Benjamin Dadoun

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Résumé

I am since August 2021 a postdoctoral researcher at the university of Rouen. My current research interests include asymptotic geomeometric analysis. I am also a teaching assistant in analysis, probability and statistics.

With a double degree in mathematics and computer science (2011–2014, Cachan), my research experience started with a first summer internship in formal computation (2012, Nancy), then with a second summer internship in probabilistic analysis of algorithms (2013, Frankfurt). My taste for random phenomena then led me to a research master in probability and statistics (2014, Orsay), then to a Ph. D. thesis on a class of branching processes (2015–2019, Zurich).

In parallel to my research activities, I have taken on and still take on multiple teaching assignments (tutorials, orals, corrections), and I have contributed to a book of themes in mathematics.

Course

Postdoctoral research associate

NYU Abou Dabi *octobre 2020 – janvier 2021, puis[*] février 2022 –*
With Pierre Youssef, we are interested in *free entropy*, as it appears in free probability, and its applications to random matrix theory.

Université Rouen Normandie (LMRS) *August 2021 – February 2022*
With Pierre Calka, we are interested in some statistics of random polytopes in high dimension. This is the second part of a a postdoctoral position funded by ANR ASPAG[†]

Université Gustave Eiffel (LAMA) *Februrary 2021 – August 2021*
With Matthieu Fradelizi, Olivier Guédon, and Pierre-André Zitt, we have verified the variance conjecture for Schatten balls, by exploiting results on interacting particle systems.

University NYU Abu Dhabi *October 2020 – January 2021*[‡]
With Pierre Youssef, we were interested in the notion of *free entropy*, as it appears in noncommutative probabilities and in particular in the theory of random matrices.

University of Bath *June 2019 – May 2020*
This project, funded by a British company specialising in nuclear reactor modelling, aimed at studying the neutron transport equation in prospect of proposing new simulation (Monte Carlo type) algorithms for the industry.

Graduate student

University of Zurich *September 2015 – May 2019*
Thesis *Some Aspects of Growth-Fragmentation* directed by Prof. Dr. Bertoin (vita in Oct. 2019)

Abstract. This thesis treats stochastic aspects of fragmentation processes when growth and/or immigration of particles are incorporated as a compensating phenomenon. In a first part, we study the asymptotic behavior of self-similar growth-fragmentation processes, extending the results related to pure fragmentations. In a second part, we prove that self-similar growth-fragmentations arise as scaling limits of truncated Markov branching processes and we provide a rather general criterion. This bolsters the conviction that growth-fragmentations appear in many discrete Markovian structures, as already observed in random planar geometry. Lastly, we study a growth-fragmentation with immigration equation. In particular, we investigate the asymptotic behavior of the solution by relating it to a stochastic particle system in which immigrate copies of a certain growth-fragmentation process.

[*] L'interruption dans ce postdoc est due à la crise sanitaire.
[†] Analyse et Simulation Probabilistes d'Algorithmes Géométriques
[‡] This postdoc, initially planned for 2 years, was shortened to 4 months due to the health crisis.

ENS student

Master Probability and Statistics, Université Paris-Sud, Orsay *2014 – 2015*

Agrégation de mathématiques, option Informatique *2013 – 2014*

Undergraduate studies, ENS Cachan and Université Paris-Diderot *2011 – 2013*

Publications

[6] D. Chafaï, B. D., P. Youssef, *Monotonicity of the logarithmic energy for random matrices* (*preprint*, 2022)

Abstract. It is well-known that the semi-circle law, which is the limiting distribution in the Wigner theorem, is the minimizer of the logarithmic energy penalized by the second moment. A very similar fact holds for the Girko and Marčenko–Pastur theorems. In this work, we shed the light on an intriguing phenomenon suggesting that this functional is monotonic along the mean empirical spectral distribution in terms of the matrix dimension. This is reminiscent of the monotonicity of the Boltzmann entropy along the Boltzmann equation, the monotonicity of the free energy along ergodic Markov processes, and the Shannon monotonicity of entropy or free entropy along the classical or free central limit theorem. While we only verify this monotonicity phenomenon for the Gaussian unitary ensemble, the complex Ginibre ensemble, and the square Laguerre unitary ensemble, numerical simulations suggest that it is actually more universal. We obtain along the way explicit formulas of the logarithmic energy of the mentioned models which can be of independent interest.

[5] B. D., M. Fradelizi, O. Guédon, and P.-A. Zitt, *Asymptotics of the inertia moments and the variance conjecture in Schatten balls*, *submitted* (*July 2021*)

Abstract. We study the limit, when the dimension tends to infinity, of the moments of the Hilbert-Schmidt norm of a uniformly distributed matrix in the p-Schatten ball, with entries in the real, complex or quaternionic field. We also consider the restriction to the space of self-adjoint matrices. We build on the connection with the spectral analysis of β-ensembles by adapting some fluctuation results due to Bekerman, Leblé and Serfaty. When $p > 3$, this allows us to obtain the next asymptotic order for the ratios of q-inertia moments of p-Schatten balls of self-adjoint matrices, and to establish a strong version of the variance conjecture for these families of convex bodies.

[4] B. D. et P. Youssef, *Maximal correlation and monotonicity of free entropy and of free Stein discrepancy*, Electron. C. Probab. 26 (2021), Paper No. 24, 1-10.

