](#). A series of functions are developed that allow converting objects of type *inla.segment* and *inla.mesh* into spatial objects from the *sp* and *sf* packages. These functions enable obtaining spatial objects considering any arbitrary number of holes within the polygons, whether they have multiple levels of depth or a single level of depth.

Skills

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|---------------------------------|---|
| Computing |  R, Python, Julia, C/C++ ... |
| Composition of Scientific Texts |  Markdown, $\text{\LaTeX}$, Beamer, Quarto, ... |
| Miscellanea |  HTML/CSS, Hugo, TikZ, knitr, ggplot2, ... |