CLASS DESCRIPTIONS — WEEK 4, MATHCAMP 2018

Contents

9:05 Classes

ARML Power Rounds. (Misha, Tuesday–Saturday)
For those not in the know: ARML is a team-based high school math competition in the US. In one part of the competition, called the Power Round, the entire team of 15 people works together on a bunch of questions on the same topic.

In this class, we'll work on some past ARML Power Rounds together, and talk about the math behind the topics.

Chilis:
Homework: Recommended
Prerequisites: None

Differential Topology. (Kevin, Tuesday–Saturday)
It is often said that topologists can't tell the difference between a donut and a mug. But if the mug has some parts that aren't so smooth, a differential topologist sure can distinguish them!

You may have heard of the Klein bottle, a surface (also known as a two-dimensional manifold) that can be embedded in three-dimensional space, but with a self-intersection. It can, however, live perfectly happily in four dimensions. We'll use the power of differential topology to show that, in general, we can fit any manifold of dimension d in $2d$-dimensional space.

Chilis:
Homework: Recommended
Prerequisites: Knowledge of derivatives. We'll talk about linear maps and continuous maps in $\mathbb{R}^n$, but there will be some first day homework questions to catch you up if you haven't seen them before.
Related to (but not required for): DIY Hyperbolic Geometry (W1); How Curved is a Potato? (W2)

Public-Key Cryptography. (J-Lo, Tuesday–Saturday)
The e-commerce site parana.com has a problem: thousands of customers want to provide their credit card info, but anything sent over the internet can be intercepted by pirates!

So parana.com produces a scrambling function, which customers can use to hide their sensitive info. But here too there is a problem: for customers to be able to use it, this function must be public! So what's stopping the swashbucklers from just computing the inverse of this function and unscrambling all the messages?

"Public Key Cryptography" is a search for the best possible scrambling technique. Some common candidates include RSA, Diffie-Hellman, and Elliptic Curve Cryptography; in addition to discussing the pros and cons of each, we'll see how all of these are actually special cases of the same deeper problem.

Chilis: 🌶🌶 → 🌶🌶🌶

Homework: Recommended

Prerequisites: None

Related to (but not required for): Group Theory (W1); Intro Number Theory (1/2) (W1)

Representation Theory (2/2). (Aaron, Tuesday–Saturday)

This class is a followup to the first week of representation theory, where we applied various theorems to classify all representations of various symmetry groups, such as those of platonic solids. Suitably motivated, this week, we'll explain why those theorems are true.

Chilis: 🌶🌶🌶🌶

Homework: Required

Prerequisites: Linear algebra, group theory

Related to (but not required for): Group Theory (W1); Intro Ring Theory (W2); Linear Algebra (2/2) (W2); The Outer Automorphism of S_6 (W2); Representation Theory (1/2) (W3); Galois Theory (W3)

The Erdős Distance Problem. (Ben, Tuesday–Saturday)

Grab a piece of paper, and mark a bunch of points on it. Now, grab a ruler, and check how many distances you can make by measuring the distance between two of your points. The Erdős Distance Conjecture, very roughly, says that the number of these distances will grow almost linearly in the number of points, no matter how carefully you try to keep the number of distances small. The conjecture was first formulated in 1946 and was established to be true only in 2011, with quite a few intermediate results.

In this course, we'll explore a few of these intermediate results, starting with Erdős's result from the 1946 paper formulating the conjecture and going up to a result from the 1990s. This later result will involve a few tools from graph theory and many useful analytic techniques. Although we won't be able to get to the full proof of the conjecture, we will see how a wide variety of mathematical ideas can be brought to bear on one particular problem. We will also see some of the evolution of methods in this problem, with later proofs relying on ways of attacking the problem that the first authors hadn't realized yet.

Chilis: 🌶🌶🌶

Homework: Recommended

Prerequisites: None; we will use some graph theory but I'll cover what we need

10:10 Classes

Hat Problems ft. Hamming Codes. (Agustin, Friday)

There may come a time in your life in which you are imprisoned with only one way out: play a game that involves you and some inmates wearing hats of two possible colors, and have at most one inmate guess the color of their own hat wrong. And that's if the prison guards are nice.

This class is meant to prepare you for the various cruel hat problems your prison guard will inevitably force you to solve. We'll start with a few puzzle-y hat problems, and then spend some of the time attacking a trickier hat problem. To solve it we'll have to talk about Hamming codes, which we can use to transmit messages accurately, even if an error is introduced! After all, you know what they say– come for the hats, stay for the linear error-correcting codes.

