HMMT November 2023 Education Events

Education Events Schedule

November 12, 2023

Time (EST)	Emerson 101	Emerson 108	Emerson 305	Emerson 104
8:00 AM–8:50 AM	**Breakfast** Ticknor Lounge			
9:00 AM–9:50 AM	**Ophelia Sommer** *Emergence, Phases of Matter, and Why More is Different*	**Colin Defant** *Friends and Strangers Walking on Graphs*	**Gabrielle Scullard** *Elliptic Curves in Cryptography*	
10:00 AM–11:00 AM	**Corrine Yap** *Uniform Convergence* Emerson Hall Room 210			
11:05 AM–11:45 AM	**Lunch** Ticknor Lounge			
11:50 AM–12:40 PM	**Hahn Lheem** *Why 163 is my favorite number*	**L. Mahadevan** *Mathematics and Life*	**Serena An** *How to Get Good at Set*	**Bowen Kerins** *Mathematics of Game Shows*
12:50 PM–1:40 PM	**Zach Abel** *Straws Thing Craft Workshop* Emerson Hall Room 210			

9:00 AM–9:50 AM

Ophelia Sommer

Emergence, Phases of Matter, and Why More is Different

Location: 101

Physics is commonly portrayed to be about the search for the most fundamental truths of the universe. Everything is made of molecules, molecules of atoms, atoms of nucleons and electrons, nucleons of quarks, and so on. Does this mean that we need to know about quarks to understand how ice melts or magnets form? In this talk, we will explore that question, figure out how mathematics and physics can give us new organizing principles for the natural world, and see how this all relates to emergence, symmetry and topology.

Ophelia Sommer is a second year PhD student at Harvard University working with Prof Ashvin Vishwanath. Her research interests range broadly within theoretical condensed matter and quantum many body physics, with a current focus on the classification of topological phases of matter. Before her PhD she was an undergraduate at Trinity College, University of Cambridge, where she won numerous prizes, including the Hartree and Clerk Maxwell prize, the Ver Heyden de Lancey Prize, and the AC5 International Union of Pure and Applied Physics Early Career Scientist Prize.

Gabrielle Scullard

Elliptic Curves in Cryptography

Location: 305

An elliptic curve is a beautiful object which connects geometry, group theory, and many other areas of mathematics. Surprisingly, they are also useful in the world of cryptography. In this talk, we'll define elliptic curves, talk about the ways they've been used in (classical) cryptography, and give a brief glimpse into what we think we can do with elliptic curves in a world with quantum computers. (Spoiler alert: As of quite recently, the answer is...less than we originally thought!) Some exposure to groups would be helpful but not necessary; this is intended to be a mostly non-technical glimpse into this research area.

Gabrielle Scullard is a sixth-year Ph.D. student at Penn State and has been a mentor at Canada/USA Mathcamp. Her research is in the area of arithmetic geometry, with an eye towards applications to isogeny-based cryptography (a branch of post-quantum cryptography which uses maps between elliptic curves).

Colin Defant

Friends and Strangers Walking on Graphs

Location: 108

Let X and Y be simple graphs, each of which has n vertices. Identify the vertices of Y with n people, any two of whom are either friends or strangers (according to the edges and non-edges in Y), and imagine that the people sit on distinct vertices of X. Two people are allowed to swap places with each other if they are friends with each other and they are sitting on adjacent vertices of X. The friends-and-strangers graph $\mathrm{FS}(X,Y)$ has as its vertex set the collection of all configurations of people sitting on the vertices of X, where two configurations are adjacent when they are related via a single swap of this form. It is natural to study the connected components of $\mathrm{FS}(X,Y)$, which correspond to the equivalence classes of mutually-reachable configurations. This framework provides a common generalization for the famous 15-puzzle, transposition Cayley graphs of symmetric groups, and earlier works of Stanley and Wilson. I will discuss three natural settings: in the first setting, X is a particular fixed graph (such as a path or a cycle) and Y is allowed to vary; in the second setting, there are constraints placed on X and Y (such as lower bounds on their minimum degrees); in the third setting, X and Y are random.

This talk is based on joint work with Noga Alon and Noah Kravitz. I will also mention numerous other related works, many of which were produced by undergraduate and high school students.

Colin Defant received his undergraduate degree at the University of Florida in 2017. In 2022, he completed his Ph.D. at Princeton under the supervision of Noga Alon. He spent one year as an NSF Postdoc at MIT, and he is now an NSF Postdoc and Benjamin Peirce Fellow at Harvard. Colin is broadly interested in combinatorics, especially when it is algebraic, enumerative, or dynamical. Colin is also dedicated to promoting undergraduate research. He worked as an advisor at the Duluth Mathematics REU program each summer from 2017 to 2022; starting this past summer, he has been a co-director for this program. Colin once ate two Pigs Troughs at Betty's Pies in one sitting.

