CLASS DESCRIPTIONS—WEEK 1, MATHCAMP 2022

Contents

9:10 Classes

Computability theory (🌶🌶🌶🌶, Steve, TWΘFS)
There is a sense in which, for any reasonable interpretation of the term "solvable," there are some problems which are not solvable. However, this leaves two major follow-up questions open: are there any *natural* unsolvable problems, and can we meaningfully compare the difficulty of unsolvable problems (so that some problems are "more unsolvable" than others)?

In this class we'll study one particular perspective on the idea of solvability—**computability theory**. Roughly speaking, a set of natural numbers A is computable iff there is a computer program which successfully determines membership in A (regardless of "resource" issues, like runtime). We will start off by answering both questions above in the affirmative, giving natural examples of unsolvable problems and a robust notion of "computable relative to." We will spend the rest of the class attacking Post's problem, which roughly asks whether the natural examples of unsolvable problems we see are optimal. If we have remaining time, we will look at current problems in computability theory.

Homework: Required

Class format: Lecture

Prerequisites: Mathematical maturity, and ideally the uncountability of the reals

Introduction to graph theory (🌶, Narmada, TWΘFS)
A graph is an object with a bunch of things (called "vertices"), some of which have connections between them (called "edges"). You could argue that just about anything is a graph. As a corollary, you might deduce that graph theory is the most important subject in all of mathematics.

Exaggerated deductions aside, there are many problems that naturally lend themselves to being modeled by graphs. For example, can Euler traverse the islands of Königsberg without crossing any bridge twice? Can Hall successfully arrange marriages for his fussy friends? Can you color a map of the world so that neighboring countries have different colors? In this class, we'll learn how to formulate these (and other problems) in the language of graph theory to provide elegant solutions.

Homework: Required

Class format: Mostly split into small groups to work on problems

Prerequisites: None

Required for: Extremal graph theory (W2); The Ra(n)do(m) Graph (W2); Szemerédi's {theorem, regularity lemma} (W3); Problem solving: graph theory (W3); Baire necessities for Banach–Tarski (W4)

Introduction to number theory (🌶🌶🌶, Mark, TWΘFS)
How do you find $\gcd(a, b)$ for two large integers a and b without having to factor them? Which integers are the sum of two (or the sum of three, or the sum of four) perfect squares? What postages can you get (and not get) if you have only 8 cent and 17 cent stamps available? Besides the famous $3, 4, 5$ triangle (and scaled versions of it), what right triangles are there for which all the side lengths are integers? How does the RSA algorithm (used for such things as sending confidential information, such as your credit card number, over the internet) work? (If you know the answers to all these questions, please don't take this class; you'll be bored, and you might make others feel bad.)

Besides the answers to such questions, number theory offers insight into many beautiful and subtle properties of our old friends, the integers. For thousands of years professional and amateur mathematicians have been fascinated by the subject (by the way, some of the amateurs, such as the 17th century lawyer Fermat and the theoretical physicist Dyson who passed away in 2020, are not to be underestimated!) and chances are that you, too, will enjoy it quite a bit. Although we'll start from scratch, in order to touch on as many as we can of the topics mentioned above (and maybe a few others) the class will go at a good pace—thus the three chilis.

Homework: Recommended

Class format: Lecture

Prerequisites: None beyond modular arithmetic (which I can catch you up on if needed)

Required for: 2-adic computer science (W3); The distribution of prime numbers (W4); The abc's of polynomialand (W4)

Machine geometry (🌶🌶🌶, Misha, TWΘFS)
This class is inspired by, but not strictly about, computer algorithms for solving geometry problems. We avoid ugly coordinates, but also remain skeptical of proofs that rely on cleverly spotting the right similar triangle or cyclic quadrilateral.

We will begin with the area method, and use it to prove theorems in affine geometry: geometry where we can't measure distances or angles. We like distances and angles, though. To be able to handle those, we will define a notion of coarea, which relates to area as cosine relates to sine.

This is not a class on olympiad geometry, but we will often apply our method to examples from various math competitions.