Chilis: 🌶 → 🌶🌶
Homework: Optional
Prerequisites: None

Mathematical Art History. (Viv, Wednesday–Saturday)
Lucia Pacioli, one of Leonardo da Vinci's contemporaries, is quoted as saying
"Without mathematics, there is no art."

Now, it's certainly easy for many of us to agree with that, but there are also many examples throughout history of times when the art world was obsessed, wittingly or unwittingly, with mathematical ideas. We'll talk about some of these times, including topics like perspective, the golden ratio, proto-Cubism, and fractals.
Chilis: 🌶
Homework: Recommended
Prerequisites: none!

Mathematics of Democracy. (Mira, Wednesday–Saturday)
Everyone knows that elections involve choices, but it turns out that the most important choice is one that most voters don't even think about. Before anyone can vote, you have to choose a voting *system*. For instance, do we split the country into small districts each of which elects a single Congressional representative, or do we use larger districts each of which elects several representatives? Do the voters get to list only their first choice of candidate, or do they get to rank or rate all the candidates? And of course, once the votes are in, what algorithm do we use to select the winner(s)? The choice of voting system can have a huge effect on the outcome of an election, so this topic is obviously important from a political point of view. But it also turns out to be really interesting mathematically.

During the first two days, we will focus on systems for electing a single person (e.g. a president). We will prove some depressing theorems showing that no voting system can have all the nice properties you want it to have, and that all voting systems are vulnerable to strategic voting. Then we will move on to multi-winner systems (systems for electing a Congress or parliament), and talk about apportionment, gerrymandering, and various methods of proportional representation.

If you've taken a voting theory class outside of Mathcamp, or at Mathcamp $2000 + N$ for $N < 17$, you may know some of the material in the first day or two, but probably not the last three days. (This stuff is rarely taught in standard voting theory courses.) If you took Mira and Ari's voting theory superclass at MC2017, the first three days will be mostly review, but the last two will be things we didn't cover last summer. Talk to Mira for more details.
Chilis: 🌶
Homework: Required
Prerequisites: none.
Related to (but not required for): Game Theory (The Economic Variety) (W1)

Teaching Computers to Read. (*Greg Burnham*, Saturday)
Human language is tantalizingly close to a formal system. We *feel* like there is a clear relationship between the words we express and the information these words convey. At worst, we just need to be a little more verbose and explicit. If this intuition is true, then we should be able to write computer programs to perform linguistic tasks – like reading a document and answering questions about it. But we've been trying to write such programs for 50 years, and the results are mixed at best.

This class will be a quick survey of some interesting topics in the (very broad) field of computational natural language understanding. We'll try to motivate why it's so difficult to write computer programs capable of performing linguistic tasks and then describe what tasks computers *can* currently perform, focusing on how recent algorithmic and technological progress has allowed for improved performance. We will conclude by noting that the big problems remain unsolved and speculating on what might be necessary for the next steps forward.

As a teaser, here is a simple example illustrating why computational language understanding is hard. Consider the following two sentences, which differ only in the last word:

"The cat caught the mouse because it was clever." "The cat caught the mouse because it was careless."

What does the pronoun "it" refer to in each sentence? Humans share a clear intuition about the right answer to this question. And yet, consider what it would take to write a computer program with this same capability. That's the problem in a nutshell.

Chilis: 🌶

Homework: None

Prerequisites: None!

Related to (but not required for): MCMC (W2)

The Fundamental Group. (Larsen, Wednesday–Saturday)
What do a circle, a square, and the Republic of South Africa all have in common? They all have a hole in the middle! We may be able to give a name to the hole (e.g. "Lesotho") but the hole isn't a part of the original shape itself, despite still somehow being an intrinsic feature.

If X is topological space (a shape, with continuity properties), then there is is a special group called the *fundamental group of* X or $\pi_1(X)$, with algebraic properties depending on the topological characteristics of X. If X doesn't have any holes in it (e.g. if X is a line), then $\pi_1(X)$ is the trivial group, but if X is a circle (or South Africa), then $\pi_1(X)$ is the group of integers $\mathbb{Z}$. The fundamental group is very useful as an invariant, and we will also use it to prove interesting facts, for example: If you have a map of Colorado (of any size, possibly warped or folded) and the map is in Colorado, then there is a point on the map representing its own exact location.

The fundamental group is the first part of a wider field called Algebraic Topology.

