Kilian Fatras

Research scientist in Machine Learning - 2023/2024

Montréal, Québec, Canada
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Scholar
Website

Research interest: Optimal Transport, Out-of-distribution samples, Generative models, Supervised learning

Education and positions

Current **Post-doctoral fellow in Out-Of-Distribution samples and Optimal Transport** - Mila Quebec AI institute and McGill University - Supervisors : Professor Adam Oberman & Professor Ioannis Mitliagkas

2021 **PhD (applied mathematics) "Optimal transport & deep learning: learning from one another"** IRISA - Supervisors : Professor Nicolas Courty & Professor Rémi Flamary

2018 **Master of Science in Technological Innovation sp. data science** - UC Berkeley & Polytechnique

2018 **Engineering Diploma in Applied Mathematics and Computer Science** - ENSTA Paris

2015 **Bachelor in Mathematics and Physics (Double Major)** - University of Western Brittany

Published papers

Conference papers

1. **Optimal transport meets noisy label robust loss and MixUp regularization for domain adaptation** - [URL] - *Kilian Fatras, Hiroki Naganuma, Ioannis Mitliagkas*
   Conference on Lifelong Learning Agents (CoLLAs) 2022, Montréal
2. **Unbalanced minibatch Optimal Transport; applications to Domain Adaptation** - [URL] - *Kilian Fatras, Thibault Séjourné, Nicolas Courty and Rémi Flamary*
   International Conference on Machine Learning (ICML) 2021, Virtual
3. **Learning with minibatch Wasserstein: asymptotic and gradient properties** - [URL] - *Kilian Fatras, Younes Zine, Rémi Flamary, Rémi Gribonval and Nicolas Courty*
   AISTATS 2020, Palermo, Italia
4. **Proximal Splitting meets Variance Reduction** - [URL] - *Fabian Pedregosa, Kilian Fatras et al.*
   AISTATS 2019, Naha, Okinawa, Japan

Journal papers

5. **Generating natural adversarial Remote Sensing Images** - [URL] - *Jean-Christophe Burnel, Kilian Fatras, Rémi Flamary and Nicolas Courty*
   IEEE Transactions on Geoscience and Remote Sensing (TGRS), 2021
6. **Wasserstein Adversarial Regularization (WAR) on label noise** - [URL] - *Kilian Fatras, Bharath Damodaran, Sylvain Lobry, Rémi Flamary, Devis Tuia and Nicolas Courty*
   IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), 2021
7. **POT: Python Optimal Transport** - [URL] - *Rémi Flamary, Nicolas Courty et al.*
   Journal of Machine Learning Research Open Source Software, 2021

Submitted papers

Conference papers

8. **On making optimal transport robust to all outliers** - [URL] - *Kilian Fatras (Single author paper)*

Journal papers

9. **Minibatch optimal transport distances; analysis and applications** - [URL] - *Kilian Fatras, Younes Zine, Szymon Majewski, Rémi Flamary, Rémi Gribonval and Nicolas Courty*

Research internships

May 2018 **Research Assistant - University of British Columbia, Vancouver**

The purpose of this 6 month research internship was to work on optimization for optimal transport and on the generation of adversarial examples. I worked under the supervision of Professor Mark Schmidt.

Sept. 2017 **Research Assistant - University of California, Berkeley**

The purpose of this 8 month research project was to develop and to improve the analysis of sparse distributed variance reduction algorithms. I worked under the supervision of Fabian Pedregosa.

May 2017 **Research Assistant - University of Otago, New Zealand**

The purpose of this 4 month internship was to study and to model the 'Zitterbewegung' behavior of a Dirac field over a sphere. I also implemented a framework in Python.

