Dr. Sara Pérez Vieites

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RESEARCH PROFILE

I am a postdoctoral researcher at the CERI Systèmes Numériques (Digital Systems) of IMT Nord Europe, where I am carrying out research in computational statistics under the supervision of Dr. Víctor Elvira (University of Edinburgh). More specifically, I am interested in Bayesian inference, parameter estimation, filtering techniques and their application to different fields of science (e.g., engineering, ecology, meteorology, etc.).

I completed the Ph.D. in Statistical Signal Processing from Universidad Carlos III of Madrid in 2022, under the supervision of Dr. Joaquín Míguez. My novel research has been published in two journals of different disciplines and in three well-known peer-reviewed signal processing conferences. I have presented all my research advances in nine international and two national conferences.

During the William Gordon Seggie Brown Research Fellowship I will propose new Bayesian methodology for parameter and state estimation of high-dimensional dynamical systems. I will design novel and theoretically sound methods for an efficient estimation of the model unknowns, all constrained under the realistic assumption of finite computational resources. The proposed algorithms will be applied in other fields (ecology, meteorology, geosciences, and epidemiology), developing multi and interdisciplinary research. I also plan to contribute to the teaching activity of the School of Mathematics, as well as to undertake development training as necessary.

PROFESSIONAL EXPERIENCE

Visiting Researcher Jan. 2023 - Present
School of Mathematics, University of Edinburgh (Edinburgh, UK)

Postdoctoral Researcher Sept. 2022 - Present
CERI Systèmes Numériques, IMT Nord Europe (Villeneuve-d'Ascq, France)

Research Assistant Dec. 2016 - May 2022
Department of Signal Theory & Communications, University Carlos III of Madrid (Madrid, Spain)

PhD internship Apr. 2019 - July 2019
Department of Mathematics and Statistics, University of Reading (Reading, UK)

Research collaboration/visit Jan. 2019
MeteoGalicia (Santiago de Compostela, Spain)

Research collaboration/visit July 2018
Centre Tecnològic de Telecomunicacions de Catalunya (CTTC, in Barcelona, Spain)

Trainee June 2015 - Aug. 2015
Gradiant, Technology Centre of Telecommunications of Galicia (Vigo, Spain)

Trainee June 2014 - Aug. 2014
R Cable y Telecomunicaciones, S.A. (A Coruña, Spain)

EDUCATION

Ph.D. in Statistical Signal Processing Sept. 2017 - Jan. 2022
Universidad Carlos III de Madrid (Spain)
Title: Nested filtering methods for Bayesian inference in state space models
Supervisor: Joaquín Míguez Arenas
Description: Development of Bayesian filtering methods, from a practical en theoretical point of view, in order to perform accurate parameter estimation and prediction of time- varying high-dimensional systems.

Master's Degree in Telecommunications Engineering Sept. 2015 - Sept. 2017
Universidad Carlos III de Madrid (Spain)

Master's Degree in Multimedia and Communications Sept. 2015 - July 2017
Universidad Carlos III de Madrid (Spain)
Description: Master specialised in topics such as machine learning, computer vision and signal processing.

Bachelor's Degree in Telecommunication Technologies Engineering Sept. 2011 - June 2015
Universidade de Vigo (Spain)
Description: Specialisation in Sound and Image.

LIST OF PUBLICATIONS

My research has been published in two journals of different disciplines and in three well-known peer-reviewed signal processing conferences/workshops.

Journal papers:

- Pérez-Vieites, S., & Míguez, J. (2021). *Nested Gaussian filters for recursive Bayesian inference and nonlinear tracking in state space models.* Signal Processing, 189, 108295.
  Description: The proposed method is based on the nested hybrid filtering (NHF) framework, that combines two layers of filters, one inside the other, to compute the joint posterior probability distribution of the static parameters and the state variables. We explore the use of deterministic sampling techniques for Gaussian approximation in the first layer of the algorithm, instead of the Monte Carlo methods employed in the original procedure. The resulting scheme reduces the computational cost and so makes the algorithms potentially better suited for high-dimensional state and parameter spaces.
- Pérez-Vieites, S., Mariño, I. P., & Míguez, J. (2018). *Probabilistic scheme for joint parameter estimation and state prediction in complex dynamical systems.* Physical Review E, 98(6), 063305.
  Description: The proposed scheme combines two layers of inference: in the first layer, a grid-based scheme is used to approximate the posterior probability distribution of the fixed parameters; in the second layer, filtering (or data assimilation) techniques are employed to track and predict different conditional probability distributions of the state variables. Various types of procedures (deterministic grids, Monte Carlo, Gaussian filters, etc.) can be plugged into both layers, leading to a wealth of algorithms. For this reason, we refer to the proposed methodology as nested hybrid filtering.

