Louis Berthier

PhD candidate experienced in ML, Mathematics, and Programming.

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Education

Ecole Polytechnique | PhD in Applied Mathematics & Machine Learning *March 2024 - Present*

Paris, France

- Industrial Thesis (CIFRE) in collaboration with Michelin, supervised by Pr. Eric Moulines, & Dr. Ahmed Shokry.
- Developing predictive-generative algorithms: conformal and adaptive soft sensors monitoring in real-time the production line quality.

Imperial College London | MSc Advanced Computing in ML *October 2022 - October 2023*

London, United Kingdom

- Master thesis supervised by Pr. Antoine Cully: model-based uncertainty quantification for quality-diversity optimisation
- Diploma with merit (2:1), and thesis with distinction (1st).
- Modules: machine learning, deep learning, reinforcement learning, computer vision, natural language processing, independent study option, mathematics for machine learning, computational finance, robot learning, machine learning for imaging, principles of distributed ledgers.

IMT Mines Alès | MSc AI & Data Science (Diplôme d'ingénieur) *September 2020 - September 2023*

Alès, France

- Average grade (GPA): 3.7/4 with first class honours and jury's congratulations.
- Ranked 2^{nd} in the computer science & AI department among 56 students, and in the top 5% of all students.
- Relevant modules: machine learning, advanced probabilities & statistics, operational research, algorithms & complexity, time series, computer vision, image & signal processing, software engineering, numerical analysis.

Lycée Déodat de Séverac | Scientific Preparatory Classes *September 2018 - July 2020*

Toulouse, France

- Completed intensive and advanced courses in mathematics, physics and computer science for highly competitive nationwide science exams.

Research & Work Experience

Michelin | Research Engineer (PhD Contract) *March 2024 - Present*

Clermont-Ferrand, France

Conformal and adaptive soft sensors for rubber production line quality monitoring.
Supervised by Guillaume Ramelet (Principal Data Scientist) & Dr. Sylvain Desroziers (R&D Manager).

Adaptive & Intelligent Robotics Lab (AIRL) | Research Assistant *April 2023 - September 2023*

London, United Kingdom

Model-based uncertainty quantification for quality-diversity optimisation.
Supervised by Pr. Antoine Cully (AIRL director), Manon Flageat, & Bryan Lim (AIRL PhD candidates) at Imperial College London.

- Improved MAP-Elites data efficiency and noise robustness through a model-based implementation.
- Introduced new hyperparameters to bridge the gap between model-based and model-free QD algorithms.
- Introduced new metrics to assess uncertainty quantification.
- Demonstrated the importance of (1) probabilistic modelling, (2) explicit sampling and (3) container reset mechanisms in a non-deterministic environment.

Centre National de la Recherche Scientifique (CNRS) | Research Intern *May 2022 - July 2022*

Toulouse, France

Detection of pathological oscillations in epilepsy using signal processing and convolutional neural networks.
Supervised by Dr. Ludovic Gardy (CNRS research engineer), Pr. Emmanuel Barbeau (CNRS research director), & Pr. Christophe Hurter (ENAC research professor).

- Optimized signal and image processing methods, reducing computation time by 15% using the Cython library.
- Built 7 NoSQL databases for analyzing EEG data at macro and micro scales.
- Improved model performance by 5% through fine-tuning techniques.

- Implemented Grad-CAM to enhance model explainability and alignment with underlying data.
- Evaluated model resilience and generalization to multiple biomarkers.

EuroMov DHM | Research Assistant *January 2022 - April 2022*

Alès, France

Design of an image filter for narrow contour detection and multi-scale adaptation using machine learning. Supervised by Pr. Baptiste Magnier & Pr. Binbin Xu, research-professors at IMT Mines Alès

- Developed a novel 2D filter for detecting adjacent and multi-scale ridges in images.
- Implemented state-of-the-art edge detection models (DexiNed, RCF) within images.

Research & Personal Projects

Model-Based Approaches for Uncertainty Quantification *January 2023 - April 2023*

- Explored the impact of uncertainty on QD algorithms and investigated techniques for handling and quantifying uncertainty.
- Implemented and thoroughly evaluated various QD algorithms, particularly focusing on MAP-Elites, in both deterministic and uncertain environments.

Agent Control & Uncertain Environments *January 2023 - March 2023*

- Developed advanced learning methods by integrating MBRL approaches into existing techniques like RS and CEM to tackle challenging and noisy environments.
- Implemented strategies to optimize agent movement and design novel reward functions for enhanced learning.

