Funded in part by a grant from the National Science Foundation, DMS 1807502

Summary

Map of St. Lawrence University **3**

Schedule Overview **4**

Invited Address **6**

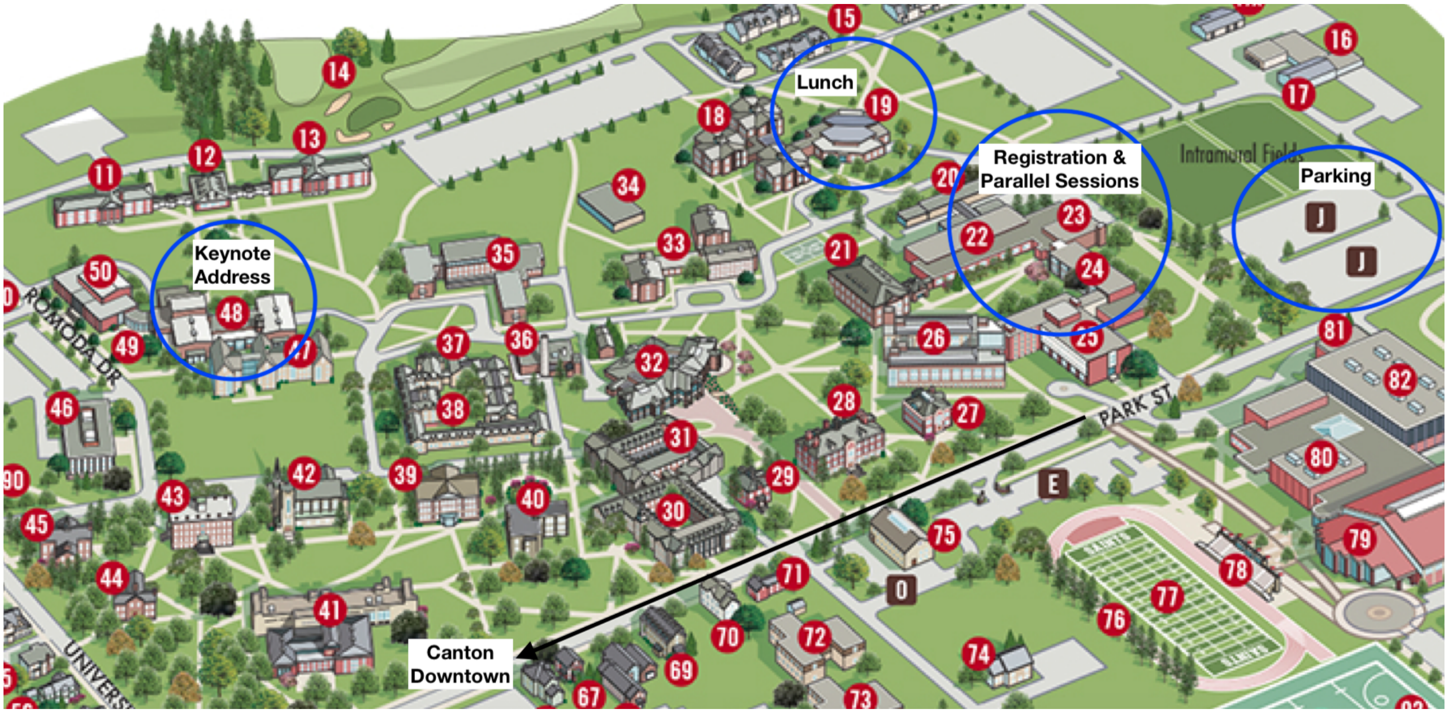
Panels at Lunch **8**

Parallel Sessions I **9**

Parallel Sessions II **15**

Parallel Sessions III **23**

Speaker Index **32**



Valentine Hall (24), Brown Hall (22), Gulick Theatre (Noble Center) (48),
Eben Holden Conference Center (19), Parking (J Lot)

- **Parking:** You may park in the **J Parking Lot** located behind Valentine Hall. The entrance to the J Parking Lot will be on your left as you drive on Park Street toward St. Lawrence University from downtown.

- **Registration & Breakfast:** Registration will be on the first floor of the **Valentine Hall**, shown as Building 24 on the map above.

- **Parallel Session Talks:** The talks will be on the first and second floors of **Valentine Hall** (Building 24) and in **Bloomer Auditorium** (Building 22) in Brown Hall. Valentine Hall is connected to Brown Hall via Flint Hall (Building 23). The Mathematics, Computer Science, and Statistics Department at St. Lawrence University is located on the first floor of Valentine Hall.

- **Keynote Address:** The welcome and invited address will take place in the Gulick Theatre in **Noble Center**, shown as Building 48 on the map above.

- **Lunch:** Lunch will be served in **Eben Holden Conference Center**, shown as Building 19 on the map above.

Schedule Overview

8:00-9:30am	Registration and Light refreshments	Valentine Hall
9:30-10:30am	Parallel Sessions I	Valentine Hall & Bloomer Auditorium (Brown Hall 122)
10:45-11:45pm	Official Welcome and Keynote Address	Gulick Theatre (Noble Center)
12:00-1:30pm	Lunch and Panels	Eben Holden Conference Center
1:45-2:45pm	Parallel Sessions II	Valentine Hall & Bloomer Auditorium (Brown Hall 122)
2:45-3:15pm	Coffee and Birthday Cake Break	Valentine Hall
3:15-4:15pm	Parallel Sessions III	Valentine Hall & Bloomer Auditorium (Brown Hall 122)

Login Information for Presenters

You can log into the computer for presentation with the following login credentials.

Username: `labguest` Password: `@HRUMC2018`

Wireless Network

eduroam is available in all campus buildings for attendees from participating institutions. Use your institution email address and password to log on to eduroam. You can check if your institution participates in *eduroam* at `https://www.eduroam.org/where/`.

If you are not from an *eduroam* participating institution, use the network *guest*. No password is required, but you will need to accept the policy before usage.

If you need more assistance, please refer to the Wireless document at `https://www.stlawu.edu/it/service/network-wireless/wireless`.

Welcome, everyone!

Welcome to the twenty fifth annual Hudson River Undergraduate Mathematics Conference (HRUMC). Whether you are a student at your first conference or an experienced speaker, we hope that you will find today beneficial, rewarding, and inspiring, and that you will make new friends. Our aim is to build an atmosphere that includes the message, "We are glad that you are joining the mathematics community!" This conference features fifteen minute talks by students and faculty, and a longer plenary address. Each year, we invite students and faculty from universities and colleges in New York and New England to send abstracts for the short talks. These describe research projects, independent study projects, or any other independent work by students and faculty.

If you are a first time attendee then start by studying the short talks schedule to find some that grab your interest. Each of these is marked as Level 1 or Level 2: the Level 1 talks are accessible to everyone while Level 2 talks are aimed at faculty and advanced students.

