Louis Béthune

PhD student

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Phd topic

Title *Deep learning under architectural constraints*

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 at **NeuRIPS 2022**, **ICML 2023**, **CVPR 2023**, **AISTATS 2023**, *MDPI Algorithms*, *MDPI Information*.

Education

Since 2020 **PhD candidate in Computer Science**, *Université Paul-Sabatier*, Toulouse
Supervised by Mathieu Serrurier. Hosted by IRIT. Under ANITI funding, and the chair "Fair and robust learning" of Jean-Michel Loubes. I am also part of DEEL team.
- Research internship at **Google Brain** (2021) under the supervision of Mathieu Blondel.
- Animator of more than **160 hours** of courses and practical sessions in computer science.

2016–2020 **Diplôme de l'École Normale Supérieure de Lyon**, *ENS de Lyon*, France
Obtained as civil servant. Additionnal achievement:
- English CEFR C1 level, Cambridge English Advanced (2020) score 199/210.

2017–2019 **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.

Programming: see my github page Algue-Rythme

Python **9 years of practice**, *in machine learning and deep learning.*
- **Top-3 contributor of Jaxopt library**, a Jax library for differentiable optimization.

C++ **8 years of practice**, *in various topics*, with libraries Boost, SFML, Eigen, CGAL.
- **Team leader of CartomensIA project (17 people)**.
- Competitive programming. SWERC, Prologin, FranceIOI.

Miscellaneous C, Cuda, OCaml, Haskell, SQL.

Tools Git, CMake, Bazel, Linux, Slurm, ssh, LaTeX, PowerPoint.

Service to research community

Peer review	ICML (2023), Computo journal (2023), AISTATS (2023), CVPR (2023, 2021), **Top 10% reviewer of NeurIPS 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	**2023 (6 months)**, *Thomas Masséna*
Courses	**Animation and creation of the curriculum, slides, exercices, and evaluations.**
	2022-2023 46h in total, bachelor level.
Practical sessions	**Computer science, machine learning, algorithmics.**
	2020-2023 More than 120h in bachelor, master, and engineering schools.
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

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*, 4 months
2020	**Research intern**, *Institut des Mines-Télécom Atlantique*, 6 months
2019	**Research intern**, *ENS de Lyon*, 5 months
2019	**Google Software Engineering intern**, *Google Paris*, 5 months
2018	**Research intern**, *Universidade do Algarve*, 3 months
2017	**Research intern**, *Laboratoire de Recherche en Informatique*, 6 weeks

All publications and preprints: see my scholar page

[1] 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.

[2] 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. *preprint*, 2023.

[3] 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.

[4] 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.

[5] 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.

[6] Louis Béthune and Mathieu Serrurier. Certifiable metric one class learning with adversarially trained lipschitz classifier. In *NeurIPS ML Safety Workshop*, 2022.

[7] 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.

[8] 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.

[9] 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.

[10] Mathieu Serrurier, Franck Mamalet, Thomas Fel, Louis Béthune, and Thibaut Boissin. When adversarial attacks become interpretable counterfactual explanations. *arXiv preprint arXiv:2206.06854*, 2022.

[11] Myriam Bontonou, Louis Béthune, and Vincent Gripon. Predicting the generalization ability of a few-shot classifier. *Information*, 12(1):29, 2021.

[12] 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.

[13] 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.