Generative Models *January 2023 - March 2023*

- Implemented VAE and GAN architectures to generate and reconstruct images across diverse domains.
- Conducted comprehensive visual evaluations to assess the fidelity and realism of the generated images from both models.
- Performed in-depth theoretical and mathematical analyses of VAE and GAN frameworks, elucidating their underlying principles and highlighting their strengths and limitations.

Patronizing Classification *January 2023 - March 2023*

- Utilized the Don't Patronize Me! dataset to accurately identify and categorize instances of Patronizing Classification (PCL).
- Implemented techniques such as data augmentation, optimized pre-processing methods, and extensive hyperparameter studies to enhance the performance of the RoBERTa model for PCL.
- Conducted a comprehensive comparative analysis, evaluating the RoBERTa model against various baseline approaches to assess its effectiveness in PCL tasks.

Time Series Forecasting - Energy Consumption *December 2022 - January 2023*

- Utilized XGBoost to predict energy consumption, enabling proactive resource planning and decision-making.
- Implemented outlier removal and time series cross-validation to improve the accuracy and robustness of the model.
- Leveraged lag features and analyzed feature importance to capture historical patterns and identify key drivers impacting energy consumption, enhancing understanding and enabling strategic insights.

Deep Q Networks *October 2022 - December 2022*

- Implemented and transformed a DQN into a DDQN using OpenAI Gym and Maze environment.
- Conducted a comprehensive investigation and comparative analysis of various RL methods, such as DP, MC, and TD, to enhance the learning process while striking an optimal balance between exploration and exploitation.

Portfolio Optimization - FAANG *September 2022 - November 2022*

- Developed a portfolio optimization system to create efficient portfolios with optimized risk-return trade-offs.
- Constructed diversified portfolios by selecting assets and assigning appropriate weights based on historical performance.
- Implemented volatility and variance calculations to measure risk and evaluated the efficiency of portfolios using performance metrics such as Sharpe ratio and maximum drawdown.

Time Series Forecasting - Jobs & Industries *March 2022 - April 2022*

- Employed statistical analysis, seasonality, and trend to accurately predict the evolution and behaviour of time series data within employment contracts and diverse industry sectors.
- Implemented and compared several forecasting models such as SES, Holt Winter, ARIMA, and SARIMA.

Brain Tumors Classification *February 2022 - April 2022*

- Implemented a CNN architecture to classify the presence of brain tumours in MRI images accurately.
- Employed data augmentation techniques, optimized pre-processing methods, and conducted rigorous hyperparameter studies to enhance the performance of the model.

Kalman Filter *October 2021 - December 2021*

- Implemented and applied the Kalman filter algorithm to analyze the movement patterns of individuals using MOT databases and bee videos.
- Enhanced performance and reliability of motion prediction by integrating image background pre-processing techniques with the Kalman filter.

Teaching & Supervision

Teacher Assistant | ENSTA Paris *September 2024 - October 2024*

Paris, France

- Introduction to machine learning and data science, 3rd year of BSc in mathematics (20h/year).

Talks & Outreach

MT180 Finalist (Public Award) | École Polytechnique *February 2025 - April 2025*

Palaiseau, France

- Finalist in "Ma Thèse en 180 secondes" (MT180), a science communication competition challenging PhD students to present their research in 180 seconds.
- Title: *Robust real-time quality monitoring and reliable adaptation of manufacturing processes in the tire industry.*
- Selected among 25 participants; received the Public Award and qualified for the national finals.
- More resources: my video presentation, finalists presentation, awards.

Research Seminar Founder & Organizer | Michelin *April 2024 - Present*

Clermont-Ferrand, France

- Weekly seminar for researchers and data scientists, consisting of a presentation and discussion of a research paper.
- Topics: machine & deep learning, computer vision, natural language processing, uncertainty quantification.
- My presentations:
  - Quality-Diversity Optimization: a novel branch of stochastic optimization
  - Attention Is All You Need
  - HyenaDNA: Long-Range Genomic Sequence Modeling at Single Nucleotide Resolution
  - A Gentle Introduction to Conformal Prediction and Distribution-Free Uncertainty Quantification
  - TorchSOM: A Scalable PyTorch-Compatible Library for Self-Organizing Maps

Publications

Conference Papers

[C2] Louis Berthier, Ahmed Shokry, Eric Moulines, Guillaume Ramelet, and Sylvain Desroziers. "Knowledge Discovery in Large-Scale Batch Processes through Explainable Boosted Models and Uncertainty Quantification: Application to Rubber Mixing". In: *ESCAPE 35 (2025) - European Symposium on Computer Aided Process Engineering*. 2025

[C1] Baptiste Magnier, Ghulam Sakhi Shokouh, Louis Berthier, Marcel Pie, and Adrien Ruggiero. "2DSBG: A 2d Semi Bi-Gaussian Filter Adapted for Adjacent and Multi-Scale Line Feature Detection". In: *ICASSP 2023 - 2023 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. 2023