Note that each session has a Chair, who keeps all presentations strictly to the schedule. This means that you can easily move from room to room to see talks - you know that each talk that you attend will end on time, and each next one will start when it says it will.

If you are a first time presenter then we especially say, "Welcome!" Giving a presentation can be daunting, but is also energizing. The session Chair will be able to help with any questions that you have, including any technology questions.

The first HRUMC was held at Siena College in 1994, and now it is an annual tradition. For information about previous meetings, pictures from this year's conference, as well as information about next year's conference you can check out the web site:
`http://www.skidmore.edu/hrumc`.

Presenter or attendee, we hope that you enjoy the HRUMC and that you will you will learn a great deal. And, if you can, we hope to see you again, sharing your work, at next year's conference.

Steering Committee
Paul Friedman (Union College)
Pam Harris (Williams College)
Emelie Kenney (Siena College)
Choong-Soo Lee (St. Lawrence University)
Michael Schuckers (St. Lawrence University)
Lucy Spardy (Skidmore College)
David Vella (Skidmore College)
William Zwicker (Union College)

Local Organizing Committee
Diane Chase (St. Lawrence University)
Natasha Komarov (St. Lawrence University)
Choong-Soo Lee (St. Lawrence University)
Daniel Look (St. Lawrence University)
Jeff McLean (St. Lawrence University)
Ivan Ramler (St. Lawrence University)
Michael Schuckers (St. Lawrence University)
Lisa Torrey (St. Lawrence University)

Welcome and Invited Address

Welcoming Remarks and Introduction for the President:
Dr. Michael Schuckers, St. Lawrence University

Welcoming Remarks from the President:
Dr. William Fox, St. Lawrence University

Introduction of the Speaker:
Yuxi Zhang '18

Keynote Address
Dr. Karen Saxe, Macalester College

Keynote Address:

Dr. Karen Saxe
Macalester College

Mathematics & Social Justice

Abstract

Societal inequalities pose some of the biggest and most intractable challenges facing our nation today. Can mathematical concepts help us understand and analyze social inequality? What is the relationship between various imbalances in the U.S. today such as those we see in income distribution and political polarization? This talk will explore answers to these questions. We will focus on quantitative approaches that mathematicians and political scientists use to measure inequalities. The metrics we will look at include the Gini Index for measuring income inequality, and the Roeck measure for detecting gerrymandering. We'll also discuss how our political environment and policies can reduce or intensify inequalities in society.

Biography

Karen Saxe is Director of Government Relations for the American Mathematical Society. She works in Washington DC to connect the mathematics community with decision makers who impact scientific research and education. She is also DeWitt Wallace Professor of Mathematics at Macalester College in St Paul, MN. She has been awarded a Distinguished Teaching Award by the Mathematical Association of America, and the Macalester College Excellence in Teaching Award. She is active with policy and advocacy activities for both the Mathematical Association of America and the Association for Women in Mathematics. Karen has been a resource in Minnesota on redistricting, consulting with city governments, is currently part of the Common Cause Redistricting Leadership Circle, and served on the Minnesota Citizens' Redistricting Commission, created to draw congressional districts following the 2010 census. She also serves on the Advisory Board for Transforming Post-Secondary Education in Mathematics (TPSE Math), an initiative sponsored by Carnegie Corporation of New York and the Alfred P. Sloan Foundation, aiming to effect constructive change in mathematics education at community colleges, 4-year colleges and research universities.

Panels at Lunch

Mentoring Undergraduate Research Panel — Moderator: Robin Lock

- Joel Foisy (Mathematics) (SUNY Potsdam)
- Catherine Paolucci (National Science Foundation)
- Ivan Ramler (Statistics) (St. Lawrence University)
- Margaret Robinson (Mathematics) (Mt. Holyoke College)

So You're Thinking about Grad School — Moderator: Daniel Look

- Blaine Ayotte '17 (Mathematics, Physics)
  MS Candidate, Electrical and Computer Engineering, Clarkson University,
- Darcy Buckingham '12 (Mathematics, Economics, Minor in Statistics)
  MBA and Masters in Accounting, Northeastern University
- Ben Leblanc '13 (Mathematics, Physics, 3+2 Engineering)
  PhD Candidate, Civil and Environmental Engineering, University of Vermont
- Johnathan Muckell '06 (Computer Science, Mathematics)
  MS in Computer and Systems Engineering, PhD in Informatics, University at Albany
  Professor of Practice, Electrical and Computer Engineering, University at Albany

Making the Most of your First Years in Industry — Moderator: Ed Harcourt

- Geoff Baum '10 (Computer Science)
  Lead Front End Engineer at Veoci
- Matt Dodge '12 (Mathematics, Economics)
  Certified Financial Planner at UBS
- Dan Downs '09 (Computer Science)
  Eclipse IT Project Lead
- Emma Kearney '12 (Environmental Studies - Mathematics)
  Core Quality Assurance Associate II at AIR Worldwide
- Jenna Street '15 (Mathematics, Economics, Minor in Statistics)
  Senior Actuarial Analyst at BPAS Actuarial & Pension Services

Parallel Sessions I

Abstract Algebra I — Valentine Hall 104
Chair: Maegan Bos (SLU)

9:50-10:05 *Drawing Braid Diagrams* (Level 1)
Shana Crawford (Bennington College)
Mathematical braids are twisted strings which can be defined as a group. This group appears in many places in mathematics, and contains interesting examples of group theoretic ideas and problems. This talk briefly explores the braid group by examining a paper by F. A. Garside, and dissecting his method for diagramming braids for solutions to a version of the "word" problem in the braid group.

10:10-10:25 *Projective Planes and Groups* (Level 2)
Cassandra Call (Union College)
Projective planes are geometrical structures that grew out of projective art, in which the 2-dimensional plane is extended so that any two lines will always intersect. In projective geometry, we follow rules that are quite different from the normal Euclidean geometry that most mathematicians work with. Instead, the leading players of projective geometry are lines and points defined differently than their Euclidean counterparts and the incidence relations between them. We will discuss projective planes through various mathematical lenses, use group theory to further study the properties of these structures, and reach some fascinating conclusions.

Applied Mathematics I — Valentine Hall 103
Chair: Mitchell Joseph (SLU)

9:50-10:05 *Forecasting IPhone X Prices on EBay* (Level 1)
Noah Castle (Westfield State University)
The new IPhone X differs from past models since its market price is significantly higher than any other phone model. Buying this product on EBay using online auction may be the optimal way to purchase this expensive product. Using the incredibly useful sales data EBay provides, statistics and analytics are a powerful tool to predict trends in sales price. Using my data collection, methodology, and analysis of IPhone X sales data, my goal is to build a model that forecasts prices of the IPhone X.

