

Dear editor,

Please find attached the manuscript, "Average-case matrix discrepancy: satisfiability bounds", which I hope you will find suitable for publication in Random Structures and Algorithms.

In this manuscript, I study the problem of average-case matrix discrepancy. This problem is rooted both in discrepancy theory, where matrix discrepancy has received a lot of recent attention, and in the theory of constraint satisfaction problems and statistical physics.

Concretely, I study in this work the minimal operator norm achievable by a signed sum of a system of Gaussian i.i.d. matrices, when both the dimension of the matrices and the number of signings are very large. This model can be seen as a random variant of the celebrated Matrix Spencer conjecture, and as a matrix-valued analog of the symmetric binary perceptron in statistical physics.

I establish a sharp satisfiability transition in this problem in the critical regime when the number of signings is quadratic in the dimension of the matrices. My proof techniques combine a first and second-moment type approach with deep results on the large deviations and concentration properties of the spectra of random matrix models which were developed in the random matrix theory literature.

Notably, I prove that a system of  $n = O(d^2)$  Gaussian random matrices can be balanced so that the spectrum of the resulting matrix macroscopically shrinks compared to the typical semicircle law. I also prove that (under a technical assumption), the second moment method is not sufficient to fully characterize the satisfiability diagram of this problem, uncovering a richer picture than in the vector-analog symmetric binary perceptron.

I believe that these findings should appeal to a broad audience interested in random structures, discrepancy theory, and constraint satisfaction problems (and the phase transitions phenomena in such problems), particularly due to the application of sophisticated random matrix techniques in this context. The manuscript is original, unpublished, and not under consideration elsewhere.

I would like to suggest Will Perkins as an editor who would be well suited to handling this manuscript.

Thank you for your time and consideration, and please do not hesitate to contact me if you have any questions. I look forward to hearing back from you.

Sincerely,

Antoine Maillard

Inria Paris & DI ENS, Ecole Normale Supérieure, Paris.