

# Louis Béthune

PhD

Toulouse, France

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Driving licence

## Deep learning under Lipschitz constraints

- Advisor Mathieu Serrurier (IRIT, UPS).
- Abstract Deep learning with constraints covers various topics such Lipschitz constrained neural networks, convex neural networks, and “optimization as a layer”. This thesis explores how structural constraints in training pipeline yields theoretical guarantees like generalization, robustness, privacy. It draws links to optimal transport, differentially private learning, computer graphics and explainability.
- Publications **ICLR (2024), NeurIPS (2023, 2022), ICML 2023, CVPR 2023, AISTATS 2023**, MDPI Information, MDPI Algorithms.
- Jury Alexandre Allauzen (ESPCI, Université Paris-Dauphine), Loïc Barthe (IRIT, UPS), Rémi Flamary (École Polytechnique), Gabriel Peyré (ENS d’Ulm, CNRS), Louise Travé-Massuyès (LAAS, CNRS).

## Education

- 2020–2023 **PhD in Computer Science**, *Université Paul-Sabatier*, Toulouse  
Supervised by Mathieu Serrurier. Hosted by [IRIT](https://www.irit.fr). Under [ANITI](https://www.aniti.fr) funding, and the chair “Fair and robust learning” of [Jean-Michel Loubes](https://www.jmlr.org/authors/jean-michel-loubes/). I am also part of [DEEL](https://www.deel.fr) team.
  - Research internship at **Google Brain** (2021) under the supervision of [Mathieu Blondel](https://www.mathieu-blondel.com).
  - Animator of more than **160 hours** of courses and practical sessions in computer science.
- 2020 **École Normale Supérieure de Lyon Diploma**, *ENS de Lyon*, France  
Obtained as civil servant. Additionnal achievement:
  - English CEFR C1 level, Cambridge English Advanced (2020) score 199/210.
- 2019 **Master in Fundamental Computer Science**, *ENS de Lyon*  
“Complex systems” speciality. Courses in optimization, graph signal processing, complex networks, data-science, machine learning, statistical physics, computer science for biology.
  - Research internship at **Google Brain** (2019) under the supervision of Matthieu Geist
- 2014–2016 **MPSI-MP\***, *Lycée Henri-Wallon*, Valenciennes, France  
Preparatory classes for selective higher-education institution with a competitive entrance examination, in mathematics and physics.
- 2014 **Scientific Baccalauréat**, *Jessé de Forest*, Avesnes-sur-Helpe, with highest honors.

## Programming: see my github page [Algue-Rythme](#)

Python **10 years of practice**, *in machine learning and deep learning*.

- **Top-3 contributor of Jaxopt library**, a Jax library for differentiable optimization.
- Deep-learning: Jax&Flax, Tensorflow, Pytorch, wandb.
- Miscellaneous: scikit-learn, xgboost, pandas, numba, plotly, jupyter.

C++ **8 years of practice**, *in various topics*, with libraries Boost, SFML, Eigen, CGAL.

- **Team leader of CartomensIA project (17 people)**. We coded a multiplayer card game for desktops and mobile phones, with Monte Carlo Tree Search powered AI (2017–2018).
- Notable programs.
  - Inpainting software (2018), SQL interpreter (2018), raytracing engine (2017), neural network and backpropagation (2016), procedural map generation on GPU with Voronoi diagrams (2016), genetic algorithm for Eternity II (2015), game of Hex AI (2014).
- Competitive programming.
  - SWERC (Regional Selection for ACM ICPC): rank 36 (2017), rank 30 (2018).
  - Finalist of the national contest Prologin (2013, 2014, 2015, 2016, 2017, 2018).
  - Training for International Olympiad in Informatics with France-IOI (2012, 2013, 2014).

Miscellaneous C, Cuda, OCaml, Haskell.

Tools Git, CMake, Linux, Slurm, ssh, L<sup>A</sup>T<sub>E</sub>X.

## Service to research community

Peer review ICLR(2024), ICML (2023), Computo journal (2023), AISTATS (2024, 2023), CVPR (2023, 2021), NeurIPS(2023, **Top 10% reviewer in 2022**), ICCV (2021), IEEE Transactions on Signal Processing (2021, 2020), ECML/PKDD (2020).

