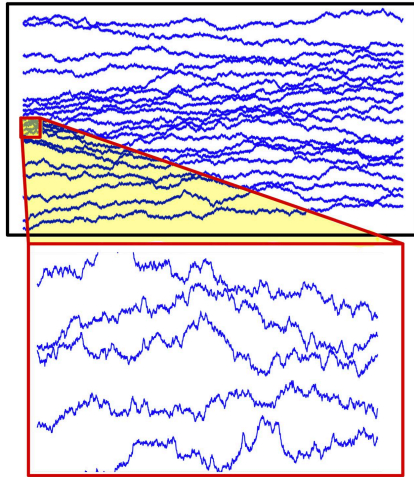# Seminar: Random Matrices

WiSe 2023/2024   Prof. Torben Krüger

Content

In this seminar we will explore the topic of random matrix theory (RMT). The theory is concerned with understanding the statistical behaviour of eigenvalues and eigenvectors of matrices with random entries.


Dynamics of eigenvalues - non-intersecting Brownian motions

RMT has numerous applications in several branches of science beyond mathematics, including physics, computer science, statistics, and engineering and its techniques provide a versatile toolkit that can be applied to solve problems in diverse disciplines. Universal distributions arising from RMT are observed e.g. in complex quantum systems as the spacings of energy levels, in number theory as the distribution of zeros of the Riemann zeta function and when performing a principle component analysis in statistics. Although mathematically proving the emergence of such distributions remains an open problem for many physically realistic systems, extensive numerics and experimental data overwhelmingly confirm their relevance in this context. In this seminar we will present the basic principles and notions of RMT. We will discuss the proofs of the analogues of the law of large numbers and the central limit theorem for eigenvalues of random matrices. Furthermore, we will give an overview of applications of RMT, depending on the preferences of the participants.

Key Topics Covered:

- Introduction to Random Matrices: Basics and Notions

- Spectral Analysis of Random Matrices

- Universal distributions

- Applications of RMT (e.g. to Quantum mechanics, network science, machine learning, statistics)
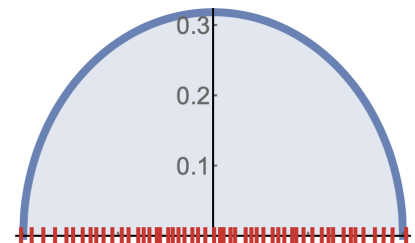
Semicircle law for eigenvalues of symmetric matrices with independent Gaussian entries (GOE)

Seminar information

Instructions: If you are interested in the seminar please **register in StudOn and Campo**. The schedule will be fixed at our first meeting. For more information and literature visit:

https://sites.google.com/site/torbenkruegermath/teaching/seminar-random-matrices

Time and Place: time: Mondays 8:30-10:00 (c.t.);
location: 04.363 - Seminarraum Mathematik (Cauerstraße 11);

First meeting: Our first meeting is on Friday, **October 6 at 10:00 in Übung 1** (Cauerstraße 11). There we will distribute the topics and fix the schedule for the seminar. If you want to participate, but cannot come to this meetings, please contact me via mail.

Prerequisites: The participants are expected to have a basic knowledge of linear algebra, analysis and stochastics. Interested graduate students and postdocs are very welcome to join as well.

Language: English.