Chilis: 🌶🌶🌶

Homework: Recommended

Prerequisites: Group Theory

Related to (but not required for): How Curved is a Potato? (W2); Cohomology via Sheaves (W4)

Trail Mix. (Mark, Wednesday–Saturday)
Is your mathematical hike getting a little too strenuous? Would you like to relax a bit with a class that offers an unrelated topic every day, so you can pick and choose which days to attend, and that does not expect you to do homework? If so, some Trail Mix may be just what you need to regain energy. Individual descriptions of the four topics follow.

Day 1 (🌶, Wednesday): **Perfect Numbers**

Do you love 6 and 28? The ancient Greeks did, because each of these numbers is the sum of its own divisors, not counting itself. Such integers are called *perfect*, and while a lot is known about them, other things are not: Are there infinitely many? Are there any odd ones? Come hear about what is known, and what perfect numbers have to do with the ongoing search for primes of a particular form, called Mersenne primes — a search that has largely been carried out, with considerable success, by a far-flung cooperative of individual "volunteer" computers.

Prerequisites: None

Day 2 (🌶🌶→ 🌶🌶🌶, Thursday): **Intersection Madness**

When you intersect two ellipses, you can get four points, right? So why can't you get four points when you intersect two circles? Well, actually you can, and what's more, two of the four points are always in the same places! If this seems paradoxical (and, I hope, interesting), wait until we start intersecting two cubic curves (given by polynomial equations of degree 3). There's a "paradox" there too, first pointed out by the Swiss mathematician Cramer in a letter to Euler, and the resolution of that paradox leads to a "magic" property of the nine intersection points. If time permits, we'll see how that property (known as the Cayley-Bacharach theorem) gives elegant proofs of Pascal's hexagon theorem and of the existence of a group law on a cubic curve.

Prerequisites: None, although a little bit of linear algebra might show up.

Day 3 (🌶🌶→ 🌶🌶🌶, Friday): **Integration by Parts and the Wallis Product**

Integration by parts is one of only two truly general techniques known for finding antiderivatives (the other is integration by substitution). In this class you'll see (or review) this method, and two of its applications: How to extend the factorial function, so that there is actually something like (1/2)! (although the commonly used notation and terminology is a bit different), and how to derive the famous product formula

$$\frac{\pi}{2} = \frac{2}{1} \cdot \frac{2}{3} \cdot \frac{4}{3} \cdot \frac{4}{5} \cdot \frac{6}{5} \cdot \frac{6}{7} \cdots \quad ,$$

which was first stated by John Wallis in 1655.

Prerequisites: Basic single-variable calculus

Day 4 (🌶→ 🌶🌶, Saturday): **The Nine-Point Circle**

There is some beautiful geometry hidden in and around every triangle. In particular, there are several points that can qualify as "centers" of the triangle, but that are different unless the triangle is equilateral. One of those points is the center of a circle that goes through nine related points, so it's not surprising that it's called the nine-point circle. If you haven't seen this (and the Euler line) but you like plane Euclidean geometry, you're in for a treat.

Prerequisites: None

Chilis: See individual descriptions above.

Homework: None

Prerequisites: See individual descriptions above.

Visualizing Groups. (Sara, Wednesday–Thursday)

If you know the basics of group theory, but want to gain a better intuitive understanding of groups, this is the class for you. We will focus on *pretty pictures*, more commonly referred to as *Cayley graphs*. On Day 1, we will define Cayley graphs, learn how to visualize subgroups and cosets, and learn a simple way to recognize normal subgroups using a Cayley graph. On Day 2, we will look at direct and semidirect products. Semidirect products are very cool. They allow you do things such as construct nonabelian groups out of abelian groups. Without semidirect products, you might find yourself saying: "Bippidy bazinga! I have a rotation group of a square (order 4) and a reflection group of a square (order 2), and I want to put them together to make the symmetry group of a square D_8, but the direct product isn't powerful enough to product a group as janky as D_8. Wow, this really makes me sad." If you want to learn more about groups and not be sad, consider taking this class.