Abstract. We introduce the maximal correlation coefficient between two noncommutative probability subspaces and show that the maximal correlation coefficient between the sub-algebras generated by $s_n := x_1 + \cdots + x_n$ and $s_m := x_1 + \cdots + x_m$ equals $\sqrt{m/n}$ for $m \leq n$, where $(x_i)_{i\in\mathbb{N}}$ is a sequence of free and identically distributed noncommutative random variables. This is the free-probability analogue of a result by Dembo–Kagan–Shepp in classical probability. As an application, we use this estimate to provide another simple proof of the monotonicity of the free entropy and free Fisher information in the free central limit theorem. Moreover, we prove that the free Stein Discrepancy introduced by Fathi and Nelson is non-increasing along the free central limit theorem.

[3] B. D., *Self-similar growth fragmentations as scaling limits of Markov branching processes*, J. Theoret. Probab. 33 (2020), no. 2, 590–610.

Abstract. We provide explicit conditions, in terms of the transition kernel of its driving particle, for a Markov branching process to admit a scaling limit toward a self-similar growth-fragmentation with negative index. We also derive a scaling limit for the genealogical embedding considered as a compact real tree.

[2] B. D., *Asymptotics of self-similar growth-fragmentation processes*, Electron. J. Probab. 22 (2017), Paper No. 27, 30 pp.

Abstract. Markovian growth-fragmentation processes introduced by Bertoin extend the pure-fragmentation model by allowing the fragments to grow larger or smaller between dislocation events. What becomes of the known asymptotic behaviors of self-similar pure fragmentations when growth is added to the fragments is a natural question that we investigate in this paper. Our results involve the terminal value of some additive martingales whose uniform integrability is an essential requirement. Dwelling first on the homogeneous case, we exploit the connection with branching random walks and in particular the martingale convergence of Biggins to derive precise asymptotic estimates. The self-similar case is treated in a second part; under the so called Malthusian

hypotheses and with the help of several martingale-flavored features recently developed by Bertoin et al., we obtain limit theorems for empirical measures of the fragments.

[1] B. D. et R. Neininger, *A statistical view on exchanges in Quickselect*, ANALCO14—Meeting on Analytic Algorithmics and Combinatorics, SIAM, Philadelphia, PA, 2014, pp. 40–51.

Abstract. In this paper we study the number of key exchanges required by Hoare's FIND algorithm (also called Quickselect) when operating on a uniformly distributed random permutation and selecting an independent uniformly distributed rank. After normalization we give a limit theorem where the limit law is a perpetuity characterized by a recursive distributional equation. To make the limit theorem usable for statistical methods and statistical experiments we provide an explicit rate of convergence in the Kolmogorov–Smirnov metric, a numerical table of the limit law's distribution function and an algorithm for exact simulation from the limit distribution. We also investigate the limit law's density. This case study provides a program applicable to other cost measures, alternative models for the rank selected and more balanced choices of the pivot element such as median-of-$2t+1$ versions of Quickselect as well as further variations of the algorithm.

Participation in conferences and seminars

- *Topics in High Dimensional Probability*, ICTS, Bengaluru (India), janvier 2023
- *Probability and Statistics Seminar*, Université d'Angers, juin 2022
- *Phenomena in High Dimension*, IHP, Paris, juin 2022
- *Marne Mathematics Seminar*, Université Gustave Eiffel, janvier 2022
- *Working group in Probability, Ergodic Theory and Dynmical Systems*, Université de Rouen, 2021
- *Informal Seminar in Analysis*, Université Gustave Eiffel, 2021
- *Working group in Point processes and Applications*, Université de Lille, 2021
- *Working group in Stochastic Modelisation*, Université de Paris, 2020
- *Statistical Science Seminar*, University College London, 2019
- *Seminar in Applied Mathematics*, Université de Nantes, 2019
- *Ph. D. Student Seminar*, University Zurich, 2018
- *Saint-Flour Probability Summer School*, 2018
- *Stochastic Processes and Applications*, Moscow, 2017
- *Ph. D. Student Seminar*, ETH Zurich, 2017
- *Growth-Fragmentation Day*, Université Sorbonne Paris Nord, 2016
- *Saint-Flour Probability Summer School*, 2016
- *Séminaire des doctorants*, ETH Zurich, 2016
- *Ph. D. Student Seminar*, ETH Zurich, 2015
- *Symposium on Discrete Algorithms*, Portland, 2014
- *Workshop MPFR/MPC*, Talence, 2012

Reviewing activities

- Proofread three chapters of *Stable Levy processes via Lamperti-type representations*, 2020
- Reviews for Annals of Probability (2021) and Annales de l'Institut Henri Poincaré (2022)

Teaching activities

Tutorials

Université Rouen Normandie September 2021 - December 2021

(*about 36 hours*) Analysis (for Computer Scientists)

Université Gustave Eiffel February 2021 – May 2021

(*about 64 hours*) Statistics [for Economists], Probability and Statistics [for Physicists]

University of Bath February 2020 – May 2020

(*about 20 hours*) Statistics with Programming in R

University of Zurich September 2015 – May 2019

(*about 400 hours*) measure theory, introduction to probability, martingales, Markov chains, linear algebra, combinatorics of integer partitions
Collection of corrected exercices

Oral exams September 2014 – May 2015

(*about 64 hours*) math-physics class

Other March 2020 – August 2020

contributions to a book collecting themes in mathematics,
tutoring (volunteer work)

Skills

Tech Programming languages and softwares I am familiar with include C/C++, Python, Mathematica, R, OCaml, Javascript, SQL, UNIX, LaTeX, Git...

Natural languages French (mother tongue), English, German (advanced), Arabic, Hebrew (a bit)

Other interests

sport (badminton, tennis, table tennis, swimming), baking