

IMS DISTINGUISHED VISITOR LECTURE SERIES

Dynamical spectral transition for optimization in very high dimensions

G rard Ben Arous

In recent work with Reza Gheissari (Northwestern), Aukosh Jagannath (Waterloo) we gave a general context for the existence of projected “effective dynamics” of SGD in very high dimensions, for “summary statistics” in much smaller dimensions. These effective dynamics (and, in particular, their so-called ‘critical regime’) define a dynamical system in finite dimensions which may be quite complex, and rules the performance of the learning algorithm.

The next step is to understand how the system finds these “summary statistics”. This is done in the last work with the same authors and with Jiaoyang Huang (Wharton, U-Penn). This is based on a dynamical spectral transition of Random Matrix Theory: along the trajectory of the optimization path, the Gram matrix or the Hessian matrix develop outliers which carry these effective dynamics.

I will naturally first come back to the Random Matrix tools needed here (the behavior of the edge of the spectrum and the BBP transition), and then illustrate the use of this point of view on a few central examples of Machine Learning : multilayer neural nets for classification (of Gaussian mixtures) and the XOR task.

11 January 2024, 2–2.55 pm

The talk is part of the program on

The Mathematics of Data
(02 Jan 2024–26 Jan 2024)

Program webpage

<https://ims.nus.edu.sg/events/the-mathematics-of-data/>

Venue

IMS Auditorium
National University of Singapore
3 Prince George’s Park Singapore 118402

Registration

<https://tinyurl.com/IMS2024MathDataReg>

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Professor G rard Ben Arous is a French mathematician, specializing in stochastic analysis and its applications to mathematical physics, and to the mathematics of data science and artificial intelligence. He served as the Director of the Courant Institute of Mathematical Sciences and the Vice-Provost for Science and Engineering Development at New York University, where he is the Silver Professor of Mathematics. Prof Ben Arous studied Mathematics at  cole Normale Sup rieure (ENS) and earned his PhD from the University of Paris VII. Prior to NYU, he has been a Professor at the University of Paris-Sud (Orsay), at the ENS, and more recently at the  cole Polytechnique F d rale de Lausanne (EPFL), where he held the Chair of Stochastic Modeling. He has headed the Department of Mathematics at Orsay and the Departments of Mathematics and Computer Science at the ENS, and founded the Bernoulli Center in Lausanne.

Professor Ben Arous has been richly decorated in his illustrious career, including the Rollo Davidson Prize, the Montyon Prize of the French Academy of Sciences, the senior Lady Davis Fellowship from Israel, the Medallion Lecture of the Institute of Mathematical Statistics, invited speaker at the International Congress of Mathematicians and plenary speaker at the European Congress of Mathematicians. He has served on the editorial board of highly prestigious journals, including the Journal of the European Mathematical Society, Communications on Pure and Applied Mathematics and the co-editor-in-chief of Probability Theory and Related Fields. Prof Ben Arous is a Fellow of the Institute of Mathematical Statistics, an elected member of the International Statistics Institute, a member of the American Academy of Arts and Sciences and a member of the United States National Academy of Sciences.

