Anas Barakat

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RESEARCH INTERESTS

Stochastic optimization; (multi-agent) reinforcement learning; learning in games; machine learning

PROFESSIONAL EXPERIENCE

Feb. 2022 - **ETH Zurich, Department of Computer Science**
Foundations of Data Science Postdoctoral Fellow
Host: Prof. Niao He (Optimization & Decision Intelligence group)

EDUCATION

2018 - 2021 **Institut Polytechnique de Paris, Télécom Paris**
Ph.D. in Applied Mathematics and Computer Science
Thesis: Contributions to non-convex stochastic optimization and reinforcement learning.
Advisors: Prof. Pascal Bianchi and Prof. Walid Hachem.
Referees: Prof. Vivek S. Borkar, Prof. Sébastien Gadat.

2017 - 2018 **Université Paris Saclay**
M.Sc. in Data Science (with highest honors)

2015 - 2018 **Télécom Paris**
M.Sc. in Applied Mathematics and Computer Science, Engineering Degree
Machine Learning track
Top 5% ranking in one of the top french engineering schools

2013 - 2015 **Lycée Stanislas, Paris**
Classes préparatoires (intensive courses of Mathematics and Physics)
Post-secondary studies leading to the nationwide highly competitive exam
for admission to a graduate-level engineering school ("Grande Ecole")

PUBLICATIONS

The <u>names of the students</u> under my supervision in the publications below are underlined.

<u>Under Review</u>

(C1) Pragnya Alatur*, **Anas Barakat***, Niao He,
"Independent Policy Mirror Descent for Markov Potential Games: Scaling to Large Number of Players",
Equal contribution. *Submitted.*

(C2) <u>Kimon Protopapas</u>, **Anas Barakat**,
"Policy Mirror Descent with Lookahead",
Under review.

(C3) **Anas Barakat**, Souradip Chakraborty, Peihong Yu, Pratap Tokekar, Amrit Singh Bedi, Niao He,
"Reinforcement Learning with General Utilities: Scaling to Large State Action Spaces via Occupancy Measure Approximation",
Under review.

(C4) <u>Jiduan Wu</u>, **Anas Barakat**, Ilyas Fatkhullin, Niao He,
"Learning Zero-Sum Linear Quadratic Games with Improved Sample Complexity and Last Iterate Convergence",
Under review in SIAM Journal on Control and Optimization.

Journal Publications

(J1) **Anas Barakat**, Pascal Bianchi, Walid Hachem, Sholom Schechtman,
"Stochastic optimization with momentum: convergence, fluctuations, and traps avoidance",
Electronic Journal of Statistics 15 (2), 3892-3947, 2021.

(J2) **Anas Barakat**, Pascal Bianchi,
"Convergence and Dynamical Behavior of the Adam Algorithm for Non-Convex Stochastic Optimization",
SIAM Journal on Optimization 31 (1), 244-274, 2021.

Peer-Reviewed Conference Papers with Proceedings

(C1) Philip Jordan, **Anas Barakat**, Niao He,
"Independent Learning in Constrained Markov Potential Games",
International Conference on Artificial Intelligence and Statistics (AISTATS), 2024.

(C2) <u>Jiduan Wu</u>, **Anas Barakat**, Ilyas Fatkhullin, Niao He,
"Learning Zero-Sum Linear Quadratic Games with Improved Sample Complexity",
IEEE Conference on Decision and Control (CDC), 2023.

(C3) **Anas Barakat**, Ilyas Fatkhullin, Niao He,
"Reinforcement Learning with General Utilities: Simpler Variance Reduction and Large State-Action Space",
International Conference on Machine Learning (ICML), 2023.

(C4) Ilyas Fatkhullin, **Anas Barakat**, Anastasia Kireeva, Niao He,
"Stochastic Policy Gradient Methods: Improved Sample Complexity for Fisher-non-degenerate Policies",
International Conference on Machine Learning (ICML), 2023.

(C5) **Anas Barakat**, Pascal Bianchi, Julien Lehmann,
"Analysis of a Target-Based Actor-Critic Algorithm with Linear Function Approximation",
International Conference on Artificial Intelligence and Statistics (AISTATS), 2022.