Volunteering Teaching assistant of Reinforcement Learning Virtual School (RLVS 2021).  
IEEE ISIT student volunteer (2019).

## Teaching activities and supervision

Master intern **Creation of the topic, recruitment, and supervision.**

Thomas Masséna (from Grenoble INP Phelma) in February-July 2023, at IRT Saint-Exupéry.

Courses **Animation and creation of the curriculum, slides, exercices, and evaluations.**

2022-2023 L3 IA, Université Paul Sabatier (16h)

2021-2022 L2 CUPGE, Université Paul Sabatier (32h)

Practical sessions **Computer science, machine learning, algorithmics.**

2023-2024 Master 1 SID, Université Paul Sabatier (8h)

2022-2023 L3 IA, Université Paul Sabatier (20h)

2022-2023 Data Science Master of Science program, ISAE SUPAERO (10h)

2021-2022 L3 INFO, Université Paul Sabatier (8h)

2020-2021 MAG1, Université Toulouse Capitole (36h)

2020-2021 Data Science Master of Science program, ISAE SUPAERO (29h)

2020-2021 Master 2 MAT-SID, Université Paul Sabatier (12h)

2017–2018 Teaching assistant in preparatory classes for practical sessions (4h)

Volunteering **Animator of the summer camp *Girls can code!***

2017–2019 Initiations to programming for high school girls (Pygame, BBC Microbit)

## Academic talks and broader public scientific communication

- December 2023 *Invited talk*, Université Paris-Dauphine.
- November 2022 *NeurIPS Paris pre-conference*, Sorbonne Center on Artificial Intelligence (SCAI).
- July 2022 *32nd Association of European Operational Research Societies (EURO) Conference*, Aalto University Espoo, Finland.
- June 2022 *"Intelligence artificielle : peut-on lui faire naturellement confiance ?"* public debate, Quai des savoirs, Toulouse. See the interview in [companion article](#).
- June 2022 *53èmes Journées de Statistique de la Société Française de Statistique*, Université Claude Bernard Lyon 1, France.

## Research Experiences

- 2021 **Google Research intern**, *Google*, Paris  
Within Combini team (Brain), under the supervision of Mathieu Blondel.
  - Top-3 contributor of Jaxopt library, a Jax library for differentiable optimization.
- 2020 **Research intern**, *MILA*, Montréal, Canada  
Supervised by Jian Tang and Sophie Xhonneux. Remote internship.
- 2020 **Research intern**, *Institut des Mines-Télécom Atlantique*, Brest, France  
Supervised by Vincent Gripon.
  - Myriam Bontonou, Louis Béthune, and Vincent Gripon. Predicting the generalization ability of a few-shot classifier. *Information*, 12(1):29, 2021
- 2019 **Research intern**, *ENS de Lyon*  
Within SiSyPhe team, supervised by Pierre Borgnat and Aurélien Garivier.
  - Louis Béthune, Yacouba Kaloga, Pierre Borgnat, Aurélien Garivier, and Amaury Habrard. Hierarchical and unsupervised graph representation learning with loukas's coarsening. *Algorithms*, 13(9):206, 2020
- 2019 **Google Software Engineering intern**, *Google*, Paris  
Supervised by Olivier Pietquin and Matthieu Geist. Toward long term planning in reinforcement learning with hyperbolic discounting in policy gradient.
- 2018 **Research intern**, *Universidade do Algarve*, Faro, Portugal  
Supervised by Daniel Graça, and the help of Amaury Pouly. Characterization of PSPACE with polynomial ordinary differential equations and continuous time analog machines.
- 2017 **Research intern**, *Laboratoire de Recherche en Informatique*, Orsay, France  
Within INRIA TAO team, under the supervision of Guillaume Charpiat. Train convolutional neural network using policy gradient to track paramecium.

