Higher-order matrix concentration inequalities* (*temporary title*)

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This paper studies random matrix chaoses that can be modeled as multivariate polynomials in random variables with matrix coefficients. These objects often occur in theoretical computer science for proving lower bounds for the Sum-of-Squares proof systems, or in randomized linear algebra as tensor random projections.

Since the beginning of the century, the research community has developed a broad theory of linear random matrix concentration, where almost all classical scalar concentration inequalities have been translated to the matrix setting. These include the noncommutative Khintchine, Bernstein, Chernoff, Rosenthal, and many others. This translation usually brings an additional logarithmic dependence on dimension, and in the last few years, there has been significant progress in determining when this dependence is necessary, providing sharp refinements to the previous inequalities. We present a framework on how this well-developed theory can be lifted to the setting of polynomial random matrices. From this, we are able to deduce norm bounds on the so-called "graph matrices", while also removing unnecessary polylog factors in some cases.

Joint work with Afonso Bandeira (ETH Zurich), Kevin Lucca (ETH Zurich), and Ramon van Handel (Princeton).

* This poster is based on a paper that is about to appear on arXiv in August 2024.