(C6) **Anas Barakat**, Pascal Bianchi,
"Convergence Rates of a Momentum Algorithm with Bounded Adaptive Step Size for Nonconvex Optimization",
Asian Conference on Machine Learning (ACML), 2020.

Thesis

Anas Barakat, "Contributions to non-convex stochastic optimization and reinforcement learning",
PhD dissertation, Institut Polytechnique de Paris, 2021
Advisors: Prof. Pascal Bianchi and Prof. Walid Hachem.
Referees: Prof. Vivek S. Borkar, Prof. Sébastien Gadat.
Examiners: Prof. Robert M. Gower, Prof. Niao He, Prof. Edouard Pauwels.

AWARDS AND SCHOLARSHIPS

2022-2024	ETH Zurich Foundations of Data Science Postdoctoral Fellowship (2 years funding)
Nov 2023	DAAD Postdoctoral Networking Tour in Artificial Intelligence (Postdoc-NeT-AI) fellow German Academic Exchange Service Program offering a one-week networking tour in Germany https://www.daad.de/en/the-daad/postdocnet/
2022	AISTATS 2022 Top 10 % reviewer.
9 Sep 2021	Dodu Prize http://smai.emath.fr/spip.php?article624&lang=en Best communication of a young researcher at the Optimization and Decision annual days, French Society of Applied and Industrial Mathematics (SMAI) Jury: M. Akian, P. Bich, J. Bolte, J-B. Caillau, S. Gaubert, V. Leclere, P. Mertikopoulos, F. Santambrogio (president of the jury), H. Zidani
2018-2021	Mines-Télécom Institute (IMT) Ph.D scholarship Future & Disruptive innovation research program Awarded to top 5% students of Télécom Paris and other IMT schools.
2015-2018	Moroccan Government Merit Scholarship Moroccan Ministry of Higher Education, Scientific Research and Professional Training Awarded to students in top french engineering and business schools.
2013-2015	Agency for French Education Abroad (AEFE) "Excellence-Major" scholarship Awarded by the French Ministry for Europe and Foreign Affairs to top foreign (non french) students from french high schools all over the world for pursuing high-level studies in France

TALKS

Jul 2024	Invited talk, Fourth Symposium on Machine Learning and Dynamical Systems Fields Institute, Toronto, Canada

"Stochastic optimization with momentum: convergence, fluctuations, and traps avoidance."

28 Jul 2022	Invited talk, ICCOPT 2022 Lehigh University, Bethlehem, USA
20 Dec 2021	Invited talk (online), 14th CMStatistics International Conference Session: "Dynamical systems in machine learning" organized by Anna Korba. King's College, London, United Kingdom

"Convergence and dynamical behavior of the ADAM algorithm for non-convex stochastic optimization."

15 Oct 2020	Invited Seminar, "Image, Optimization and Probabilities" research group Bordeaux Institute of Mathematics (IMB), Bordeaux, France
21 Sep 2020	2nd Symposium on Machine Learning and Dynamical Systems Fields Institute for Research in Mathematical Sciences, online
7 Sep 2020	Mathematical Optimization and Decision (MODE) group days French Society of Applied and Industrial Mathematics (SMAI), online
17 Oct 2019	Mathematics of Optimization and Applications (MOA) annual days National Institute of Applied Sciences (INSA), Rennes, France

"Convergence of the ADAM algorithm from a dynamical systems viewpoint."

| 12 Sep 2019 | Junior Conference on Data Science and Engineering |
| | Centrale Supéléc, Gif-sur-Yvette, France |

| 29 Aug 2019 | Francophone colloquium of Signal and Image Processing (GRETSI) |
| | Lille University, Lille, France |

"Convergence analysis of a momentum algorithm with adaptive step size for non-convex optimization."

| 14 Dec 2019 | 11th OPT Workshop on Optimization for Machine Learning |
| | Exchange Hotel Vancouver, Vancouver, Canada |

"Convergence of the ADAM algorithm from a dynamical systems viewpoint."

| 2 Oct 2019 | Machine Learning in the Real World workshop |
| | Criteo, Paris, France |

PROFESSIONAL SERVICE

Reviewing
Journal reviewing

Mathematical Programming, SIAM Journal on Optimization (SIOPT), Journal of Machine Learning Research (JMLR), Journal of Optimization Theory and Applications (JOTA), Systems & Control Letters, Mathematics of Control, Signals, and Systems (MCSS), IEEE Transactions on Image Processing.

