

## LATINX MATHEMATICIANS RESEARCH COMMUNITY PROJECT DESCRIPTIONS

### MEASURING POLYTOPES

**Federico Ardila and Pamela E. Harris**

We propose projects in studying various ways of measuring polytopes (by computing their volumes, counting their lattice points, etc). This may include studying tropical geometric properties of combinatorially defined objects, or studying the space of all possible configurations for problems of combinatorial interest, focusing on enumerative, topological, and geometric aspects.

### CODES FROM GEOMETRY

**Adriana Salerno and Tony Várilly-Alvarado**

Linear codes are subspaces of finite-dimensional vector spaces over a finite field. They are used to transmit information through noisy channels, as well as securely store data that is vulnerable to erasures, e.g., hard-drive failures in server farms. We will propose projects in the construction of codes, using the geometry of algebraic varieties, that are optimal in a precise sense: we want codes that have a high information rate and good reconstruction properties, while simultaneously having largest possible distance between individual code words (which is used to detect and correct error during transmission of information). We will assume no prior knowledge of coding theory or of algebraic geometry.

### TEACHING AND LEARNING OF UNDERGRADUATE MATHEMATICS – THE ROLE OF BODY MOVEMENT

**Vilma Mesa and Hortensia Soto**

Embodied cognition is the philosophy that learning is body-based – that is that we convey mathematical ideas via gesture, facial expressions, body movement, etc. in conjunction with verbiage and inscriptions (symbolism and diagrams). In this project we will explore how students develop, convey, and grapple with mathematics using such modes of communication in various collegiate classrooms. We hope to explore the implications that such communication has for curriculum development and for teaching practices. Prior knowledge of embodied cognition is not required.

## FINDING PATTERNS IN UNEXPECTED PLACES

**Stephan R. Garcia and Victor H. Moll**

We will collaboratively investigate a variety of fascinating and accessible topics at the intersection of Number Theory, Combinatorics, and Analysis. Research projects will involve traditional proof techniques along with free-spirited experimentation and computer-based data visualization. This work has already proven fertile ground for undergraduate research, so participants will eventually be well-armed to supervise related projects on their own.

Some things we may explore together are:

- Given an integer  $x$  and a prime number  $p$ , the  $p$ -adic valuation of  $x$  is  $\nu_p(x) = k$ , where  $p^k$  is the largest power of  $p$  that divides  $x$ . If  $x_n$  is a “reasonable” sequence of integers, then sequence of valuations  $\nu_p(x_n)$  often exhibits interesting behavior. For example, there is a simple formula for  $\nu_2(n^2 + 1)$ , but  $\nu_2(n^2 + 7)$  is much more complicated and the data exhibits surprising, fractal-like behavior.
- Primes numbers are “supposed to be” random. However, the Bateman–Horn conjecture describes their behavior with stunning accuracy. How does the conjecture explain the emergence of unexpected, large-scale patterns in geometric arrangements of numbers?

## DATA-DRIVEN MODELS FOR PANDEMIC RELATED DECISION MAKING

**Jesús De Loera and Sara Del Valle**

We will assemble a team of junior researchers who will investigate a variety of questions that decision makers would like to answer to help mitigate the pandemic. We will provide some background reading and encourage them to tackle a problem from different perspectives and methods (e.g., statistics, probability, game theory, optimization, control theory, machine learning, combinatorics, etc). Some questions we may explore include:

- What is the best way to allocate a scarce set of tests or vaccines (optimal vaccination strategies)?
- What is the optimal location of health care facilities so as to maximize patients we vaccinate?
- What are optimal strategies for sequencing medical or screening tests?
- What are optimal vaccination strategies to reduce health disparities?