Conference peer-reviewed papers:

- Pérez-Vieites, S., & Míguez, J. (2020). *A nested hybrid filter for parameter estimation and state tracking in homogeneous multi-scale models.* In 2020 IEEE 23rd International Conference on Information Fusion (FUSION) (pp. 1-8). IEEE.
- Pérez-Vieites, S., & Míguez, J. (2020). *Kalman-based nested hybrid filters for recursive inference in state-space models.* In 2020 28th European Signal Processing Conference (EUSIPCO) (pp. 2468- 2472). IEEE.
- Pérez-Vieites, S., Vilà-Vals, J., Bugallo, M. F., Míguez, J., & Closas, P. (2019). *Second Order Subspace Statistics for Adaptive State-Space Partitioning in Multiple Particle Filtering.* In 2019 IEEE 8th Intenational Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP) (pp. 609-613). IEEE.

Pre-prints and submitted papers:

- Pérez-Vieites, S., Molina-Bulla, H., & Míguez, J. (2022). *Nested smoothing algorithms for inference and tracking of heterogeneous multi-scale state-space systems.* arXiv preprint arXiv:2204.07795.
- Pérez-Vieites, S., & Elvira, Víctor (2022). *Adaptive Gaussian nested filter for parameter estimation and state tracking in dynamical systems.* Submitted to ICASSP 2023.

FELLOWSHIPS, GRANTS, PRIZES AND AWARDS

Submission to MSCA Postdoctoral Fellowship Sept. 2022
Assessment in progress

Submission to EPSRC Open Postdoc Fellowship Aug. 2022
Assessment in progress

Runner up poster presentation 07/06/2019
SIAM-IMA student chapter conference, University of Reading (Reading, UK)

PIPF grant (Personal Pre-doctoral en Formación) for Ph.D. students 11/09/2017 – 09/04/2019
Universidad Carlos III de Madrid (Madrid, Spain)

ORGANISATION ACTIVITIES

Local arrangements committee, SMC 2022 04/05/2022 - 06/05/2022
Description: I have been involved in the organisation of the 5th Workshop in Sequential Monte Carlo Methods 2022 (SMC 2022) in Madrid, Spain. To be specific, I led the **local arrangements committee**, producing the programme, arranging the registration materials, and supporting the sessions.

CONFERENCES AND SUMMER SCHOOLS

I have presented all my research advances in nine international and two national conferences. I have also attended other workshops and summer schools.

- **SIAM Conference on Mathematics of Data Science (MDS22)** 26/09/2022 - 30/09/2022
  Hybrid conference. San Diego, California (US)
  Attendance and poster presentation
- **5th Workshop in Sequential Monte Carlo Methods 2022 (SMC 2022)** 04/05/2022 - 06/05/2022
  Universidad Carlos III de Madrid (Spain)
  Attendance and poster presentation
  Part of the local arrangements committee
- **9th Spanish Workshop on Signal Proc., Communications & Inf. Theory (SIC 2022)** 03/05/2022
  Universidad Carlos III de Madrid (Spain)
  Attendance and poster presentation
- **28th European Signal Processing Conference (EUSIPCO 2020)** 18/01/2021 - 22/01/2021
  Virtual conference
  Attendance and poster presentation
  Paper title: *Kalman-based nested hybrid filters for recursive inference in state-space models.*
- **23rd Conference on Information Fusion (FUSION 2020)** 06/07/2020 - 09/07/2020
  Virtual conference
  Attendance and poster presentation
  Paper title: *A nested hybrid filter for parameter estimation and state tracking in homogeneous multi-scale models.*
- **27th European Signal Processing Conference (EUSIPCO 2019)** 02/09/2019 - 07/09/2019
  Universidade de A Coruña (Spain)
  Attendance and 3 minutes thesis talk
- **Workshop on Stochastic Parametrizations & Their Use in Data Assimilation** 01/07/2019 - 05/07/2019
  Imperial College London (UK)
  Attendance
- **Mathematics of Planet Earth Centre for Doctoral Training Summer School** 24/06/2019 - 28/06/2019
  Met Office (Exeter, UK)
  Attendance
- **SIAM-IAM student chapter conference** 07/06/2019
  University of Reading (UK)
  Attendance and poster presentation

- **LMS Invited Lecture Series & CRISM Summer School in Comp. Statistics** 09/06/2018 - 13/06/2018
  Warwick University (UK)
  Attendance and poster presentation
- **ISBA 2018 World Meeting** 24/06/2018 - 29/06/2018
  University of Edinburgh (UK)
  Attendance and poster presentation
- **Particle methods and Data assimilation workshop** 08/05/2018 - 10/05/2018
  Imperial College London (UK)
  Attendance
- **7th Spanish Workshop on Signal Proc., Inf. Theory & Communications** 23/01/2018
  Universidad de Navarra (San Sebastián, Spain)
  Attendance and poster presentation
- **Sequential Monte Carlo Workshop 2017 (SMC 2017)** 30/08/2017 - 01/09/2017
  Uppsala University (Sweden)
  Attendance and poster presentation

PROJECTS

I have participated in the following research projects at Universidad Carlos III as part of the scientific team.