Chilis: 🌶🌶 → 🌶🌶🌶

Homework: Recommended

Prerequisites: From group theory: definition of a group, the dihedral group, permutation groups, normal subgroups. From graph theory: definition of a graph, graph isomorphism.
Related to (but not required for): Group Theory (W1); Trees! (W3)

11:15 Classes

Commutative Algebra and Algebraic Geometry (2/2). (Mark, Tuesday–Saturday)
A continuation of the week 1 class. If you're thinking of joining, ask me to get an idea of what you might need to catch up on (and/or find someone who took good notes during the first week).
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Homework: Optional
Prerequisites: Week 1 of this class, or the equivalent.
Related to (but not required for): Algebraic Number Theory (W1); Symmetries and Polynomials (W1); Intro Ring Theory (W2); Modular Forms (W2); The Outer Automorphism of S_6 (W2); Representation Theory (1/2) (W3); Cohomology via Sheaves (W4)

Knot Theory. (Jeff, Tuesday–Saturday)
In the 1860s, Lord Kelvin developed the following theory of matter: atoms, the indivisible particles that composed the universe, were actually tiny whirlwind vortices in the ether. He beleived that shape of these vortices were tiny knots, and you could make compounds out of these knots by linking them together. Inspired by the quest to classify atoms, a mathematician named Tait made a list of all knots up to 10 crossings (no small feat, considering that there are around 250 of them.)
Kelvin's theory turned out to be bunk (as both the idea of ether and tiny vortices were too crazy), but mathematicians kept on thinking about knots. It took mathematicians nearly a hundred years to realize that Tait's list was wrong, and we still have a lot to learn about knots. We now study knots not because they represent atoms, but because they are some of the simplest objects a topologist can study: maps from the circle to 3-dimensional space. And despite these objects being so fundamental, a classification of knots eludes mathematicians to this very day.
In this class, we'll take the first step to classifying knots, by describing invariants of knots and giving a procedure to (non-uniquely) describe every knot.
Chilis: 🌶🌶
Homework: Optional
Prerequisites: None
Related to (but not required for): Topological Zoology (W3); The Fundamental Group (W4)

Machine Learning (No Neural Nets). (Linus, Tuesday–Saturday)
Machine learning is about getting examples of a function and guessing what that function is.

For example, let's say you want to classify emails as spam or not spam. You have a large supply of example emails which are already classified. You guess that the correct truth is some majority function of words — such as "If the email mentions at least three of medicine, cheap, rich, campaign, virus, then it's spam." If your guess is correct, then how can you figure out which words to use? What if instead of a perfect truth, there's a 1% chance of error? Can you figure out words that give a 99% success rate?

Okay, here's a more complicated question: let's say we have a large collection of Mathcamper board game ratings. Not everyone has rated every game. If I haven't played Spirit Island yet, then what's the best way to guess how much I would enjoy it? How confident should I be of my guess?
Chilis: 🌶🌶🌶
Homework: Recommended

Prerequisites: Basic linear algebra; be willing to think about vectors in high-dimensional space. Programming skill *not* needed.

Simple Models of Computation. (Pesto, Tuesday–Saturday)
Almost all programming languages are equally powerful—anything one of them can do, they all can.

We'll talk about less powerful models of computation—ones that can't even, say, tell whether two numbers are equal. They'll nevertheless save the day if you have to search through 200MB of emails looking for something formatted like an address.[1]

This is a math class, not a programming one—we'll talk about clever proofs for what those models of computation can and can't do.

Chilis: 🌶🌶

Homework: Recommended

Prerequisites: None

The Continuum Hypothesis (2/2). (Susan, Tuesday–Saturday)
The exciting continuation!!!

Chilis: 🌶🌶🌶🌶

Homework: Required

Prerequisites: Some knowledge of the ordinal numbers, particularly ω_1. Stupid Games on Uncountable Sets could function as a prereq.

1:10 Classes

Cohomology via Sheaves. (Apurva, Tuesday–Saturday)

Why could all the king's horses and all the king's men,
Not put Humpty Dumpty back together again?

Because Humpty Dumpty lacked sheaf datum. A sheaf is a mathematical tool that allows us to glue local mathematical data together. In this class, we'll learn how to use the *locally constant sheaf* to compute topological invariants (cohomology) of spaces, which in turn enable us to use algebraic techniques to study topology.

This will be an IBL class. This is NOT a class on sheaves, this is a class on cohomology of spaces.

Chilis: 🌶🌶🌶 → 🌶🌶🌶🌶

Homework: Required

Prerequisites: You should be able (and willing) to compute the rank and nullity of linear transformations. You should be familiar with the notions of "connected components" and "continuous functions".

Related to (but not required for): Modular Forms (W2); The Fundamental Group (W4); Commutative Algebra and Algebraic Geometry (2/2) (W4)

Combinatorial Designs. (Ania, Thursday–Saturday)
You probably know Set and Dobble games. Hopefully you think they are cool and "mathy". Maybe you are even curious about that math behind them? If so, this class is for you! It turns out that even though at the first glance Set and Dobble seem to be completely different they do have a common

[1] `http://www.xkcd.com/208`

denominator. Both of them are examples of a combinatorial design, which is a structure of finite sets that satisfies generalized concepts of balance and/or symmetry.