Homework: Recommended

Class format: Lecture, which we will occasionally interrupt to solve problems together

Prerequisites: None

The answer is χ (🌶🌶, Assaf, TWΘFS)
In this class, we will prove:

$$\sum \text{ind} = \chi(S).$$

Though it's up to you to figure out what each of these symbols mean. Without spoiling too much, we will talk about triangulations of surfaces, height-functions, and why you can't comb a hairy sphere, but you can comb a hairy torus. Join this class if you are interested in strange links between surfaces and "additional structures" that surfaces may carry, and prepare to answer everything with: "The answer is χ!"

Homework: Optional

Class format: Moore method—I will only guide your exploration

Prerequisites: None

10:10 Classes

Cluster algebras from surfaces (🌶🌶🌶🌶, Kayla, TWΘFS)
Snake graphs, Farey trees, frieze patterns, cluster algebras, oh my! In this class, we will define the idea of a cluster structure. As an example, how many ways can you triangulate an n-gon into triangles? Come learn how the answer to this question leads to a rich algebraic and combinatorial structure called a cluster structure! A cluster structure takes a piece of initial data—e.g. a triangulated polygon, a directed graph, or a topological surface—a set of variables, and a mutation rule that prescribes a way to transform this data to create something new. The set of all things you can generate via this mutation rule itself has even more structure! Enter cluster algebras. This abstract phenomenon of initial seeds and mutation leads to a beautiful intersection of algebra, combinatorics, topology and geometry.

Homework: Optional

Class format: Lecture

Prerequisites: Some exposure to algebra would be helpful (more specifically, understanding defining a generation of an algebraic structure by some set e.g. seeing a basis from linear algebra would be good, group by a presentation, etc.)

Complexity theory (🌶🌶🌶, Linus, TWΘFS)
P is—roughly—the class of problems that an algorithm can efficiently solve. For example, deciding whether a graph is planar. On the other hand, NP is—roughly—the class of problems where one can efficiently *check* a purported answer. For example, Sudoku or integer factorization. I'll leave it as an exercise whether $\mathsf{P} = \mathsf{NP}$.

In this class, we'll more formally introduce P and NP, alongside a host of other complexity classes such as coNP, BPP, and P/poly. We'll prove that some of them are equal, some of them aren't, and answer vital questions such as "Is deciding which Mathcamp classes to take NP-complete?"

Homework: Recommended

Class format: Lecture

Prerequisites: None

Generating functions, Catalan numbers, and partitions (🌶🌶, Mark, TWΘFS)
Generating functions provide a powerful technique, used by Euler and many later mathematicians, to analyze sequences of numbers; often, they also provide the pleasure of working with infinite series without having to worry about convergence.

The sequence of Catalan numbers, which starts off $1, 2, 5, 14, 42, \ldots,$ comes up in the solution of many counting problems, involving, among other things, voting, lattice paths, and polygon dissection. We'll use a generating function to come up with an explicit formula for the Catalan numbers.

A *partition* of a positive integer n is a way to write n as a sum of one or more positive integers, say in nonincreasing order; for example, the seven partitions of 5 are

$$5,\ 4+1,\ 3+2,\ 3+1+1,\ 2+2+1,\ 2+1+1+1, \text{ and } 1+1+1+1+1.$$

The number of such partitions is given by the partition function $p(n)$; for example, $p(5) = 7$. Although an "explicit" formula for $p(n)$ is known and we may even look at it (in horror?), it's quite complicated. In our class, time permitting, we'll combine generating functions and a famous combinatorial argument due to Franklin to find a beautiful recurrence relation for the (rapidly growing) partition function. This formula was used by MacMahon to make a table of values for $p(n)$ through $p(200) = 3972999029388$, back when "computer" still meant "human being who does computations".

Homework: Recommended

Class format: Lecture

Prerequisites: Summation notation; geometric series. Some experience with more general power series may help, but is not really needed. A bit of calculus may come in handy, but you should be able to get by without.

