Thibault Pautrel

Postdoctoral researcher

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Born on 17 August 1994 in Le Mans (72), France

Education and experience

2025–2026 **Postdoctoral position**, *Centrale–Supélec, L2S*
Project: "Federated learning on covariance matrices for pre-trained models on health data".
Supervision: F. Bouchard

2024–2025 **Master "Smart Data"**, *ENSAI*, High honours
Internship: Riemannian Federated Learning on remote sensing data, LISTIC.
Supervisors: G. Ginolhac, A. Mian, F. Bouchard.

2018–2021 **PhD in Mathematics**, *University of Rennes 1, IRMAR*
Title: "On the universality of zeros of random functions".
Advisors: Jürgen Angst, Guillaume Poly.

2017–2018 **Master 2 Research ("Aléatoire")**, *University of Rennes 1*, Honours
Research internship: Backward reflected stochastic differential equations, LAMA.
Supervision: Ph. Briand.

2016–2017 **Master 2 in Mathematics (MEEF)**, *University of Rennes 1*, Preparation for the Agrégation, Honours

2015–2016 **Master 1 in Fundamental Mathematics**, *University of Rennes 1*, Honours

2014–2015 **Licence 3 in Mathematics**, *University of Rennes 1*, Honours

2012–2014 **CPGE MPSI–MP***, *Lycée Chateaubriand, Rennes*

Publications and research

Computer Science (Artificial Intelligence & Data)

Keywords Federated learning, Riemannian manifolds, SPD matrices, deep learning, geometric optimisation, signal processing.

[Submitted] T. Pautrel, F. Portier, *Riemannian stochastic optimization for sufficient dimension reduction*. Submitted.

Comment *Riemannian reformulation of MAVE for sufficient dimension reduction.* We show that minimizers of the MAVE criterion recover the span of the regression function's gradients—the same target as the Outer Product of Gradients method—through local regression in the projected space. Reformulating MAVE as a maximization problem on the Stiefel manifold and deriving a closed-form Riemannian gradient, we obtain the SMAVE algorithm (mini-batch Riemannian gradient ascent with adaptive k-nearest neighbor localization). On synthetic benchmarks, SMAVE matches or exceeds existing methods while running 10–50$\times$ faster; on real regression tasks, speedups exceed three orders of magnitude.

[Submitted] T. Pautrel, F. Bouchard, G. Ginolhac, A. Mian, *Projection-based Riemannian federated learning with partial participation*, submitted to *Signal Processing*, special issue on Signal Processing and Learning with Manifolds and Lie Groups.

Comment *Projection-based Riemannian federated learning supporting partial participation.* We propose two aggregation strategies, RFedProj and RFedRL, that are lightweight (relying only on standard projections and retractions), optimizer-agnostic, and support partial participation without auxiliary correction terms. Both achieve identical convergence rates under data heterogeneity, with bounds explicitly characterizing how participation ratio and heterogeneity interact—mirroring classical Euclidean federated guarantees. Experiments on EEG motor imagery classification with SPDNet on Stiefel manifolds validate competitive performance against centralized and Euclidean baselines.

[Submitted] T. Pautrel, F. Bouchard, A. Mian, G. Ginolhac, *FedSPDnet: geometry-aware federated deep learning with SPDnet*, submitted to EuSIPCO 2026.

Comment *First federated learning framework for the SPDnet architecture.* This paper proposes two optimizer-agnostic aggregation methods: ProjAvg, which projects the arithmetic mean onto the Stiefel manifold, and RLAvg, which approximates tangent-space averaging via retractions and liftings. Both preserve geometric structure at low computational cost, avoiding the pitfalls of Euclidean averaging (which breaks orthogonality) and exact Riemannian means (which are computationally prohibitive). Simulations on EEG motor imagery benchmarks show that FedSPDnet outperforms federated EEGnet in F1 score and robustness to federation and partial participation, while using fewer parameters per communication round.

Mathematics (Stochastic processes & asymptotic analysis)

Keywords Nodal sets, random trigonometric polynomials, stationary Gaussian processes, strong dependence, universality, Kac–Rice formulas.

[To appear] J. Angst, T. Pautrel, G. Poly, *Global universality of the expected number of zeros of non-analytic random signals*. To appear in INdAM–Springer Proceedings (2025).