- **PRACTICO-CM** Psiquiatría Computacional y Modelos Integrales de Comportamiento
  Funding agency: CAM. Consejería de Educación e Investigación (Y2018/TCS-4705)
  PI: Antonio Artés Rodríguez
  Duration: 01/01/2019 - 30/06/2022 (42 months)
  Budget: 645.775,90 €
- **BAYTREE** Advanced Bayesian computation methods for modelling and inference in complex dynamical networks
  Funding agency: Office of Naval Research Global (N00014-18-S-B001)
  PI: Joaquín Míguez Arenas
  Duration: 01/03/2019 - 28/02/2022 (36 months)
  Budget: 137.565,10 €
- **Métodos computacionales bayesianos avanzados para estimación, predicción y control en sistemas multisensoriales complejos**
  Funding agency: Ministerio de asuntos económicos y transformación digital (TEC2015-69868-C2- 1-R)
  PI: Antonio Artés Rodríguez, Joaquín Míguez Arenas
  Duration: 01/01/2016 - 31/12/2019 (48 months)
  Budget: 314.600,00 €
- **NICOP** - a new sequential Monte Carlo framework for tracking of non-linear complex dynamical systems
  Funding agency: Office of Naval Research Global (N62909-15-1-2011)
  PI: Joaquín Míguez Arenas
  Duration: 17/04/2015 - 16/04/2018 (36 months)
  Budget: 162.229,00 €

TEACHING EXPERIENCE

I have taken part in the teaching duties at undergraduate level, teaching (in Spanish and/or English) different courses in telecommunications engineering. I have also obtained good teaching quality indicators.

Courses taught at Universidad Carlos III as **teaching assistant**:

- **Linear systems** (2017-2019)
  Degrees: Mobile and Space Communications Engineering (B.Sc.), Telecommunication Technologies Engineering (B.Sc.) and Telematics Engineering (B.Sc.)
  Teaching hours: 112 hours
- **Linear networks analysis and synthesis** (2017 – 2018)
  Degree: Telecommunication Technologies Engineering (B.Sc.)
  Teaching hours: 5 hours

At Universidad Carlos III, detailed polls are anonymously filled by students at the end of each course. All the grades obtained have been averaged over all courses and all academic years yielding: **4.1/5**.

OUTREACH ACTIVITIES

- I have established a collaboration with **MeteoGalicia**, a meteorological centre (equivalent to the MetOffice in Galicia region, Spain), to apply stochastic filtering in **weather forecasting**. I have used the Weather Research and Forecasting (WRF) Model and data collected from meteorological base stations in Galicia.
- Participation in the **three minutes thesis (3MT)** at EUSIPCO 2019. Qualified as a finalist. Here I had to present a compelling oration on my thesis and its significance to an audience specialised in different areas.

REVIEWER ACTIVITIES

I have served as reviewer for several journals and conferences.

- **Journals:** Foundations of Data Science, IEEE Transactions on Signal Processing, and IEEE Signal Processing Letters.
- **Conferences:** EUSIPCO.

MAJOR COLLABORATIONS

I have started several collaborations with other six researchers from different research areas and universities.

- **Inés Pérez Mariño** (Professor at the Universidad Juan Carlos, Spain).
  Research area: Applied Physics.
  Description: We investigated the use of Bayesian inference methods in chaotic and nonlinear systems.
- **Jochen Broecker** (Associate Professor at the University of Reading, UK).
  Research area: Statistics.
  Description: Analysis of different stochastic parameterisations and how they affect the behaviour of simplified models.
- **Jordi Vilà-Valls** (Associate Professor at ISAE-SUPAERO, University of Toulouse, France), **Pau Closas** (Assistant Professor at Northeastern University, USA), **Mónica F. Bugallo** (Professor at Stony Brook University, USA) and **Petar M. Djurić** (Distinguished Professor at Stony Brook University, USA).
  Research area: Electrical and Computer Engineering.
  Description: We have investigated the use of Bayesian methods in engineering challenges such as multiple target tracking and estimation of high-dimensional systems.

LANGUAGES

English	Professional level
French	Intermediate level
Spanish	Native speaker
Galician	Native speaker