During the class we will explore the elementary theory describing those objects, prove basic relationships between their parameters (including Fisher's inequality and maybe theorem about symmetric designs) and also analyze some specific designs (Hadamard design, Steiner Triple System, Kirkman system). There will be many pretty pictures and fun problems (including solving a bit modified sudoku and drawing fancy graphs!) and we will also look for the other examples of designs in everyday life/math.

Chilis: 🌶🌶 → 🌶🌶🌶

Homework: Recommended

Prerequisites: Basics of finite combinatorics (inclusion-exclusion, binomial coefficients, etc.)

Infections, contractions, and tumors, Oh My! Agent Based Modeling of Biological Systems. (*Angela Gallegos & Kamila Larripa*, Tuesday–Saturday)
What do tumors, infections, and the uterus all have in common? Actually quite a bit more than you might think! All three have dynamics that can be described using mathematics, and patterns that can be explored when you look at interactions between different individualswhether those individuals be tumor cells, humans, or muscle cells. In this course we will use NetLogo to explore how we can computationally model these types of systems and you will get to explore your own research questions in our week together!

Note that classes may run over time so that you will have time to work in the computer lab on your homework and projects. You will work on modeling projects during the week and have the option of presenting your results in class on the last day.

Chilis: 🌶🌶 → 🌶🌶🌶

Homework: Recommended

Prerequisites: Specific courses are less important, than comfort with mathematical abstraction (word problems, for example) and computer programming is helpful.

Intersecting polynomials. (Tim!, Tuesday–Wednesday)
You might think that everything there is to know about one-variable real polynomials has been known for hundreds of years. Except, in 2009, while bored at a faculty meeting, Kontsevich scribbled down a brand new fact about polynomials. You'll discover it.

Chilis: 🌶🌶

Homework: Optional

Prerequisites: None

Ramsey Theory. (Misha, Tuesday–Saturday)
To a first approximation, Ramsey theory is about proving theorems that say "If we color all the whatsits of a sufficiently large thingy with yea many colors, then we will be able to find a monochromatic doodad."

We'll follow a meandering path between some results of this kind and results of a few other kinds. Topics of interest include upper and lower bounds, clever constructions that everyone should see at least once, and connections to number theory and geometry.

Chilis: 🌶🌶

Homework: Recommended

Prerequisites: None

Rational Points on Elliptic Curves. (Shiyue, Tuesday–Saturday)
Diophantine equations are equations in n variables with integer coefficients where you are looking for integer solutions. For instance, Fermat's Last Theorem says that the Diophantine equation $x^n + y^n = z^n$ for $n > 2$ has no nontrivial solutions.

The higher the degree of the equation, the harder it is to analyze. For equation of degree 2, we will show how to find all solutions using geometry of conic sections (ellipses, hyperbolae, and parabolae). Most of the class will focus on equations of degree 3, which correspond to a family of curves called elliptic curves. The structure of the solutions in this case is given by Mordell's Theorem, which describes the group structure of rational points on an elliptic curve. We won't prove the theorem in its most general form, but only focus on points of finite order. But even these special cases will help you get an idea of the tools needed for the full proof. More broadly, this course serves as an introduction to the field of arithmetic geometry, in which insights from algebraic geometry are applied to questions in number theory.

Chilis:

Homework: Recommended

Prerequisites: Group Theory (cyclic groups, direct products, quotient groups; the Week 1 introductory class will be sufficient).

Related to (but not required for): Group Theory (W1); Intro Number Theory (1/2) (W1); Intersecting Curves (W2); Intro Number Theory (2/2) (W2); Commutative Algebra and Algebraic Geometry(1/2) (W3)

Colloquium

Is Mathematics Biologys Next Microscope? (*Angela Gallegos & Kamila Larripa*, Tuesday)
Mathematical biology is poised for explosive growth as biology becomes more quantitative. The need for mathematical and computational approaches to organize this information is acute. The best models not only shed light on how a process works, but might predict what may follow or propose new experiments to try. The mathematics can be relatively simple; it is the novel application that allows us to peek into a biological system and suggest directions for future experiments. We will discuss some of our favorite examples of mathematical modeling applications in our work including cancer treatment and population biology.