10:10-10:25 *Energy Profiles of Four States* (Level 1)

Max Sharpe (Skidmore College)

Energy production and consumption makeup and underlie significant portions of the United States economy. While the production and use of renewable energy has been on the rise since 1960, the technological advances have usually not been sufficient for renewable energy to be competitive with nonrenewable energy. Our energy profile model considers renewable and nonrenewable energy usage and production in relation to total energy usage and production in order to determine which of four states states produced and used cleaner, more renewable sources of energy; we also examined historical trends of usage for each of the four states.

Computer Science Valentine Hall 124
Chair: Choong-Soo Lee (SLU)

9:50-10:05 *The Open World Assumption in Semantic Webs* (Level 1)

Ping Lin (Skidmore College)

Semantic webs represent concepts, properties and relationships between real-world entities, events, and scenes. What makes them realistic is the open world assumption, which means that there could always be something new that someone will say so we must assume that there is some information out there in the web that could be known. This thought will affect our thinking when we are using OWL to build an ontology because it is so different from other coding environments, which we usually assume to be a close world.

This talk will be about the basic concept of the open world assumption, why we have this assumption in semantic webs including some real-world examples, and how this assumption will change our way of thinking of coding with some syntax examples.

10:10-10:25 *Honeypot* (Level 1)

Xinyi Gu (Skidmore College)

Big Data is getting an increasing emphasis, and the security of data now is a big concern. The honeypot is an application of data security and benefits both business and research world. With the use of honeypots, we add another layer of security, and at the same time, we can see and study the patterns of the data we gathered.

We will talk about what a honeypot is and how it will benefit the applicator. We will also present our honeypot implementation and data we collected so far using four servers in different locations to see what patterns these attacks have.

Graph Theory Valentine Hall 105
Chair: Natasha Komarov (SLU)

9:30-9:45 *Considering Splines* (Level 1)

Alexandria Perry, Leila Eshghi, Lauren Low (Smith College)

We will consider splines' bases through examples and counterexamples before conjecturing algorithms and summarizing their proofs for more general cases.

9:50-10:05 *Network Optimization* (Level 1)

Emily Chang (Smith College)

Many real-world problems can be formulated as network flow optimization problems. One classic example is the transportation problem. We can visualize this problem as a graph with edge weights and a flow of products from supply nodes to demand nodes, where we seek to minimize the transportation costs. We discuss results about a variant of the transportation problem, where we seek to minimize the sum of the transportation cost and the cost of building the edges themselves.

10:10-10:25 *Modularity in Graphs* (Level 2)

Jack Felag (University Of Vermont)

Modular systems are becoming more and more popular for optimization, as subsystems can be improved with little risk for inhibiting the overall system. In the simplest definition, modularity is sparsely connected dense regions. Described by Mark Newman and Michelle Girvan in their 2006 paper, we can measure this with the Q-metric. Using the Newman-Girvan algorithm, Q can be computed (albeit expensively,) for a given graph and the number of modules. The Q value returned can be promising to find strong modules within the graph, but it can also be misleading. Often, other modularity scoring algorithms are used in conjunction to provide further evidence of a modular structure. These include conductance of a graph, and its partition density.

Linear Algebra Valentine Hall 117

Chair: Paul Friedman (Union College)

9:50-10:05 *The Math Behind Beacketology* (Level 2)

Craig Scharf (Union College)

Every year, as winter comes to an end and spring is right around the corner, sports followers everywhere get ready for March Madness. This is the time of year where the NCAA Division I Men's Basketball tournament begins; a 68 team, single elimination competition to determine who will be the national champion. This month is filled with statistics and analysis of teams and players to try and create the most accurate bracket. What if there is a mathematical approach to predicting who will be the Division I NCAA Men's Basketball Champion? Is a perfect bracket even possible using math? Most likely not, but we can often improve our bracket using a combination of statistics and linear algebra.

In this lecture we will be looking at two methods, the Colley Method and the Massey Method, to compute rankings of teams by solving linear equations using data from games played during the season. We will explore the mathematics and motivation behind each method. When applied to March Madness brackets, these methods have proven to have very high success rates, especially compared to the data collected by the ESPN bracket submissions over the past few years.

10:10-10:25 *Springer Fibers of Nilpotent Matrices and Their Bijections with Graphs and Webs* (Level 2)

Haley Hoech (Smith College)

A flag is a sequence of subspaces of a finite-dimensional vector space. Springer fibers are sets of flags that can be calculated for various matrices. In the study of the Springer fibers of two particular varieties of nilpotent matrices, bijections between the fibers and various graphs/webs have been assumed but not proven. This talk will present conjectured geometric maps between these objects.

Matroids Valentine Hall 106
Chair: Danny Crytser (SLU)

9:50-10:05 *Matroids I* (Level 1)

Vincent Ferlini (Keene State College)

The matroid is a good example of a mathematical abstraction that emerged from one subject (linear algebra) but soon provided an alternative way of looking at concepts in other subjects (graph theory, combinatorial optimization). In this presentation, we shall begin with some examples, introduce the definition of a matroid, and then give some basic properties.

10:10-10:25 *Matroids 2* (Level 1)

Sarah Otterbeck (Keene State College)

Matroids are associated with the greedy algorithm (a useful optimization technique) in the following way: The greedy algorithm gives an optimal solution if and only if the underlying structure is a matroid. This relationship will be illustrated with two examples.

Statistics I Valentine Hall 205-6
Chair: Ivan Ramler (SLU)

9:30-9:45 *Exploring Facebook Through R: A Statistical Computing And Graphics Environment* (Level 1)

Shyanne White (St. Lawrence University)

In a world where social media is the main way people stay in touch and stay updated with news, it is important to be able to understand and analyze what comes out of these websites. Facebook is one of many social apps used globally and contains many fascinating aspects that can be analyzed on a statistical level. Packages coming from social media websites have been created, which can be analyzed within the statistical program R. Recently the R-Facebook package has been created, which calls for exploration. With this project, not only will the limitations of what can be accessed with this new package be tested, but from the data accessed, an app that allows students who do not know much about the program R will be made so that the data from the package can be accessed and analyzed easily, as well as interactive classroom assignments to round their understanding of statistics.

9:50-10:05 *Using Sentiment Analysis to Detect Bullying and Toxicity on Social Media* (Level 1)

Nevaan Perera (St. Lawrence University)

The current project involves analyzing facebook posts and comments to detect cyber bullies and level of toxicity on social media. Sentiment analysis methods could be used to attach a score to each post or comment, and see how toxic it is. Sentiment analysis refers to the task of natural language processing to determine whether a piece of text contains some subjective information and what subjective information it expresses; for example whether a comment or attitude is positive, negative or neutral. We hope to gather a large dataset of posts and comments, where each post will have its most frequent words, positivity score, negativity score etc. By using the data we could answer many questions such as "are there particular topics that make comments toxic?" or "What are the most frequently used toxic words on the internet?". Results from the current project could help in preventing cyber bullies roaming the world wide web.

