SCHEDULE WEEK 4

All times are CDT

JULY 12 – JULY 16

http://math.uchicago.edu/ may/REU2021/FOURTH.pdf

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Talks take place Tuesday through Friday afternoons (and/or mornings, at the discretion of speakers and hosts) Talks and group meetings are open to all participants or aimed at focus groups; for focus group events, those interested in joining and are not on the list of people in the relevant group should email the host in advance. All talks are 45 minutes to an hour, with at least a half hour break between talks. Open program talks are live on Zoom; with the speaker's permission, talks will be recorded and made available on Zoom.

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For those in the full program who are focusing on number theory, we have permission for you to attend:

MTWThF 10:00 Park City Undergraduate Summer School talks
(see https://www.ias.edu/pcmi/programs/pcmi-2021-undergraduate-summer-school)
(The Zoom link has not yet been sent to us.)

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A new talk series special this week, a combination of math and computer science:

MWF 11:00 Alexander Razbarov (speaking from Russia)

Title: PROPOSITIONAL PROOF COMPLEXITY

Abstract: Propositional proof complexity studies efficient provability of statements that can be expressed without quantifiers, in various proof systems and under various notions of "efficiency". Statements of interest come from a variety of sources that, besides traditional combinatorial principles and other mathematical theorems, include areas like combinatorial optimization, practical SAT solving and operations research. A considerable attention has been paid in recent years to systems modelling algebraic and semi-algebraic reasoning, including elementary convex geometry. I will try to convey some basic ideas underlying this vibrant area by using a few illustrating examples.

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MTWThF 2:30: The probability subprogram, new talk series

MWF 2:30: Lucas Benigni

Title: Universality in random matrix theory and beyond

Abstract: Wigner conjectured that some eigenvalue statistics of large complicated quantum systems are *universal* in the sense that they do not depend on any detailed structure of the system. Interestingly, this universal behavior seems to go even beyond this as such statistics appear in analytic number theory, quantum chaos theory, combinatorics, or even actual bus systems!

In this series of three lectures, we will first present the universality conjecture in the context of random matrix theory, study some properties of these universal distributions, and finally give an idea on how to prove it using either the Lindeberg exchange or some dynamics on symmetric matrices.

Tuesday 1:00: Shmuel Weinberger (final talk, new emphasis)

Title: Reduction from geometric to algebraic topology

Abstract: First I will explain a key paradigm in geometric topology - reduction to algebraic topology. This will lead to the problem of understanding how complicated homotopies look like. In some cases one can see connections to isoperimetric problems or spectral geometry (none of which will be assumed). My focus will be on maps to very concrete spaces, like spheres.

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Geometry/Analysis/Dynamics seminar

Tuesday 2:30: Hang Yuan (Northwestern University)

Title: Non-archimedean SYZ mirror symmetry

Abstract: Mirror symmetry is a relationship between geometric objects called Calabi-Yau manifolds. Its idea comes from string theory but surprisingly gives correct predictions in enumerative geometry. The Strominger-Yau-Zaslow conjecture suggests that the mirror symmetry can be interpreted as a duality between Lagrangian torus fibrations. A major mystery lies in the so-called quantum corrections contributed by the counts of the holomorphic disks that bound the torus fibers. Recently, from a Floer-theoretic viewpoint, we can implement the SYZ dual torus fibration construction with full quantum corrections in a non-archimedean setting. In this talk, we will begin with a brief review of the mirror symmetry, and then we will discuss the motivation and some simple examples of the non-archimedean version of SYZ mirror symmetry.

Thursday 2:30: Michelle Chu (UIC)

Title: Hyperbolic 3-manifolds

Hyperbolic 3-manifolds play an important role in the study of 3-dimensional topology. In this talk I will introduce and motivate hyperbolic 3-manifolds and describe some methods to construct examples.

Links to Tu/Thu seminars:
https://uchicago.zoom.us/j/96027580738?pwd=SnNVM0ZrMmlsTmk4NkdjYkIzMHpPQT09

Meeting ID: 960 2758 0738 Passcode: 998755

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MWF 1:00: Ao Sun (continuing)

Title: Heat Equations and Geometric Flows

Abstract: This will be a series of survey talks and all are welcome. The heat equation is a partial differential equation that describes how a quantity such as heat diffuses through a given region. The heat equation is connected to Fourier analysis in harmonic analysis, the study of random walks and Brownian motions in probability, the Atiyah-Singer's index theorem in geometry, and many applications in applied math. Later people found that a class of nonlinear heat equations called geometric flows are very powerful to the study of geometry and topology. One of the famous results is the solution to Poincare's conjecture using Ricci flow, by the theory of Hamilton and Perelman.

I will start with the classical linear heat equation: how to solve it and how to read geometric information of the ambient space. Then I will discuss the geometric flows, including Ricci flow and mean curvature flow. In particular, we will describe some key ideas in Perelman's proof of Poincare's conjecture.

Algebra subprogram talk

Th 1:00: Eric Zhu

Title: Monstrous Moonshine

Abstract: I will talk about the history of monstrous moonshine and describe a bit about where we've come since. To do this, I will give an introduction to representation theory and character theory and give some brief notions of modular forms. Time permitting, I'll talk about my work on a certain extension of the theorem and why we care. I only assume some basic group theory in my talk.

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MTWF 4:00: Peter May (maybe a day off)

Title: Historical context of stable algebraic topology

Abstract: I will begin a sequence of talks largely based on "Stable algebraic topology, 1945-1966, number [92] on my web page and a related talk "The Stone age", the first from 1999, the second from 2000. That is the starting point. While I will correlate with things already talked about, the talks will be a change of pace and as independent of everything that has come before as I can manage. Spectra were introduced with at least five different motivations in mind, both conceptual and calculational. They include cobordism, Bott periodicity and K-theory, cohomology theories in general, the Adams spectral sequence, Spanier-Whitehead and Poincaré duality, and more. Statements and motivation will have priority over detailed proofs, but a complete proof of the Brown representability theorem will be included at some point since that has been requested. Other requests are welcome, as are any and all requests for clarification.

This week will likely focus on duality (categorical, algebraic, and topological), homology, and cohomology with more detail.

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SPECIAL TALK

Thursday 4:00: Rediet Abebe and Christian Ikeokwu

Title: Algorithmic Perspectives on Mutual Aid

Abstract: Mutual aid groups are characterized by a voluntary and reciprocal exchange of resources without the reliance on a central authority or legal framework for cooperation. Such groups and organizations have seen a meteoric increase in popularity in the U.S. recently as a consequence of the economic shock from the COVID-19 pandemic. However, such groups have long served as informal financial organizations addressing the needs of the economically vulnerable and citizens of lower income countries. In this talk we undertake an algorithmic analysis of one such organization, Rotating Savings and Credit Associations (Roscas) in which participants take turns lending money to each other in a rotating order. Roscas are popular in over 85 countries and across 5 continents and in this talk we algorithmically explain and justify Roscas' prevalence. We also hope to explain the prevalence and importance of mutual aid groups and informal financial organizations more broadly and discuss several possible direction where algorithmic analysis may be useful.