Quantum Hack. (J-Lo, Wednesday)
If someone were to develop a viable, decently-sized quantum computer, internet security as we know it today would cease to exist. Come to learn what mathematical computations a quantum computer can do that a classical computer can't — and why there may still be hope for our non-quantum internet to become quantum-secure.

Quantum Liquids. (*Scott Strong*, Thursday)
Mathematical physics is a branch of applied mathematics dealing with physical problems. Mathematical physicist Robbert Dijkgraaf, who was interviewed by Numberphile in 2017 [1], discusses how the first quantum revolution has left mathematicians catching up with both its concepts and language. In fact, he asserts the need for "quantum mathematicians." Perhaps he says this because we stand at the precipice of a paradigm shift that will bring about great change in the way we work with information acquisition, communication, and simulation. [2]
While mechanics and electromagnetism tend to be compulsory courses due to their alignment with single and multivariate calculus, quantum mechanics is often seen as a specialized class. For physicists it's perceived as heavily historical, while it is considered highly technical by mathematicians. Since

it is important that young mathematicians gain interest in the field, I will provide an experimental lecture that aims to start from knowledge of single-variable calculus and create models leading to a quantum mechanical prediction.

[1] `https://youtu.be/m6rfpQXzXu0`
[2] `https://youtu.be/kcTGzE_AtBc`

Building machines that learn and think like people. (*Josh Tenenbaum*, Friday)
Increasingly our lives are filled with artificial intelligence technology: machines that do things we used to think only humans could do. But we dont yet have any real AI. We dont have machines with anything like the flexible, general-purpose commonsense intelligence that lets humans do everything they do to get around in the world. Whats missing, and how could we build it?
Recent successes in artificial intelligence and machine learning have been largely driven by methods for sophisticated pattern recognition, including deep neural networks and other deep learning methods. But human intelligence is more than just pattern recognition. At the heart of human common sense is our ability to model the world: to explain and understand what we see, to imagine things we could see but havent yet, to solve problems and plan actions to make these things real, and to build new models as we learn more about the world. I will talk about our recent work attempting to reverse-engineer these capacities, drawing on several kinds of mathematical and computational tools: probabilistic (Bayesian) inference, probabilistic programming, program synthesis, and video game engines. I will show examples of how these tools let us build mathematical models of human intelligence, and also make AI systems that are smarter in more human-like ways.

Visitor Bios

Angela Gallegos. Angela wanted to work in biology and physiology, but didn't like blood or needles, and so ended up pursuing mathematical biology. Her research has been in mathematical modeling of biological topics including the uterus, bacteria, cancer dynamics, and crocodilia populations! She and her collaborator and friend, Kami, will be teaching about discrete computational ways to model these kinds of subjects while at Mathcamp this summer. In addition to math, Angela enjoys running (although is getting slower) and trying new things. She is currently living in Quito, Ecuador while on sabbatical, improving her spanish and learning more about cooking. She has two dogs now–one from her time living in Bogota, Colombia, and the second from Ecuador! She is incredibly excited for her first time at Mathcamp!

Kami Larripa. I love using mathematics to model biological systems. Some of my recent projects have included looking at how inflammation from a bacterial infection affects the cardiovascular system, and how immunotherapies for cancer can be improved. Angela and I will teach a class about math models in biology, and mentor student projects.

Fun fact: I met my co-instructor Angela at the Summer Program for Women in Mathematics at George Washington University when I was an undergraduate student. That program was pivotal to my career path, and I am so excited to have the opportunity to be part of a similar program!

I live in Humboldt, California, and love to bike, surf, and hike with my family.

Greg Burnham. Greg was a camper in '04-'06 and a JC in '07, '08, '10. He works at an artificial intelligence research lab called Elemental Cognition and lives in Brooklyn, NY.

Scott Strong. Scott Strong is a mathematical physicist who studies the geometric dynamics of vortex lines in quantum liquids. Of particular interest is understanding the mathematical models by which quantum turbulence relaxes to more highly correlated states through an interplay between the geometry of the vortices and vibrations of the medium. As a Teaching Professor in the Department of Applied Mathematics and Statistics at the Colorado School of Mines, his focus is on undergraduate education and frequently teaches multivariate calculus and differential equations.

Josh Tenenbaum. Josh is a professor of cognitive science and a member of the MIT Computer Science and Artificial Intelligence Lab (CSAIL). In his research, he builds mathematical models of human and machine learning, reasoning, and perception. His interests also include neural networks, information theory, and statistical inference.