Anas Barakat

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RESEARCH INTERESTS

Stochastic optimization; reinforcement learning (RL), multi-agent RL; learning in games; stochastic approximation

PROFESSIONAL EXPERIENCE

Singapore University of Technology and Design
Research Fellow — Fall 2024 -
Hosts: Prof. Georgios Piliouras and Prof. Antonios Varvitsiotis

ETH Zurich, Department of Computer Science
Foundations of Data Science Postdoctoral Fellow — Feb. 2022 - Aug. 2024
Host: Prof. Niao He

EDUCATION

Institut Polytechnique de Paris, Télécom Paris, Paris, France
Ph.D. in Applied Mathematics and Computer Science — Fall 2018 - Fall 2021
Advisors: Prof. Pascal Bianchi and Prof. Walid Hachem.
Thesis: Contributions to non-convex stochastic optimization and reinforcement learning
Committee: Profs. Vivek S. Borkar, Sébastien Gadat, Robert M. Gower, Niao He, and Edouard Pauwels

Université Paris Saclay, Paris, France
M.Sc. in Data Science (with highest honors) — Fall 2017 - Summer 2018

Télécom Paris, Paris, France
M.Sc. in Applied Mathematics and Computer Science — Fall 2015 - Summer 2018

Lycée Stanislas, Paris, France
Classes préparatoires — Fall 2013 - Summer 2015
Post-secondary studies in Mathematics and Physics leading to the nationwide highly competitive exam for admission to a graduate-level engineering school ("Grande Ecole")

PUBLICATIONS

The names of the students under my supervision in the publications below are underlined.

Under Review

(C1) Olivier Lepel, **Anas Barakat**. *A Prospect-Theoretic Policy Gradient Algorithm for Behavioral Alignment in Reinforcement Learning.* Under review.

(C2) **Anas Barakat**, Souradip Chakraborty, Peihong Yu, Pratap Tokekar, Amrit Singh Bedi. *Towards Scalable General Utility Reinforcement Learning: Occupancy Approximation, Sample Complexity and Global Optimality.* Under review.

(C3) Jiduan Wu, **Anas Barakat**, Ilyas Fatkhullin, Niao He. *Learning Zero-Sum Linear Quadratic Games with Improved Sample Complexity and Last Iterate Convergence.* Revision submitted to 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.

Conference Publications

(C1) Kimon Protopapas, **Anas Barakat**. *Policy Mirror Descent with Lookahead.* Advances in Neural Information Processing Systems (NeurIPS 2024).

(C2) Pragnya Alatur, **Anas Barakat***, Niao He. *Independent Policy Mirror Descent for Markov Potential Games: Scaling to Large Number of Players.* IEEE Conference on Decision and Control (CDC 2024). *Corresponding author.

(C3) Philip Jordan, **Anas Barakat**, Niao He. *Independent Learning in Constrained Markov Potential Games.* International Conference on Artificial Intelligence and Statistics (AISTATS 2024).

(C4) Jiduan Wu, **Anas Barakat**, Ilyas Fatkhullin, Niao He. *Learning Zero-Sum Linear Quadratic Games with Improved Sample Complexity.* IEEE Conference on Decision and Control (CDC 2023).

(C5) **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).

(C6) 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).

(C7) **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).

(C8) **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).

AWARDS AND SCHOLARSHIPS

- ETH Zurich Foundations of Data Science Postdoctoral Fellowship 2022-2024
- DAAD Postdoctoral Networking Tour in AI (Postdoc-NeT-AI) fellow Nov. 2023
- AISTATS Top 10 % reviewer 2022
- Dodu Prize, French Society of Applied and Industrial Mathematics (SMAI) Sep. 9th 2021
  Best communication of a young researcher at the Optimization and Decision annual days
  Jury: M. Akian, P. Bich, J. Bolte, J-B. Caillau, S. Gaubert, V. Leclere, P. Mertikopoulos, F. Santambrogio (president of the jury), H. Zidani
- Mines-Télécom Institute (IMT) Ph.D scholarship 2018-2021
- Moroccan Government Merit Scholarship 2015-2018
- Agency for French Education Abroad (AEFE) "Excellence-Major" scholarship 2013-2015

