MATH RESEARCH AT UNC CHARLOTTE 2024

Project: Schramm-Loewner Evolutions and Random Matrix Theory

Mentor: Dr. Vlad Margarint
Web: https://margarintvlad.com/
Researchgate profile

Project description:

Schramm-Loewner Evolutions (SLE) and Random Matrix Theory (RMT) are two pillars of modern Probability Theory [2], [1].

The study of SLE in Probability Theory started in 2000 when Schramm introduced a family of random fractal curves that describe the scaling limit of interfaces of planar Statistical Physics models. Since then, a wide range of lattice models and discrete processes have had their scaling limits identified as or conjectured to be SLE's of different parameters.

RMT appeared earlier in the statistical work of Wishart [4] and the pioneering Physics of Wigner [3]. RMT has applications ranging from Biology to Neural Networks and has been an active area of mathematical research since its advent. Although, both SLE and RMT have been thriving areas of Probability Theory, these two fields have developed relatively independently.

Very recently, a version of the SLE model, that is multiple SLE curves driven by Dyson Brownian Motion (DBM), was introduced. DBM is a system of interacting diffusion processes with many interesting properties that appears also in the study of certain models in RMT.

This project will focus on applications of Stochastic Analysis techniques/ Random Matrix Theory/ Computational techniques in the study of the random fractal curves that appear in this multiple SLE model. One possible direction of study is focused on the description of the geometry of these curves. Another possible direction of study is centered around parameter estimations of the model. These types of studies require both a theoretical and a computational approach. The preferred direction can be chosen according to the interest of the student.

I am looking forward to discovering together this unexplored very recent territory between two different fields of Probability Theory: Random Matrices and SLE!

REU students' role. This project assumes basic knowledge of calculus, probability, and ordinary differential equations. Students will spend the first two to three weeks studying the model using stochastic differential equations, and understanding the concepts. In the next week, students will formulate the chosen research question and will learn from the literature about different approaches and assumptions to solve similar problems. Thereafter, they will perform the required analysis both theoretically and computationally. The students will draw conclusions of the study.

References

[1] Gernot Akemann, Jinho Baik, and Philippe Di Francesco: The Oxford handbook of Random Matrix Theory, *Oxford University Press, 2011.*

[2] Gregory Lawler: Conformally Invariant Processes in the Plane, *American Mathematical Society, 2008.*

[3] Eugene P. Wigner: Characteristic vectors of bordered matrices with infinite dimensions, *Annals of Mathematics, 1955.*

[4] John Wishart. The generalised product moment distribution in samples from a normal multivariate population, *Biometrika, 1928.*