Conference reviewing

Conference on Neural Information Processing Systems (NeurIPS 2023), International Conference on Machine Learning (ICML 2022), Conference on Learning Theory (COLT 2022), International Conference on Artificial Intelligence and Statistics (AISTATS 2022, top 10% reviewer; AISTATS 2024), IEEE Conference on Decision and Control (CDC 2023).

Summer School Co-Organizer

Multi-Agent RL EPFL-ETHZ Summer School 2024 (20 000 CHF funding, accepted proposal), supported by Prof. Niao He and Prof. Volkan Cevher

Session Organizer

ICCOPT 2022, session organizer and chair: "Policy Gradient and Actor-Critic Methods: Theoretical Analysis and New Opportunities", in the Optimization for Data Science and Machine Learning cluster.

Workshop Organizer

RL workshop for industrial partners (Airbus Defence & Space, Engie, Idemia, Safran and Valeo) of the Data Science & Artificial Intelligence for Digitalized Industry & Services research and teaching chair.

TEACHING

ETH Zurich

Spring 2024	Teaching Assistant for 'Optimization for Data Science' and 'Foundations of RL'.
	Instructor for a lecture about 'Value-based methods'.
Spring 2023	Head Teaching Assistant for 'Foundations of Reinforcement Learning' (Prof. He).
	Instructor for 2 lectures within the course 'Optimization for Data Science' (Prof. He).
Fall 2022, 2023	Coordinator for the seminar course 'Advanced Topics in Machine Learning'.

Télécom Paris

Tutor and teaching assistant for the courses (more than 150 hours):

| Fall 2018, 2019, 2020 | Optimization for Machine Learning. |
| Fall 2018, 2019 | Probabilities (instructor for discrete Markov chains); Statistics; Machine Learning. |

Ecole Polytechnique

Tutor for undergraduate students in Computer Science (about 20 hours):
  Spring 2017   Design and Analysis of Algorithms; Advanced Programming

ADVISING

09/2023 - 01/2024	Kimon Protopapas, Master student semester project: *Policy Mirror Descent with Lookahead*, Under review
05/2023 - 12/2023	Philip Jordan, Master thesis: *Independent Learning in Constrained Markov Potential Games*, AISTATS 2024
10/2022 - 03/2023	Jiduan Wu, Master thesis: *Learning Zero-Sum Linear Quadratic Games with Improved Sample Complexity and Last-Iterate Convergence*; IEEE Conference on Decision and Control 2023
03/2022 - 09/2022	Harish Rajagopal, Master thesis: *Multistage Step Size Scheduling for Minimax Problems.*
04/2022 - 06/2022	Jiduan Wu, Master student semester project: *Mean Field Reinforcement Learning and Policy Gradient Methods for Linear Quadratic Zero-Sum Mean-Field Games.*
05/2021 - 10/2021	Julien Lehmann, Master thesis: *Analysis of a Target-Based Actor-Critic Algorithm with Linear Function Approximation* AISTATS 2022
10/2018 - 02/2019	Yuqing Wang and Zhengkang Shi, Master students final research and innovation project Collaboration: XLearn startup Topic: Development of an online job advising system learning skill titles' from users' profiles using Machine Learning methods

LANGUAGES

Arabic (native), French (native), English (fluent), Spanish (working level).

HOBBIES

Classical music : violonist in the "Académie de Musique de Paris" Orchestra (Paris) and Polyphonia Orchestra (Zurich), swimming

REFERENCES

Niao He
Assistant Professor
Optimization and Decision Intelligence group
Department of Computer Science
ETH Zurich

Walid Hachem
Research Director
Gaspard Monge Computer Science Laboratory
French National Research Centre (CNRS)
Gustave Eiffel University

Pascal Bianchi
Professor
Signal, Statistics and Learning group
Image, Data and Signal Department
Télécom Paris, Institut Polytechnique de Paris

Edouard Pauwels
Professor
Mathematics and Statistics Department
Toulouse School of Economics
University Toulouse 3 Paul Sabatier