PRESENTATIONS

- **Independent Learning in Constrained Markov Potential Games**
  - Online talk, Singapore University of Technology and Design research group 2024
    Host: Georgios Piliouras.
- **Avoidance of traps for nonconvex stochastic optimization and equilibrium learning in games.**
  - Invited talk, Fourth Symposium on Machine Learning and Dynamical Systems July 2024
    Fields Institute, Toronto, Canada.
- **Stochastic optimization with momentum: convergence, fluctuations, and traps avoidance.**
  - Invited talk, ICCOPT 2022, Lehigh University, Bethlehem, USA 28 Jul 2022
  - Invited talk (online), 14th CMStatistics International Conference 20 Dec 2021
    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.**
  - Invited Seminar, *Image, Optimization and Probabilities* research group 15 Oct 2020
    Bordeaux Institute of Mathematics (IMB), Bordeaux, France
  - 2nd Symposium on Machine Learning and Dynamical Systems 21 Sep 2020
    Fields Institute for Research in Mathematical Sciences, online
  - Mathematical Optimization and Decision (MODE) group days 7 Sep 2020
    French Society of Applied and Industrial Mathematics (SMAI), online
  - Mathematics of Optimization and Applications (MOA) annual days 17 Oct 2019
    National Institute of Applied Sciences (INSA), Rennes, France
- **Convergence analysis of a momentum algorithm with adaptive step size for non-convex optimization.**
  - 11th OPT Workshop on Optimization for Machine Learning 14 Dec 2019
    Exchange Hotel Vancouver, Vancouver, Canada
- **Convergence of the ADAM algorithm from a dynamical systems viewpoint.**
  - Machine Learning in the Real World workshop 2 Oct 2019
    Criteo, Paris, France
  - Junior Conference on Data Science and Engineering 12 Sep 2019
    Centrale Supélec, Gif-sur-Yvette, France
  - Francophone colloquium of Signal and Image Processing (GRETSI) 29 Aug 2019
    Lille University, Lille, France

PROFESSIONAL SERVICE

- **Conference reviewing:** NeurIPS, ICML, ICLR, COLT, AISTATS, L4DC, IEEE CDC.
- **Journal reviewing:** Mathematical Programming, SIAM Journal on Optimization (SIOPT), Journal of Machine Learning Research (JMLR), Journal of Optimization Theory and Applications (JOTA), IEEE Transactions on Automatic Control (TACON), Stochastic Systems, Systems

& Control Letters, Mathematics of Control, Signals, and Systems (MCSS), Transactions on Machine Learning Research (TMLR), IEEE Control Systems Letters (IEEE L-CSS).

- **Organization of workshops, summer schools and conferences:**
  - Multi-Agent RL EPFL-ETHZ Summer School 2024 co-organizer (20 000 CHF funding, accepted proposal), supported by Prof. Niao He and Prof. Volkan Cevher.
  - 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 EXPERIENCE

- **ETH Zurich**, Zurich, Switzerland
  - Teaching Assistant for 'Optimization for Data Science' and 'Foundations of RL' Spring 2024
  - Instructor for a lecture about 'Value-based methods' Spring 2024
  - Head Teaching Assistant for 'Foundations of Reinforcement Learning' (Prof. He) Spring 2023
  - Instructor for 2 lectures for 'Optimization for Data Science' (Prof. He) Spring 2023
  - Coordinator for the seminar course 'Advanced Topics in Machine Learning' Fall 2022, 2023
- **Télécom Paris**, Paris, France
  - Teaching Assistant for 'Optimization for Machine Learning' Fall 2018, 2019, 2020
  - Instructor for discrete Markov chains in 'Probabilities' Fall 2018, 2019
  - Teaching Assistant for 'Probabilities', 'Statistics', 'Machine Learning' Fall 2018, 2019
- **Ecole Polytechnique**, Paris, France
  - Tutor for undergraduate students in Computer Science (about 20 hours) Spring 2017 Design and Analysis of Algorithms; Advanced Programming

MENTORING AND ADVISING EXPERIENCE

- Kimon Protopapas, Master student semester project (09/2023-01/2024): *Policy Mirror Descent with Lookahead.* To appear in NeurIPS 2024.
- Philip Jordan, Master thesis (05/2023 - 12/2023): *Independent Learning in Constrained Markov Potential Games.* AISTATS 2024.
- Jiduan Wu, Master thesis (10/2022 - 03/2023): *Learning Zero-Sum Linear Quadratic Games with Improved Sample Complexity and Last-Iterate Convergence.* IEEE Conference on Decision and Control 2023.
- Harish Rajagopal, Master thesis (03/2022 - 09/2022): *Multistage Step Size Scheduling for Minimax Problems.*
- Julien Lehmann, Master thesis (05/2021 - 10/2021): *Analysis of a Target-Based Actor-Critic Algorithm with Linear Function Approximation.* AISTATS 2022.