10:10-10:25 *Statistical Data College and Analysis of SLU Lacrosse Data* (Level 1)

Ashley Norris, Madison Goodwine, Allie Roberts (St. Lawrence University)

For this project we are collecting and analyzing the St. Lawrence University Varsity Men's Lacrosse games for the 2018 season. Lacrosse analytics is a field with little prior research, so we started our project by prioritizing statistics to track with the Coaches. While statistics for the game are tracked, we are doing a more in-depth analysis by focusing on their offensive efficiency and face-offs. For offensive efficiency, we analyze both individual player involvement and also how the team is doing overall. We track statistics such as: positive/negative turnovers for individual players, the number of quality scoring opportunities within a possession, the number of quality shots in a possession and the outcomes for each offensive possession. Our goal is to find trends in the team's offensive efficiency and provide analyses for the Coaches to make data-driven decisions.

Career Opportunities in the Mathematical Sciences

Chair: Daniel Look (SLU) Bloomer Auditorium (Brown Hall 122)

9:30-9:45 *Identifying Internship & Research Opportunities*

Ron Albertson (St. Lawrence University)

In this talk, we will discuss how to go about finding internship and other research opportunities such as REU's for students in the mathematical sciences.

9:50-10:05 *Getting In... Graduate Study*

Ron Albertson (St. Lawrence University)

This talk will focus on the process of applying to graduate schools in the mathematical sciences.

10:10-10:25 *Career Options & Job Search Strategies*

Ron Albertson (St. Lawrence University)

The post-college job search is something that can be daunting for many students. We will discuss some strategies for finding a job after graduation in the mathematical sciences as part of this talk.

Parallel Sessions II

Abstract Algebra II Valentine Hall 104

Chair: Duncan Melville (SLU)

1:45-2:00 *Hilbert Schemes of Points: Introduction* (Level 2)

Mark Huibregtse (Skidmore College)

In this talk, we will introduce the Hilbert scheme $H^n_{\mathbb{A}^2_k}$ of n points of the affine plane over a field k. As a set, $H^n_{\mathbb{A}^2_k} = H$ comprises the ideals $I \subseteq k[x,y]$ such that the quotient $k[x,y]/I$ is a K-vector space of dimension n. In fact, the quotient has at least one basis B of monomials that is closed under divisibility: that is, if m and m' are monomials such that $m \in B$ and $m'|m$, then $m' \in B$. With respect to B and its border (the set ∂B of monomials of the form $b = x \cdot m$ or $b = y \cdot m$ such that $m \in B$ but $b \notin B$), the ideal I has a unique k-basis of the form $\{b - \sum_{m \in B} c_{m,b} \cdot m \mid b \in \partial B, c_{m,b} \in k\}$, called the border basis of I with respect to the monomial basis B. In this, the first of a two-talk sequence, we present the basic definitions and describe how the set of all ideals having a given monomial basis B can be given the structure of an affine variety called a border basis scheme. The second talk will describe some related algorithms and their implementation (in *Mathematica*), such as an algorithm for computing a border basis for a given ideal $I \in H$.

2:05-2:20 *Hilbert Schemes of Points: Implementations and Examples* (Level 2)

Chen Lin (Skidmore College)

In this second of a two-talk sequence, we will describe some algorithms for working with border basis schemes, in particular, an algorithm for generating a set of polynomial generators of the ideal of a border basis scheme, and an algorithm for computing a border basis (relative to a suitable order ideal) for a given ideal $I \subseteq k[x,y]$ of finite colength. We will present *Mathematica* implementations of these algorithms and use them to compute various examples.

2:25-2:40 *Counterexamples to Primary Decomposition in Commutative Rings* (Level 1)

David Vella (Skidmore College)

In 1905 Emanuel Lasker proved that in a polynomial ring, every ideal I can be written as an intersection of primary ideals. Such an expression for I is called a *primary decomposition*. In 1921, Emmy Noether extended Lasker's theorem to what are now called Noetherian rings. These Lasker-Noether decompositions are important because they simultaneously generalize the fact that every integer has a product into prime powers, and the fact that an algebraic variety is a finite union of irreducible varieties. If a student of commutative algebra wants to see an example of an ideal, which does *not* have a primary decomposition, they must look in a non-Noetherian ring. In this talk, we give a counterexample in a certain Boolean ring, which is in some sense simpler than the standard counterexample.

Applied Mathematics II — Valentine Hall 103

Chair: Melanie Brown (Champlain College)

1:45-2:00 *Modeling the Loss of Coastal Wetlands in Louisiana* (Level 1)

Victoria Slack (Hamilton College)

As the coastal wetlands of Louisiana continue to disappear, it becomes increasingly important to understand the rate at which coastal erosion occurs. By drawing from historical data and constructing a mathematical model, we can try to predict what coastal Louisiana will look like in 10 years, 20 years, etc. To help model the wetland loss, I use MATLAB to reproduce years of coastal erosion using a Monte Carlo simulation, and answer questions about how long we can continue to live in coastal Louisiana.

2:05-2:20 *Non Fibonacci Phyllotaxis: Quasi-Symmetry* (Level 1)

Angelica Estrada, Elizabeth Fitzpatrick, Oumayma Koulouh, Salomea Jankovic, Yixuan Zhang (Smith College)

Plant organs are often organized in lattice-like patterns, with two families of helices winding in opposite directions around the stem. The number of helices in these two families are usually successive Fibonacci numbers. This work focuses on the case when they are *not*: in many non Fibonacci cases, the number of helices tend to be close to equal. We provide statistical evidence for this phenomenon of "quasi-symmetry", which has only been recognized recently, and point to a mechanism that explains both types of patterns.

Fractals & Chaos I Valentine Hall 106
Chair: Danny Crytser (SLU)

1:45-2:00 *The Magnetic Spectrum on the Sierpinski Gasket* (Level 1)

Ruoyu Guo (Colgate University)

The magnetic Laplacian on a connected graph is a Hermitian matrix with 1's on the diagonal, and suitably weighted complex numbers in the xy-entry if x and y are connected by an edge, and 0 if x and y are not connected. In this talk, I will describe how to compute the eigenvalues of the magnetic Laplacian on the infinite Sierpinski Gasket (SG) graph, which is a famous self-similar fractal. By computing the Schur complement of the magnetic Laplacian from the $(n+1)$th-level graph approximation to the nth-level graph approximation, we can find a function $R(\lambda)$ which allows us to obtain the eigenvalues iteratively. The spectrum exhibits self-similarity and resembles a "butterfly."