Comment *First global universality result for non-analytic signals.* This paper shows that the universality phenomenon for the number of zeros persists for periodic signals with only finite regularity, without any analyticity assumption. By combining functional limit theorems (of Salem–Zygmund type), probabilistic control of the number of zeros, and a passage from local to global behaviour via averaging over microscopic windows, we establish convergence towards the universal constant $2/\sqrt{3}$ up to a geometric L^2 factor. This work opens the way to the study of more realistic models and provides a methodological contribution to extending the theory of random zeros beyond the classical analytic setting.

[Published] J. Angst, T. Pautrel, G. Poly, *Real zeros of random trigonometric polynomials with dependent coefficients*. *Transactions of the American Mathematical Society* **375** (2022), 7209–7260.

Comment *Complete characterization of the universality / non-universality transition.* This article establishes a precise dichotomy for trigonometric polynomials with correlated Gaussian coefficients associated with a spectral measure μ_ρ: the universal limit for the renormalized mean number of zeros is obtained if and only if the spectral density ψ_ρ is almost surely strictly positive with logarithmic integrability. Otherwise, the number of zeros depends on the measure of the zero set of this density. By combining the Kac–Rice formula with Salem–Zygmund type functional convergence, this work links dependence structure, geometry and universality phenomena, and in particular encompasses increments of fractional Brownian motion for any Hurst parameter.

[Published] T. Pautrel, *New asymptotics for the mean number of zeros of random trigonometric polynomials with strongly dependent Gaussian coefficients*. *Electronic Communications in Probability* **25** (2020), no. 36.

Comment *First explicit example of universality breakdown and a continuum of possible limits.* In this article I highlight the critical role played by the singular nature of the spectral measure in the breakdown of universality. Considering coefficients correlated via $\rho(k) = \cos(k\alpha)$, corresponding to the purely singular measure $\mu = \frac{1}{2}(\delta_\alpha + \delta_{-\alpha})$, I show that the normalized mean number of zeros no longer converges to $2/\sqrt{3}$ but can take any value in the interval $(\sqrt{2}, 2]$ depending on the choice of α. This breakdown illustrates the importance of the regularity of the spectral measure and opens a new line of research on strongly dependent models at the interface between probability, harmonic analysis and random geometry.

Teaching

2025–2026 **Computer lab sessions**, *IUT Orsay*, R101-B: Introduction to programming with C++, 33 h

Machine Learning tutorials (2A), *CentraleSupélec*, 12 h

Statistics and Learning tutorials (1A), *CentraleSupélec*

Core course covering mathematical statistics (estimation, hypothesis testing) and statistical learning (linear/logistic regression, regularisation, decision trees, neural networks, PCA, k-means). Based on lecture notes by P.-H. Cournède.

2021–2024 **Certified secondary-school mathematics teacher (agrégé)**, *Middle & high school*

Mathematics oral exams ("colles"), *BCPST, PCSI, MP*

2018–2021 **Tutorials**, *University of Rennes 1*

Department of Mathematics (∼64 h/year):

- Analysis and probability (tutorials, 2nd-year BSc in mathematics).
- Probability (tutorials, 1st-year biology).
- Supervision of undergraduate research projects (1st year ENS Rennes) on Stein's method.
- Member of mock oral exam boards (preparation for the CAPES and Agrégation in mathematics).

2016–2018 **Mathematics oral exams ("colles")**, *MP and MP**, Lycée Chateaubriand, Rennes

Competitive exams

2017 **External Agrégation in Mathematics**, *Probability–statistics option*, rank 118

Scientific service and responsibilities

2023–2025 **Member of the Centrale–Supélec entrance examination committee**

Marking of written exams (2023, 2024, 2025) and examiner for the Mathematics–Computer Science oral exam for MP candidates (2023, 2024).

2019–2021 **Co-organiser**, *Doctoral seminar in probability "Gaussbusters"*, Rennes

Skills

Programming & data Python, R, SQL, Spark, C++, OCaml, Scilab

Unix Bash scripting

Tools LaTeX

Languages

English Fluent (C2) *Certificate of Proficiency in English (2013)*

Spanish Reading, speaking, writing

Interests

Ski touring

Running, swimming, cycling, fitness, tennis