10:00 AM–11:00 AM

Corrine Yap

UNIFORM CONVERGENCE

Location: Emerson Hall Room 210

Uniform Convergence *is a one-woman play, written and performed by mathematician Corrine Yap. It juxtaposes the stories of two women trying to find their place in a white male-dominated academic world. The first is of historical Russian mathematician Sofia Kovalevskaya, who was lauded as a pioneer for women in science but only after years of struggle for recognition. Her life's journey is told through music and movement, in both Russian and English. The second is of a fictional Asian-American woman, known only as "Professor," trying to cope with the prejudice she faces in the present. As she teaches an introductory real analysis class, she uses mathematical concepts to draw parallels to the race and gender conflicts she encounters in society today.*

Corrine Yap is a mathematician, playwright, and performer. She attended Sarah Lawrence College where the first performance of Uniform Convergence took place. Since then, she has brought the play to 20 different venues, including off-Broadway with the Pan Asian Repertory Theater, the MAA MathFest, and the 2023 Joint Math Meetings in Boston. At the same time, she attended graduate school at Rutgers University and received her PhD in mathematics this past spring. She currently resides in Atlanta where she works at Georgia Tech as a Visiting Assistant Professor in mathematics and a postdoctoral fellow with the Algorithms and Randomness Center.

11:50 PM–12:40 PM

Hahn Lheem

Why 163 is my favorite number

Location: 101

Why is $n^2 + n + 41$ a prime for all n between 1 and 40? Why is $e^{\pi\sqrt{163}}$ less than 10^{-12} away from the closest integer? How are these two facts related? Come for a roller coaster through some number theory!

Hahn Lheem is a senior at Harvard studying math, with special interests in number theory and algebraic geometry. He is really passionate about teaching, having taught for the first HMMT Education event, and is excited to return in his final year! Outside of math, he loves to sing, play basketball, watch soccer, and eat ramen.

Serena An

How to Get Good at Set

Location: 305

We will learn about some fun math behind the game SET and variants such as UltraSET! We will also discuss a few tips for getting faster at SET, followed by a mass game! At the end, I'll share a bit about my competition math journey and hold an open Q&A.

Serena An is a sophomore at MIT studying math. In addition to being on the HMMT problems staff, she is the mentorship chair for USWIM, a TA for the Math Olympiad Program, a member of the USAMO editorial board, and the current EGMO deputy leader for the US. She has also done research in algebraic combinatorics through the MIT math department's SPUR program and PRIMES-USA. In high school, she participated extensively in math competitions, attending MOP twice and winning a gold medal at the 2021 European Girls Math Olympiad. She also founded the Brookings Math Circle and ran it for five years to address the lack of math interest and resources in her town in South Dakota (which became the topic of her TEDx talk "Building Your Own Math Community"). Besides math, she loves learning languages, including Chinese, Korean, and most recently, Japanese. Before college, she took a gap year to study abroad in South Korea through the Department of State's NSLI-Y program; this semester, she is translating a Korean play as part of her class 21M.716. In her free time, she enjoys cooking, going on walks, and teaching friends how to play Nertz.

L. Mahadevan

Mathematics and Life

Location: 108

Mathematics is the study of reproducible mental patterns. Science is the study of reproducible worldly patterns. I will discuss the interplay between the two in the context of two old problems in science: morphogenesis, i.e. understanding how the body makes itself, and and cognition, i.e. how the brain and body learn to function in the world. Along the way, I will also discuss the changing role of mathematics in and as a science over the past century.

Lakshminarayanan Mahadevan is Lola England de Valpine Professor of Applied Mathematics at the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS), and Professor of Organismic and Evolutionary Biology, and of Physics (Faculty of Arts and Sciences), at Harvard University. Mahadevan is a cross-disciplinary scientist who seeks to understand motion and matter at the human scale integrating the physical and biological sciences, mathematics and engineering, and using experiments, theory and computation.
His recent work includes elucidating the biophysical principles underlying the morphogenesis of organs and organisms, the cognitive dynamics of embodied intelligence in social insects, and the mathematical physics underlying art forms such as origami and kirigami, and musical instruments such as musical saws and steelpan drums. He is a MacArthur Fellow and a Fellow of the Royal Society of London.

Bowen Kerins

Mathematics of Game Shows

Location: 104

Game shows are filled with logical and statistical questions, from the players' perspective but also from the producers' perspective. How are budgets estimated? How are games built toward a particular probability of victory? We'll play games and win prizes, then discuss the math from both sides of the games.

Bowen Kerins *has been writing math curriculum for 20 years. He has been a lead writer on multiple curricula for Grades 6-12, and is the author of an eight-book AMS series. He has a BS in mathematics from Stanford University and a master's in teaching from Boston University. He scored in the top 10 on the USAMO and attended the Math Olympiad Program in 1990. He has been a mathematical advisor for over 20 game shows. He loves Slurpees and once won $1000 for knowing the number of degrees in a right angle.*

12:50 PM–1:40 PM

Zach Abel

STRAWS THING CRAFT WORKSHOP

Location: Emerson Hall Room 210

Ever join straws end to end to drink chocolate milk from extreme distances? No, just me? Come put that skill (joining, not drinking) to good use while assembling your own Straws Thingy, an intricate symmetrical arrangement of 60 drinking straws forming an elegant geometric sculpture. You'll hear about the shape and its symmetries, learn how to build one for yourself, and take it home with you! All supplies and instructions will be provided for you.

Zach Abel lectures in the MIT EECS theory group, putting his math competition background to good use while teaching discrete math and proof writing — come find him if you also have strong opinions about induction! His research usually lies somewhere between the intersection and union of geometry and algorithms. When the geometry builds up for too long, he taps the pressure valve by designing and building elaborate geometric sculptures with office supplies and other everyday objects, usually binder clips for some reason. He's also a big fan of logic puzzles. And puppies.