2:05-2:20 *Dynamics of Quadratic Networks* (Level 1)

Simone Evans (SUNY New Paltz)

Many natural systems are organized as self-interacting networks composed of coupled quadratic nodes. Because these nodes receive functional input from not only themselves but also the other nodes in the network, they have ensemble behavior different from that of isolated functional nodes. Our objective is to study how the architecture of a network affects asymptotic dynamics. We extend accepted theorems and results from systems with isolated quadratic nodes to networks of quadratic nodes.

2:25-2:40 *Chaos Theory in Economic Markets* (Level 1)

Michael Williams (St. Lawrence University)

Chaos Theory, which was discovered throughout the late 19th century and deeply studied through the mid-20th century, is a mathematical insight that concentrates on dynamical systems that are highly sensitive to initial conditions as well as minuscule changes in inputs. When applying Chaos Theory to economic markets, it is easy to see the relation of an economic market to a chaotic dynamic system, as they are each highly volatile and non-linear. In this application, a question lies in whether these markets show random chaos or deterministic chaos, or similarly, how much of the market outcomes are random and how much could be predicted. In attempting to uncover this question, I will show why traditional market predicting tools are often inaccurate without the idea of chaos as well as the benefits in predicting markets when taking into account four-dimensional models as opposed to two or three. I will also explore long-standing economic and social ideas such as the "butterfly effect" and the "invisible hand" and explain how Chaos Theory is at the root of these ideas.

Graphs & Knots I Valentine Hall 105
Chair: Patti Lock (SLU)

1:45-2:00 *Comparison and Enumeration Algorithms for gamma-Acyclic Hypergraphs* (Level 1)

Aaron Gregory (SUNY Polytechnic Institute)

Cavallo & Klir defined hypergraph γ-acyclicity in 1979, a concept that has since found many applications in database theory, including constraint satisfaction and reconstruction analysis.

Whereas γ-acyclicity is commonly defined in negative terms (that is, forbidden substructures), we discuss local and global hypergraph properties that are positively associated with γ-acyclicity. Using these properties we construct a polynomial time algorithm for comparing unlabelled γ-acyclic hypergraphs, and improve on current γ-acyclic hypergraph enumeration algorithms.

2:05-2:20 *Maximally Efficient Threading Circuits for DNA Self-Assembly* (Level 1)

Anna Cook (Saint Michael's College)

This research produces mathematical models that can be used to obtain the most successful DNA threading circuits for polyhedral skeletons that are common targets from nano-scale DNA self-assembly. In order to create Euler circuits, we had to add symmetrical augmenting edges to make our Platonic and Archimedean polyhedra four-regular. We provide a directionality proof that calculates the lower bound for the number of vertex configurations necessary to thread our target polyhedra. This proof can also be applied to other four-regular polyhedra. We prove that our threading sequences for the cube, dodecahedron, truncated cube, and the great rhombicuboctahedron result in the minimum number of vertex configurations. While vertex configuration and augmenting edge arrangement were our key objectives, we also attempted to maintain rotational symmetry of the threading circuits for each of our target structures.

1:45-2:00 *Pi Day in a Middle School Classroom* (Level 1)

Rebecca Weisburgh (Saint Michael's College)

For mathematics in middle school, the first time students are introduced to the number Pi is when they are learning about the different types of numbers. Students learn the categorization of it into its class and are introduced to finding circumference and area of circles, which usually occurs in seventh grade. There is never an in depth explanation as to how Pi is discovered because it is left as just the symbol as part of an equation. My presentation will focus on the use of lesson plans on Pi day to challenge my students with a new concept and help them determine where this number comes from and how it applies to their lives. This was accomplished through various hands on activities. One of the main activities was measuring the circumference and diameter of items found in houses and schools. They kept track of the results on a worksheet, which they used to convert to the fraction 22/7, which is a close approximation of Pi. I then read the book "Sir Cumference and the Dragon of Pi", which directly relates to their exploration. I also showed a clip of a video that recites many digits of Pi. Using this, I wanted them to create either a rap/song about Pi or create a visual representation (poster, jewelry, etc). Because the classes are only 50 minutes, my goal was to engage them in the activities for as long as possible and allow them to explore and ask questions about Pi. I have designed the lessons to reflect the Common Core State Standards for Mathematics, so the students will have started meeting different learning targets. My presentation consists of an outline of the lesson plan, samples of student work, and a brief reflection on the day.

2:05-2:20 *Mathematical Modeling: A Study of its Current and Possible Applications in the Math Classroom* (Level 1)

Richard Luczak (Niagara University)

What is math modeling, and how can it be used to positively impact a student's problem solving and critical thinking skills? Math modeling can be used in any branch of high school math mathematics - in algebra, geometry, algebra II, and even calculus! I am interested in looking at how students of differing backgrounds solve these types of math problems. I have selected three math modeling problems, designed by the experts at the SIAM organization (Society of Industrial and Applied Mathematics) and will examine the different maths students may use in order to solve them. Several correct solutions exist mathematically for all of these problems. The question becomes, based on the current standards, what are the most likely ways in which students will solve them? An in-depth study of the New York State Common Core State Standards in Mathematics (grades 9-11) will also be conducted to see where math modeling is currently in the curriculum, and I will make recommendations as to where more math modeling can be incorporated to better serve the students of the Empire State.

Number Theory Valentine Hall 124

Chair: Paul Friedman (Union College)

1:45-2:00 *The Collatz Tree* (Level 1)

Cameron Young (Westfield State University)

The Collatz Conjecture is a well-known unsolved problem in number theory. Proposed in 1937 by Lothar Collatz, this conjecture involves the behavior of the following system which starts at any integer $x > 0$ and is then iterated:

$x \to \frac{x}{2}$ if x is even, or

$x \to 3x + 1$ if x is odd.

The conjecture states that for all integers $x > 0$, iterating this process will eventually reach the number 1. We can use the conjecture's iterative properties to create a

2:05-2:20 *Does a perfect cuboid exist?* (Level 1)

Zachary Scannell (Westfield State University)

The Pythagorean theorem allows us to find right triangles with integer side lengths and rational area. However, if we eliminate the need for the right angle we can look at all triangles in an attempt to find a "perfect triangle". Can we extrapolate these requirements into a "perfect" 3D object, such as a "perfect tetrahedron" (a 3D prism made up of these "perfect triangles")? We are going to look at a progression of "perfect" geometric figures starting with a perfect triangle and progressing to the desired perfect cuboid; the goal being to figure out how many of these objects we can discover.

