

HRUMC – THIS SATURDAY!

It is finally here! The sixteenth annual Hudson River Undergraduate Mathematics Conference (HRUMC) will be held this **Saturday, April 18** on the Union College campus. Eight (8) members of the Union community will be presenting talks during the conference, and sixteen (16) will be chairing sessions. A brief schedule of the day follows, followed by the abstracts of the eight Union talks. More details about the entire conference can be found at www.skidmore.edu/hrumc.

- 8:30 – 9:50
 - Registration in the Nott Memorial (YES, Union students still need to register!)
 - Breakfast in Hale House and the Everest Lounge
- 10:00 – 10:55: Session I in HUM, SSCI, and OLIN. (Three 15-minute talks in this session.)
- 11:05 – 12:15: Welcoming Remarks and Invited Address
 - **KEYNOTE ADDRESS** by **Professor Erica Flapan of Pomona College**

TITLE: When Topology Meets Chemistry

ABSTRACT: Mirror image symmetry plays an important role in predicting the behavior of molecules. Recently, knots and links and other non-planar molecules have been synthesized which are large enough that they do not have the rigidity that is characteristic of small molecules. In order to understand the symmetries of such molecules we need to understand how they can be deformed. Topology is the area of mathematics that analyzes how geometric objects can be deformed and which properties of such an object will be preserved by deformations. In this talk we will discuss how topology can be used to help us analyze the symmetries of flexible molecules

- 12:25 – 1:35: Lunch in College Park Hall
- 1:45 – 2:40: Session II in HUM, SSCI, and OLIN. (Three 15-minute talks in this session.)
- 2:50 – 3:25: Coffee break in Olin Quad
- 3:30 – 4:45: Session III in HUM, SSCI, and OLIN. (Four 15-minute talks in this session.)

Presentations by Union Folk

10:00-10:15 (SSCI 012)

Michael Topka

Batting Around with Continued Fractions: Exploring the Use of Continued Fractions to Determine Batting Records

Baseball is one of America's favorite pastimes. As in any sport, baseball is very competitive on a professional level. Statistics are frequently used to determine how a player performs. For example, a batting average is often used and can be described as the number generated by the ratio of hits to at-bats. This number describes a player's offensive abilities. What specific ratios are able to produce these numbers that are used to rank these players? There are an infinite number of hits to at-bats that lead to a particular batting average. Using the unique properties of continued fractions, we will present an algorithm that will enumerate all possible batting records producing a particular batting average.

10:00-10:15 (SSCI 016)**William Zwicker**

Voting Machines I: Voting with the Mean and the (spatial) Median

A “voting machine” is a mathematical model that explains the dynamics of some voting rule via a physical process. We demonstrate a **rubber-band machine** for computing the Borda rule (normally described in terms of accrued points) in the case of 3 candidates:

- Each voter gets one rubber band
- She loops one end about one vertex of a regular hexagon (choosing the vertex labeled with her preferred ranking of the candidates)
- All the free ends are attached to a single, movable “outcome point”
- When the outcome point is released, it moves towards an equilibrium position, whose location determines the winner (according to proximity).

Our “rubber” will be entirely simulated – we’ll demonstrate a web-based interactive graphics package developed by Professor Davide Cervone.

Certain properties of Borda’s rule may now be explained by the fact that the tension in a rubber band increases as it stretches. If we change the forces so that each voter’s “tug” is independent of distance, we get a **pulley machine** that models a strange, new voting rule. This “M^CBorda rule” is based on a spatial version of the median, while Borda’s original version was based on the mean. The switch from mean to median results in some interesting voting-theoretic properties.

10:20-10:35 (SSCI 016)**Andrew Mackenzie**

Voting Machines II: Computer-Assisted Investigation of Voting Properties

In voting theory, it is typical to characterize and distinguish among voting rules by considering desirable voting properties. Such properties include participation, which asserts that no honest person would find it beneficial to abstain from voting, or the majority condition, which asserts that if a majority of votes rank a certain alternative first, that alternative will win.

Some properties for some rules can be particularly difficult to prove; we will consider such a property and rule here. We will consider the M^CBorda rule and the property of one-way monotonicity. After briefly defining this rule and property, we will explain a particular computer algorithm and how its implementation generated failures of one-way monotonicity in an irresolute “tie-breaking” sense, proving that the property did not hold for this rule. We will present various violations and observe patterns between them. If time allows, we will discuss several implications of the failure of this property.

10:20-10:35 (Olin 206)**Patricia Linden**

Using Riemann Sums to Analyze Martingales

In this presentation we will prove a function is a Martingale using Riemann sums and other tools such as Gaussian continuous random variables. We use Riemann sums to approximate functions in stochastic integration. Because a left Riemann sum and right Riemann sum yield can different results in stochastic functions, we use left sums, as they produce Martingales. We will use the function

$$\int_0^t B_s dB_s$$

to show a left Riemann sum is a Martingale while a right Riemann sum is not. In order to do so, we will provide a basic introduction to Brownian motion, random walks, and expected values.

10:20-10:35 (Olin 115)

Jue Wang

Correction of Shadowing and Enhancement Artifacts in Ultrasound Images

Variations in attenuation across layers of tissue can result in shadowing and enhancement in ultrasound B-scan images. These artifacts affect the underlying signal backscatter which is the main component of ultrasound images and has clinical significance in detecting diseases and tumors. We present a PDE-based approach to separate the attenuation effects from signal backscatter and correct the artifacts. A three-step alternating minimization procedure is adopted to compute the numerical solutions. Furthermore, the existence, uniqueness, stability and convergence results for the minimization problems are proved.

10:40-10:55 (HUM 019)

Sarah Britton

Elliptic Curve Factoring Algorithm

The security of many cryptosystems relies on the difficulty of factoring a number that is a product of two prime numbers (usually hundreds of digits long) so it is important to understand ways that one might attempt to find divisors of these large composite numbers. The Elliptic Curve Factoring Algorithm, first developed by H.W. Lenstra, is a method to factor numbers using elliptic curves over a finite field. By taking an equation for an elliptic curve (of the form $y^2 = x^3 + Ax + B$) and performing addition on the points on the elliptic curve over a finite field, we are sometimes able to find a factor. The validity of the algorithm is dependent on Hasse's Theorem, which we will also describe.

4:10-4:25 (SSCI 010)

Kate Colantuono

Phi: The Irrational Number

Irrational numbers outnumber the rational numbers in the set of all real numbers, and they also dominate much of the mathematical world, as evident through the golden ratio. The golden ratio, or Phi, is an irrational number that was first defined in a line segment by Euclid. It is apparent in other geometric shapes, including a circle, an isosceles triangle, and a golden rectangle.

4:10-4:25 (Olin 115)

John Robens

Analysis and Exploration of Mathematical Models Pertaining to Changes in Body Weight

Weight gain is very difficult to measure on a small scale, but several models have been developed using the first law of thermodynamics (conservation of energy) to help understand why and how weight gain occurs. Based on previous ideas, an energy control system within the body is found to self-regulate body mass for most individuals, but when a weight increase occurs, there is feedback that further promotes weight gain and may cause it to become unstable. Breaking down the model into a few cases, bifurcation diagrams were developed using the feedback to further explore the unstable situations. It was determined that instability in weight gain is quite obtainable, and that the best way to prevent instability is to maintain an adequate physical activity level.

The Problem of the Newsletter will return NEXT WEEK!