Journal Papers

[J2] Louis Berthier, Ahmed Shokry, Eric Moulines, Guillaume Ramelet, and Sylvain Desroziers. "A Robust and Reliable Data-Driven Framework for Quality-Related Knowledge Discovery in Large-Scale Rubber Mixing Batch Processes". In: *Journal of Cheminformatics* (2025)

[J1] Ludovic Gardy*, Jonathan Curot, Luc Valton, Louis Berthier, Emmanuel J. Barbeau, and Christophe Hurter. "Detecting fast-ripples on both micro- and macro-electrodes in epilepsy: A wavelet-based CNN detector". In: *Journal of Neuroscience Methods* (2025)

Talks

[T1] July 2025 — **ESCAPE 35**, Ghent, Belgium. Selected to give a talk instead of presenting a poster.

Posters

[P2] December 2024 — **Welcome PhD Day**, Palaiseau, France. **Best PhD poster in mathematics**.

[P1] November 2024 — **Michelin Doctoral Day**, Clermont-Ferand, France.

Language & Technical Skills

- Python, (No)SQL, Git, Docker, Azure ML, Kubernetes, Weights & Biases, Singularity, LaTeX
- NumPy, Pandas, TensorFlow, PyTorch, JAX, QDax, OpenCV, Scikit-learn, Matplotlib, SciPy, Seaborn, Pytest
- French (native), English (fluent), Spanish (business proficient)

Academic honours, Grants & Distinctions

Honours

- **Master Thesis with Distinction (1st)** | Imperial College London, 2023
  Proposal for a PhD in the AIRL laboratory under the supervision of Pr. Antoine Cully.
- **Master of Science with Merit (2:1)** | Imperial College London, 2023
- **Diplôme d'ingénieur with First Class Honours (1st)** | IMT Mines Alès, 2023
  Jury's congratulations for obtaining excellent results, ranked 2^{nd} in the CS & AI department, and in the top 5% of all students.
- **French Scientific Baccalaureate with High Honors** | Lycée Saint-Exupéry, 2018
  Highschool project selected for the Engineering Sciences Olympiad.

Grants & Awards

- **MT180 Public Award** — 100€ | Institut Polytechnique de Paris, 2025
- **Award of the best PhD poster in mathematics** — 500€ | Institut Polytechnique de Paris, 2024
- **Winner of the Manufacturing IT Hackathon 'AI'NNOV'** — 500€ | Michelin, 2024
- **International Mobility Scholarship for Imperial College London** — 4000€ | Région Occitanie, 2022
- **Alumni Scholarship for Imperial College London** — 1300€ | Mines Alès Alumni 2022
- **Excellence Scholarship** — 4000€ | IMT Mines Alès, 2022
- **Creativity Laureate** — Communication & Media | Cora Hypermarket, 2021

Distinctions

- 3^{rd} **position in the highest national league** — Handball | British Universities and Colleges Sport, 2023
- 4^{th} **position in the highest national league** — Handball | Fédération Française du Sport Universitaire, 2022
- **Winner of the** 49^{th} **Challenge Centrale Lyon** — Handball | Centrale Lyon, 2022
- **Winner of the** 19^{th} **TRAMS** — Handball | ENTPE, 2021
- **Finalist in a male modelling constest** | Socute Models, 2019 & 2020

Voluntary Experience

Bureau des Sports (Sports Association) | Vice President *February 2021 - April 2022*
Alès, France

- Led a team of 25 people to manage 5 tournaments, 20 sports, and 50 captains-coaches.
- Secured many partners to support us, including Armor Lux and Tony Parker.
- Supervised and updated the IT part of the website.
- Planned meetings with several stakeholders to ensure the progress of projects.

EmaVisual (Photography & Video Association) | Vice President *April 2021 - April 2022*
Alès, France

- Led a team of 10 photographers to cover 25 association events.
- Edited multiple videos and about 10000 photos.
- Planned meetings with several stakeholders to ensure the progress of projects.

Tsiky Zanaka (International Humanitarian Association) | Volunteer *September 2020 - September 2021*
Alès, France

- Cooked meals for 300 students on several evenings and raised 3500€ with 30 other students through activities.
- Participated in the development of several solidarity projects in Madagascar.

EmaMix (DJs Association) | Disc Jockey *September 2020 - September 2021*
Alès, France

- Animated the student life by mixing at meals, parties, and student events.

Trophée Orlandini (Rugby Tournament Association) | Logistics Volunteer *September 2020 - October 2020*
Alès, France

- Participated in the logistic organization and the progress of the tournament gathering 6 schools on a weekend.