2:25-2:40 *Generalized Rascal Triangles* (Level 1)

Philip Hotchkiss (Westfield State University)

In 2010, three middle school students, Alif Anggaro, Eddy, Liu and Angus, Tulloch introduced the *Rascal Triangle*, a variation of Pascal's Triangle. Adopting the notation from Anggaro, Liu and Tulloch, the entries in Pascal?s Triangle can be determined by the well known formula, $South = East + West$. To construct the Rascal Triangle, Anggaro, Liu and Tulloch used the formula
$South = \frac{East \times West + 1}{North}$.
In 2015, students in a Mathematics for Liberal Arts (MLA) class taught by my colleague, Julian Fleron, discovered that the formula
$South = East + West + 1 - North$
also generates the Rascal Triangle.
In this talk we will discuss examples and properties of number triangles (many of which were discovered by our MLA students) that can be generated by a variation of one of these formulas.

Statistics II	Valentine Hall 205-6 Chair: Robin Lock (SLU)

1:45-2:00 *An In-Depth Look at Pace of Play and Blown Leads in the NBA* (Level 1)

Ryan Packer (St. Michael's College)

In NBA basketball over the past 20 years, pace of play has increased and that appears to have led to an increase of blown leads. The goal of my research is to look at data collected from the 1996-1997 seasons through the 2016-2017 season, to see if there is any correlation between pace and the number of comebacks that occur throughout the season. Linear regression models are used to predict rates of blown leads as a function of pace. Results are statistically significant and illustrated with scatter plots. Forecasting methods are used to predict relationships in the future.

2:05-2:20 *Sentiment Analysis in R* (Level 1)

Anna Izzo (St. Lawrence University)

In a world that is ever-evolving, people are no longer complaining about companies through their 1-800 numbers. Rather, if a company's products or services are disliked, consumers visit social media platforms, such as Facebook, twitter, Instagram, etc., and post their complaints in plain sight. Because of this, companies must show diligence in listening and responding to those who reach out in this manner.

Over the summer, Anna Izzo worked to understand and improve the efficiency and accuracy of determining sentiment through automation, instead of human power. From back end to front, she will share how she created a model in R to score over 15000 tweets in less than 20 seconds- now that's fast!

2:25-2:40 *The Effect of Demographic Factors on Hourly Wages* (Level 1)

Jingxian Hu (Hamilton College)

The relationship between hourly wages and demographic factors are of practical relevance, perhaps even moral significance. Research reveals that work experience, education, marital status, gender, demographic factors all contribute to the major differences among individuals? incomes. In this paper, I will identify the demographic characteristics involved in determining hourly wages.

Career Opportunities in the Mathematical Sciences

Chair: Lisa Torrey (SLU) Bloomer Auditorium (Brown Hall 122)

1:45-2:00 *Identifying Internship & Research Opportunities*

Ron Albertson (St. Lawrence University)

In this talk, we will discuss how to go about finding internship and other research opportunities such as REU's for students in the mathematical sciences.

2:05-2:20 *Getting In... Graduate Study*

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This talk will focus on the process of applying to graduate schools in the mathematical sciences.

2:25-2:40 *Career Options & Job Search Strategies*

Ron Albertson (St. Lawrence University)

The post-college job search is something that can be daunting for many students. We will discuss some strategies for finding a job after graduation in the mathematical sciences as part of this talk.

Parallel Sessions III

Applied Mathematics III Valentine Hall 103
Chair: Duncan Melville (SLU)

3:15-3:30 *US Airways Optimizes flight-crew schedule* (Level 1)
Lanlan Yu (Hamilton College)
US Airways flies more than 350 aircrafts over 100 cities per day and employs 5000 pilots and 8000 flight attendants. The flight-crew schedule is updated once a month, and each schedule contains a set of bidlines, which combine pairings (trips) and rest periods. There are a few rules when the scheduler produce the schedule. For example, the rest period is at least two days long, and a pilot cannot be on call for more than six days in a row. To improve the efficiency of pilots, US Airways implements an optimization algorithm for crew-scheduling. The objective function is to maximize the sum of quality points to bidlines minus the unmet demand points. The total run-time of the model is 3.5 hours after improvements, and US Airways has been using this model to produce flight-crew schedule since 1995.

3:35-3:50 *The Solow Growth Model and Optimal Debt Level* (Level 1)
Yongzheng Liang (Hamilton College)
Finding the perfect debt level has always been a headache for governments–carrying too much debt for an extended period of time can drag the nation into credit trouble and cause panic among the public, whereas spending too little is likely to reduce investment and stagnate growth. Using the Solow Growth Model and differential equations, we will discuss how we can find the optimum level for a government to spend so that growth is still sustained. We will also look at how this strategy will differ at an individual level concerning personal savings.

Cryptography Valentine Hall 104
Chair: Paul Friedman (Union College)

3:15-3:30 *Sharing a Secret in Plain Sight: The Diffie-Hellman Key Exchange Protocol* (Level 1)

Gregory Quenell (Plattsburgh State University Of New York)

To use a private-key encryption scheme, Alice and Bob need to agree ahead of time on a shared secret key, which is usually a large, random-looking number. Alice uses her copy of the key and some off-the-shelf software to encrypt her message. Bob has the only other copy of the key, so only he can decrypt the message.

But how can Alice and Bob negotiate the shared key in the first place? Whitfield Diffie, Martin Hellman, and Ralph Merkle came up with a method by which Alice and Bob can have a conversation over an insecure channel – where anyone can listen in – and at the end of the conversation, Alice and Bob will have a shared secret number that no one else can figure out.

3:35-3:50 *Creating a 3D Variation of the Standard 2D Playfair Cipher to Optimize Encryption Security* (Level 1)

Aaron Hamilton (Champlain College)

A standard *Playfair Cipher* is a block substitution cipher where the key is a 2-dimensional 5x5 grid with the 26 letters, wherein I and J typically occupy the same space. The standard 2D cipher encrypts plaintext digrams by finding each letter on the grid and treating them as two corners of a rectangle; with the ciphertext letters being the other two corners. I have developed a 3-dimensional variation of Playfair where the key is a 68x68x68 cube with 26 letters, 10 numbers and 32 characters. In this talk, I will introduce this new cipher and discuss its encryption strength.

3:55-4:10 *Approximation of Continuous Functions by Neural Networks* (Level 1)

Zongliang Ji (Union College)

An artificial neural network is a biologically-inspired system that can be trained to perform computations. Recently, techniques from machine learning have trained neural networks to perform a variety of tasks. It can be shown that any continuous function can be approximated by an artificial neural network with arbitrary precision. This is known as the universal approximation theorem. In this talk, we will introduce neural networks and one of the first versions of this theorem, due to Cybenko. He modeled artificial neural networks using sigmoidal functions and used tools from measure theory and functional analysis.