Seminar Organisation

11/18/2021 Co-organisation of the GDR-ISIS-MIA Optimal Transport in Machine Learning workshop

2018-2021 Co-organisation of INRIA Panama team seminar

2018-2021 Co-organisation of IRISA Obelix team seminar

Teaching and co-supervision

2022- Co-supervision of Hiroki Naganuma on Out-Of-Distribution samples

2021/2022 Introduction to Optimal Transport - Lecturer - UdeM and McGill universities

2020/2021 Deep Learning - Lecturer - Copernicus Master in Digital Earth - University of Southern Brittany

2019/2020 Co-supervision of Jean-Christophe Burnel on Generating natural adversarial Remote Sensing Images

Open Source Software

- Unbalanced minibatch Optimal Transport; applications to Domain Adaptation https://github.com/kilianFatras/JUMBOT
- Minibatch optimal transport distances; analysis and applications: https://github.com/kilianFatras/unbiased_minibatch_sinkhorn_GAN
- Learning with minibatch Wasserstein: asymptotic and gradient properties: https://github.com/kilianFatras/minibatch_Wasserstein
- Generating natural adversarial Remote Sensing Images: https://github.com/PythonOT/ARWGAN
- POT: Python Optimal Transport library contributor: https://github.com/PythonOT/POT

Selected invited talks

04/04/22 DS4DM Coffee Talks Polytechnique Montréal : Unbalanced minibatch Optimal Transport

14/02/22 Guathier Gidel's group : Adversarial examples meet optimal transport

01/09/21 CMAP Ecole Polytechnique : Unbalanced minibatch Optimal Transport; applications to Domain Adaptation

28/04/21 Montréal Machine Learning and Optimization (MTL MLOpt) - Unbalanced minibatch Optimal Transport; applications to Domain Adaptation

09/07/19 GDR-ISIS: Optimal Transport in statistical learning - Wasserstein adversarial regularization for label noise

Community service

Reviewer for JMLR, JOTA, ICML, ECML, IEEE TGRS, AISTATS, NeurIPS, ICLR (best reviewer award 2022)

Languages

French (Native), **English** (Fluent/ TOEIC 975/990), **Spanish** (Basics)

Associations

Science and music day - 2019 edition

Role I was in the logistic team of the science and music day in Rennes to promote research in music.

President of TApage - Communication student organization of ENSTA Paris

Role I was President of ENSTA Paris's communication student organization. I managed 11 communication projects with a 40.000-euro budget. My team was composed of 30 people.

Vice-President of FUPS - Music Festival of Paris-Saclay University

Role Co-founder and Vice-President of the 'University Paris-Saclay student music festival'. The festival had a 14.000-euro budget and had gathered 800 people. The FUPS won the 'EY prize' (6000 euros).

Research Summary

Optimal Transport has become a standard theory to compare probability distributions in machine learning. It has been successful in multi-label learning, generative models or domain adaptation for instance. My current research investigates the use of optimal transport in the context of out-of-distribution samples with deep learning methods.

In domain adaptation, I investigated the use of the MixUp regularization with noisy label robust loss function to mitigate the non optimal connections from minibatch optimal transport [1.]. Using these regularizations together led to SOTA results. More recently, I highlighted some weaknesses of outlier robust OT costs which transport outliers close to the target domain [8.]. These samples can be seen as noisy label samples, and to detect them, I proposed to train a classifier with adversarial training. I then proposed a modified ground cost based on the classifier to not transport the outliers to strenghten OT.

During my PhD, I focused on using optimal transport for deep learning tasks and to bring knowledge about optimal transport theory through its use in Deep Learning. I have made the following contributions:

- I extensively studied minibatch optimal transport [3., 2., 9.]. Using minibatches is a standard approach in deep learning to fasten computation, but it changes the original problem by computing the expectation of optimal transport between minibatches instead of computing original optimal transport. I have studied the formalism of this minibatch problem, the consequences on connections between samples, the concentration bounds and stochastic optimization properties. Then, I have designed new loss functions for generative models and domain adaptation which reached state of the art performances.
- I proposed an Optimal Transport regularization for learning with noisy labels [6.]. The idea was to design a regularization which would promote a local prediction uniformity around each input. I relied on optimal transport to modulate the regularization value depending on closeness of classes. The intuition is that for close classes, such as cars and trucks, we want to have a complex boundary, thus a smaller regularization.
- I also used Optimal Transport to generate data which are misclassified for a pretrained classifier [5.]. Using a Wasserstein GAN, the idea was to adapt the training data distribution and give bigger weights to misclassified data than correctly classified data, thus forcing the generator to generate misclassified data.