Introduction to group theory (🌶🌶, Susan, TWΘFS)
Let's list some operations on sets! Let's see... there's addition on the integers, multiplication on the rationals, and taking the average of two real numbers. Those are three good ones. Now let's think of some more exotic operations. How about multiplying square matrices over the complex numbers, or composing continuous functions from the reals to the reals?

Broadly, abstract algebra is the study of operations of sets. A binary operation that satisfies a collection of particularly nice properties (associativity, identity, and inverses) is called a *group operation*, and the set that it acts on is called a *group*. Groups pop up all over mathematics. They can be used to explore symmetries of geometric objects, prove the existence of an unsolvable quintic polynomial, and solve tricky counting problems in combinatorics. But they are also a beautiful class of mathematical objects in their own right.

In this class, we'll be getting to know our good friend the group. Starting with a few simple axioms, we'll build a fundamental toolkit of theorems that give us an instinct for how these objects behave. We'll learn what it means for two groups to be secretly "the same." We'll learn about subgroups and what Lagrange's theorem has to say about their sizes. We'll go over the construction for building quotient groups, and if we have time we'll talk about the group isomorphism theorems.

Homework: Recommended

Class format: This will be a lecture-based class with substantial problem sets to work on between classes. Though homework is recommended rather than required, campers will get much more out of the class if they engage substantially with the problem sets. Come join my problem solving parties during TAU!

Prerequisites: None

Required for: Ring theory (W2); Bonus group theory part 2 (W2); Grammatical group generation (W2); Representation theory (week 1) (W3); The 17 wallpaper patterns (W3); Commutative algebra and algebraic geometry (W3); In-fun-ite groups (W3); Algebraic solutions to Painlevé VI (W4); Algebraic topology: homology (W4); Representation theory (week 2) (W4); Baire necessities for Banach–Tarski (W4); Introduction to Galois theory (W4)

The geometry of music (🌶, Emily, TWΘFS)
We all know what music sounds like, but what does it look like? In this class, we will study just that! We will learn how to visualize scales, chords, and rhythms as manipulations of polygons, and further use geometric ideas to construct our own rhythmic patterns. In addition, we will build a lattice-like structure of chords called the Tonnetz from which we can visually study many things, such as chord progressions and consonance versus dissonance.

Homework: Recommended

Class format: Lecture

Prerequisites: No mathematical prereqs. Musical prereq: be able to read sheet music

11:10 Classes

Degree theory (🌶🌶🌶, Zoe, TWΘFS)
Zero is not an odd number. This fact has a surprising number of powerful consequences when degree theory is involved. When considering the functions $f(x) = x^n$ for $x \in \mathbb{C}$ we have an easy way to

talk about degree and we have some intuition as to the properties this function might have. However, what about when we have a less clearly defined function? Or what about if we are considering some arbitrary space? We can still come up with a notion of the degree of a map which has various useful associated properties. The best part is that this notion of degree gives us a lot of the most crucial information without having to consider how bad a space or function might behave in specific areas. For example, degree theory allows us to say that the Petersen graph is 3-colorable (and not 2-colorable) by the fact that zero is not an odd number!

Homework: Recommended

Class format: Lecture

Prerequisites: None

Introduction to linear algebra (🌶🌶, Misha, TWΘFS)
Linear algebra is something that shows up in basically every field of math! Ostensibly it's about solving systems of linear equations. By the end of the course you'll be a master of understanding how to solve things like

$$13x + 3y = 20$$
$$19x + 16y = 22.$$

But the real beauty of linear algebra is that the techniques we'll learn reach so far beyond just solving systems of equations. Expect some homework problems where you learn to use linear algebra to solve some very neat problems that look decidedly non-linear to start with! This course will set you up to use linear algebra in a variety of situations throughout the rest of camp.