— All publications and preprints: [see my scholar page](#)

- [1] Louis Béthune, Thomas Masséna, Thibaut Boissin, Yannick Prudent, Corentin Friedrich, Aurélien Bellet, Franck Mamalet, Mathieu Serrurier, and David Vigouroux. Dp-sgd without clipping: The lipschitz neural network way. *International Conference on Learning Representations (ICLR)*, 2024.
- [2] François Bachoc, Louis Béthune, Alberto Gonzalez-Sanz, and Jean-Michel Loubes. Gaussian processes on distributions based on regularized optimal transport. In *International Conference on Artificial Intelligence and Statistics (AISTATS)*, 2023.
- [3] François Bachoc, Louis Béthune, Alberto González-Sanz, and Jean-Michel Loubes. Improved learning theory for kernel distribution regression with two-stage sampling. *arXiv preprint arXiv:2308.14335*, 2023.
- [4] Louis Béthune, Paul Novello, Thibaut Boissin, Guillaume Coiffier, Mathieu Serrurier, Quentin Vincenot, and Andres Troya-Galvis. Robust one-class classification with signed distance function using 1-lipschitz neural networks. In *International Conference on Machine Learning (ICML)*, 2023.
- [5] Thomas FEL, Victor Boutin, Louis Béthune, Remi Cadene, Mazda Moayeri, Léo Andéol, Mathieu Chalvidal, and Thomas Serre. A holistic approach to unifying automatic concept extraction and concept importance estimation. In *Thirty-seventh Conference on Neural Information Processing Systems*, 2023.
- [6] Thomas Fel, Agustin Picard, Louis Béthune, Thibaut Boissin, David Vigouroux, Julien Colin, Rémi Cadène, and Thomas Serre. Craft: Concept recursive activation factorization for explainability. In *IEEE / CVF Computer Vision and Pattern Recognition Conference (CVPR)*, 2023.
- [7] Fanny Jourdan, Louis Béthune, Agustin Picard, Laurent Risser, and Nicholas Asher. Taco: Targeted concept removal in output embeddings for nlp via information theory and explainability. *arXiv preprint arXiv:2312.06499*, 2023.
- [8] Mathieu Serrurier, Franck Mamalet, Thomas Fel, Louis Béthune, and Thibaut Boissin. On the explainable properties of 1-lipschitz neural networks: An optimal transport perspective. 2023.
- [9] Louis Béthune, Thibaut Boissin, Mathieu Serrurier, Franck Mamalet, Corentin Friedrich, and Alberto Gonzalez Sanz. Pay attention to your loss : understanding misconceptions about lipschitz neural networks. In *Advances in Neural Information Processing Systems (NeurIPS)*, 2022.
- [10] Louis Béthune and Mathieu Serrurier. Certifiable metric one class learning with adversarially trained lipschitz classifier. In *NeurIPS ML Safety Workshop*, 2022.
- [11] Thomas Fel, Lucas Hervier, David Vigouroux, Antonin Poche, Justin Plakoo, Remi Cadene, Mathieu Chalvidal, Julien Colin, Thibaut Boissin, Louis Bethune, et al.

- Xplique: A deep learning explainability toolbox. *arXiv preprint arXiv:2206.04394*, 2022.
- [12] Alberto González-Sanz, Lucas De Lara, Louis Béthune, and Jean-Michel Loubes. Gan estimation of lipschitz optimal transport maps. *arXiv preprint arXiv:2202.07965*, 2022.
- [13] Thomas Mullor, David Vigouroux, and Louis Bethune. Efficient circuit implementation for coined quantum walks on binary trees and application to reinforcement learning. In *2022 IEEE/ACM 7th Symposium on Edge Computing (SEC)*, pages 436–443. IEEE, 2022.
- [14] Myriam Bontonou, Louis Béthune, and Vincent Gripon. Predicting the generalization ability of a few-shot classifier. *Information*, 12(1):29, 2021.
- [15] Louis Béthune, Yacouba Kaloga, Pierre Borgnat, Aurélien Garivier, and Amaury Habrard. Hierarchical and unsupervised graph representation learning with loukas’s coarsening. *Algorithms*, 13(9):206, 2020.
- [16] Carlos Lassance, Louis Béthune, Myriam Bontonou, Mounia Hamidouche, and Vincent Gripon. Ranking deep learning generalization using label variation in latent geometry graphs. *arXiv preprint arXiv:2011.12737*, 2020.