Fractals & Chaos II Valentine Hall 106
Chair: Patti Lock (SLU)

3:15-3:30 *Generating Fractal Tiles* (Level 1)

Matthew Metcalf (SUNY Cortland)

A tiling of the plane is an arrangement of identical geometric shapes ("tiles") which cover the plane without overlap of their interiors. Fractal tilings using self-similar tiles are particularly stunning in their beauty and complexity; these will be the focus of this presentation. The theory behind generating self-similar tiles will be briefly discussed, followed by a demonstration of Mathematica-based software which I developed to streamline the process of producing such tiles. Finally, a selection of aesthetically pleasing original fractal tiles generated using this software will be shown.

3:55-4:10 *Chaotic Cryptography - Digital Image Encryption Based on Chaotic Maps* (Level 1)

Yuxi Zhang (St. Lawrence University)

Chaos theory is the study of the behavior of dynamic systems that are, among other things, highly sensitive to initial conditions and parameters. Since Edward Lorenz coined the term butterfly effect in the 1960s to describe chaotic behavior in weather prediction, chaos theory has been applied to a variety of fields including weather and climate, biology, economics, and physics. In the past few decades, people also have been exploring its potential applications in cryptography. This talk will focus on digital chaotic systems, introducing some of the newer techniques in applying chaotic maps to encrypt digital images. If time permits we will also talk about the security analysis of these cryptographic techniques.

Game Theory and Voting Theory Valentine Hall 107
Chair: David Vella (Skidmore College)

3:15-3:30 *Finite Matrix Games and the Fundamental Theory of Game Theory* (Level 1)
Anthony Zoellner (Saint Michael's College)
Various games that people play present the challenge of finding a winning strategy. From chess or checkers to situations like the prisoner's dilemma, it is possible to find a strategy that simultaneously maximizes a player's winnings while minimizing potential losses. This presentation will introduce the concept of finite matrix games and discuss the fundamental theorem of game theory for finite games (also called the minimax theorem for finite games). We will also look at applications of the theorem in classic game theory examples.

3:35-3:50 *Derived Games* (Level 1)
David Vella (Skidmore College)
Consider a two-player matrix game. If the row player has m choices of strategies and the column players has n choices, the payoff matrix for the game is size m x n. If the players have infinitely many choices of strategies, then the payoff matrix is replaced with a payoff function. In introductory game theory courses, we usually restrict attention to finite games. However, the usual concepts still apply in the infinite case. For example if an infinite game is zero-sum with a payoff function that is a surface, the solution occurs at a 'saddle point' of the surface, just as in the case for finite games.
In this talk we discuss how the consideration of mixed strategies for a given game always results in a new game determined by the given game, which we call the Derived Game. The derived game is always infinite, but it is zero-sum if the original game is zero sum. Furthermore, if the original game is 2 x 2, the payoff function for the derived game is always a surface that has a saddle point. This results in a novel proof of the fundamental theorem of game theory for 2 x 2 zero-sum games.

Geometry Valentine Hall 117
Chair: Danny Crytser (SLU)

3:15-3:30 *The Rectangular Occurrence of Pi* (Level 1)
Riley Bunker (Keene State College)
There are many mathematical ways to compute an approximate value of pi. This talk will give a geometrical method for doing that. We begin with a rectangle of horizontal length 2 and vertical width 1. By adding rectangles of area 1 in a certain way which maintains a larger rectangular shape, we create larger and larger rectangles which have the property that the ratio of the length to the width gets closer and closer to pi/2. This talk will explain the procedure and demonstrate why the ratio approaches pi/2.

3:35-3:50 *The Fundamental Theorem of Axonometry: How to draw a cube.* (Level 1)
Sam Northshield (SUNY-Plattsburgh)
How does one draw a cube (or tell if someone else has accurately drawn one)? The answer, apparently first due to Gauss, is sometimes called the Fundamental Theorem of Axonometry:
Three vectors a, b, c in the plane form the projection of the edges of a cube if and only if, as complex numbers, $a^2 + b^2 + c^2 = 0$.
We also look at a related question: When are three lines in the plane, that all cross at the origin, projections of orthogonal axes in three dimensions?
An intimately related fact is that four complex numbers a, b, c, d are the projections of the vertices of a regular tetrahedron if and only if the average of their squares is the square of their average.

3:55-4:10 *3D Rotations with Quaternions* (Level 1)
Charles McGarey (Champlain College)
Euler angles (Rotations about the x, y and z axis) have long been the standard for representing rotations of objects in $3D$ space. In 1985, Ken Shoemake published a landmark paper describing how a quaternion (a 4-dimensional vector with bases of $1, i, j$, and k, where $i^2 = j^2 = k^2 = -1$) could be used to represent $3D$ rotations in place of Euler angles. Quaternions are superior to Euler angles in describing $3D$ rotation in regard to both efficiency and avoiding singularities, such as gimbal lock. This talk will explore how a quaternion represents a $3D$ rotation, as well as why quaternions are an improvement over other methods of describing rotations.

Graphs & Knots II Valentine Hall 105
Chair: Mitchell Joseph (SLU)

3:15-3:30 *Linking Numbers in Dihedral Covers* (Level 1)

Corrie Ingall (Smith College)

Dihedral linking numbers are a powerful, but often overlooked, knot invariant, arising from colorings of a knot diagram. One way to calculate the dihedral linking number of a knot is to consider a surface built from its diagram using a Seifert-like algorithm, a method due to Perko. We find all such surfaces for certain families of knots, and give formulas for the corresponding dihedral linking numbers.

3:35-3:50 *Intrinsically linked directed graphs* (Level 1)

Joel Foisy (SUNY Potsdam)

A graph is a set of vertices and edges that connect them. A graph is said to be *intrinsically linked*, if for every way the graph is embedded (represented) in space, there are two cycles that form a non-split link. Intrinsically linked graphs have been extensively studied, and Robertson, Seymour and Thomas classified the complete set of minor-minimal (roughly meaning: simplest) intrinsically linked graphs. For a directed graph, each edge has a direction. We say a directed graph is intrinsically linked if, in every spatial embedding, there are a pair of consistently oriented cycles that form a non-split link. In this talk, I will discuss a few recent results on intrinsically linked directed graphs.

Statistics III-A Valentine Hall 205-6
Chair: Robin Lock (SLU)

3:15-3:30 *Lattice Paths* (Level 1)

Nicholas Ahlgren (Keene State College)

A mathematician lives in a city whose streets are laid out in a square grid. His apartment is at the southwest corner of the grid and the college where he teaches is at the northeast corner of the grid. Any route that he takes to work requires a series of left and right turns and each route is equally likely. Each day he randomly selects one of the routes to drive. This talk will show that the average number of turns he will make is the harmonic mean of the number or rows and the number of columns in the grid. The harmonic mean that appears in this situation is both surprising and unusual.

3:35-3:50 *Comparing Randomization Methods for Difference in Means Using Simulations in R* (Level 1)

Xiaobing Wang (St. Lawrence University)

In this presentation, I will explain five randomization methods for difference in means: Reallocate Groups, Shift Groups, Combine Groups, t-test and Pooled t-test. Then, I will use r-generated datasets to evaluate those five methods by Kolmogorov-Smirnov test and two visualization techniques: density plot and diff plot.

3:55-4:10 *More About Time Series: When the Variance is Not Constant* (Level 2)

Yue Yang (St. Lawrence University)

In time series, there is a powerful model called ARMA(autoregressive moving average) model which is used to analyze data set that is considered to have constant variance. My senior year project is about analyzing data set that does not have constant variance, so in this talk, I will briefly introduce GRACH(generalized autoregressive conditional heteroskedasticity) model and talk about how I used different packages in R to get a deeper understanding of GARCH model.

Statistics III-B Valentine Hall 124
Chair: Ivan Ramler (SLU)

3:15-3:30 *Extreme Value Theory Applied to Climate Indicators in the Midwestern United States* (Level 1)

Sophia Adams (Saint Michael's College)

This paper focuses on the application of statistical Extreme Value Theory to climate measurements in Midwestern United States. With rising global temperatures and an increased rate of severe weather events, the changing role of weather in the agrarian hub of the United States presents several instances of a pattern of more frequent extremes. This paper looks specifically at rising temperatures, precipitation, and drought severity as indicators of changing trends of extremes. Statistical Extreme Value Theory is used to model tails of probability distributions of random variables. In contrast, the Central Limit Theorem concerns the center of distributions. One can use Extreme Value Theory to predict the distributions of extreme climate indicators over time. Using models with estimated parameters based on existing data, one can predict the changing distribution and the maximum extreme values that will exist if current trends continue.

3:35-3:50 *Enhancements to a Model of American Chestnut Community Dynamics* (Level 1)

Rebecca Rouleau (Saint Michael's College)

For the past 100 years, the fungal blight *Cryphonectria parasitica* has been infecting American chestnut trees through wounds on the tree, forming cankers. In an attempt to control the spread and negative effects of the blight, a hypovirus-infected form of the fungus was introduced to the cankers, slowing the growth rate of the fungus. The addition of this hypovirulent form of blight provides more complexity to the dynamics within a community of chestnut trees. In the summer of 2017, a stochastic model simulating tree health, growth, and reproduction was formed in an REU at the University of Wisconsin-La Crosse and was statistically informed from data in a nearby grove in West Salem, WI. This presentation will summarize the furthering of that research as well as the modifications made through various statistical techniques. In particular, linear regression is used to predict the growth of trees, and logistic regression is used to model death of trees, given a tree's current size and health status.

3:55-4:10 *Bayesian Ordinal Logistic Regression Analysis of Beech Bark Disease in Fagus Grandifolia* (Level 1)

Obadiah Mulder (Green Mountain College)

Bayesian analysis techniques have the potential to provide more authentic and accurate representations of random variables. In this research, a Bayesian ordinal logistic regression was programed in R and used to analyze environmental variables as predictors of the presences and progression of beech bark disease in 200 Fagus grandifolia (American Beech), which were measured annually for 5 years. Observer measurement error was incorporated into the model explicitly, something that is not possible in traditional statistical methods; a demonstration of the advantages of Bayesian analysis. The model yielded posterior probability distributions for the relationship between environmental factors and the presence and progression of the disease. The model was validated over 100 simulated data sets. Posterior probability distributions were used to create estimates of the impact of different environmental variables on the transmission and progression of beech bark disease.

Career Opportunities in the Mathematical Sciences
Chair: Maegan Bos (SLU) Bloomer Auditorium (Brown Hall 122)

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Ron Albertson (St. Lawrence University)

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Speaker Index

1	Adams, Sophia	Saint Michael's College	29
2	Ahlgren, Nicholas	Keene State College	28
3	Bunker, Riley	Keene State College	27
4	Call, Cassandra	Union College	9
5	Castle, Noah	Westfield State University	9
6	Chang, Emily	Smith College	11
7	Cook, Anna	Saint Michael's College	18
8	Crawford, Shana	Bennington College	9
9	Eshghi, Leila	Smith College	11
10	Estrada, Angelica	Smith College	16
11	Evans, Simone	SUNY New Paltz	17
12	Felag, Jack	University Of Vermont	11
13	Ferlini, Vincent	Keene State College	13
14	Fitzpatrick, Elizabeth	Smith College	16
15	Foisy, Joel	SUNY Potsdam	28
16	Goodwine, Madison	St. Lawrence University	14
17	Gregory, Aaron	SUNY Polytechnic Institute	18
18	Gu, Xinyi	Skidmore College	10
19	Guo, Ruoyu	Colgate University	17
20	Hamilton, Aaron	Champlain College	24
21	Hoech, Haley	Smith College	12
22	Hotchkiss, Philip	Westfield State University	21
23	Hu, Jingxian	Hamilton College	22
24	Huibregtse, Mark	Skidmore College	15
25	Ingall, Corrie	Smith College	28
26	Izzo, Anna	St. Lawrence University	22
27	Jankovic, Salomea	Smith College	16
28	Ji, Zongliang	Union College	24
29	Koulouh, Oumayma	Smith College	16
30	Liang, Yongzheng	Hamilton College	23
31	Lin, Chen	Skidmore College	15
32	Lin, Ping	Skidmore College	10
33	Low, Lauren	Smith College	11
34	Luczak, Richard	Niagara University	20
35	McGarey, Charles	Champlain College	27
36	Metcalf, Matthew	SUNY Cortland	25
37	Mulder, Obadiah	Green Mountain College	30
38	Norris, Ashley	St. Lawrence University	14
39	Northshield, Sam	SUNY-Plattsburgh	27

40	Otterbeck, Sarah	Keene State College	13
41	Packer, Ryan	St. Michael's College	21
42	Perera, Nevaan	St. Lawrence University	14
43	Perry, Alexandria	Smith College	11
44	Quenell, Gregory	Plattsburgh State University Of New York	24
45	Roberts, Allie	St. Lawrence University	14
46	Rouleau, Rebecca	Saint Michael's College	30
47	Scannell, Zachary	Westfield State University	20
48	Scharf, Craig	Union College	12
49	Sharpe, Max	Skidmore College	10
50	Slack, Victoria	Hamilton College	16
51	Vella, David	Skidmore College	16 26
52	Wang, Xiaobing	St. Lawrence University	29
53	Weisburgh, Rebecca	Saint Michael's College	19
54	White, Shyanne	St. Lawrence University	13
55	Williams, Michael	St. Lawrence University	17
56	Yang, Yue	St. Lawrence University	29
57	Young, Cameron	Westfield State University	20
58	Yu, Lanlan	Hamilton College	23
59	Zhang, Yixuan	Smith College	16
60	Zhang, Yuxi	St. Lawrence University	25
61	Zoellner, Anthony	Saint Michael's College	26