Homework: Recommended

Class format: Lecture

Prerequisites: None

Required for: Quantum computation (W2); Teichmüller theory of the torus (W2); Schubert calculus (W3); Representation theory (week 1) (W3); The 17 wallpaper patterns (W3); Machine learning (NOT neural networks) (W3); Algebraic solutions to Painlevé VI (W4); Problem solving: cheating in geometry (W4); High-dimensional potatoes (W4); Algebraic topology: homology (W4); Finite fields (W4); Representation theory (week 2) (W4)

Introduction to real analysis: epsilons and deltas (🌶🌶, Charlotte, TWΘFS)
You've probably heard of sequences, limits, and derivatives from calculus before. In this class you'll get a new introduction to all of these concepts from a much more rigorous (and in my opinion, satisfying and fun!) perspective. We'll learn various types of "epsilon-delta" definitions and get lots of practice with "epsilon-delta" proofs, which are ubiquitous in math.

Approaching these topics rigorously will help us discover some counterintuitive examples, like a function that is continuous at every irrational point, but discontinuous at every rational. Conversely, it'll also help explain some strange phenomena: for example, some infinite series can be rearranged to seemingly sum to different values.

Homework: Required

Class format: A split of lecture and group work, likely 60:40

Prerequisites: Some basic calculus—in particular, have an intuitive idea of what limits are, and know about derivatives & integrals.

Required for: Cantor before set theory (W4)

Overly convoluted plans (🌶🌶🌶, Ben, TWΘFS)
Some integrals are practical[1] to solve in the sense that you can use some combination of u-substitution, memorized integrals, and sensible clever tricks to work out an exact answer. However, some integrals, while easy to write down, are not quite as practical to solve, such as

$$\int_0^\infty \frac{\sin(x)}{x}dx,\ \int_0^\infty \frac{\sin(x)}{x}\frac{\sin(x/3)}{x/3}dx,\ \dots,\ \int_0^\infty \frac{\sin(x)}{x}\frac{\sin(x/3)}{x/3}\cdots\frac{\sin(x/15)}{x/15}dx.$$

(OK, the last one there isn't quite so easy to write down either, since we're taking a product of eight terms of the form $\frac{\sin(blah)}{blah}$, for $blah = x, x/3, x/5, \dots, x/13, x/15$.)

In this class, we'll learn one way to solve these exactly (…except for the last one, which is a lot harder). If you'd like to skip the hard work of taking this class, they're all $\frac{\pi}{2}$, except the last one, which is *very slightly less* than $\frac{\pi}{2}$.

Why does this pattern of $\frac{\pi}{2}$s break down? What does French mathematician Joseph Fourier have to do with this? And how does it all relate to the convolution product—whatever that is? We'll discuss all this, and more!

Homework: Recommended

Class format: Lecture

Prerequisites: Calculus (e.g. you should know how to take derivatives, integrals, and improper integrals). Having seen ϵ-δ proofs in the past will help but should not be strictly necessary.

The mathematics of forbidden words (🌶🌶, Travis, TWΘFS)
Don't stumble under the yoke of society and tradition—take control of forbidden words with mathematics! Dynamical systems are a cool and super-applicable field of mathematics, but studying it usually requires calculus and differential equations and all sorts of advanced tools—unless it doesn't! In this class, we'll look at discrete dynamical systems, no calculus required, and answer questions about discrete dynamical systems including, but not limited to: What are they? How do they work? And how do *forbidden words* help us understand them?

Homework: Recommended

Class format: Lecture

Prerequisites: None

1:10 Classes

Crash course (🌶, Assaf, TWΘFS)
Math is useless unless it is properly communicated. Most of math communication happens through a toolbox of terminology and proof techniques that provide us with a backbone to understand and talk about mathematics. These proof techniques are often taken for granted in textbooks, math classes (even at Mathcamp!) and lectures. This class is designed to introduce fundamental proof techniques and writing skills in order to make the rest of the wonderful world of mathematics more accessible. This class will cover direct proofs from axioms, proofs using negation, proofs with complicated logical structure, induction proofs, and proofs using cardinality and the pigeonhole principle. If you are unfamiliar with these proof techniques, then this class is highly recommended for you. If you have heard of these techniques, but would like to practice using them, this class is also right for you. Here are some problems that can assess your knowledge of proof writing:

- Negate the following sentence without using any negative words ("no", "not", etc.): "If a book in my library has a page with fewer than 30 words, then every word on that page starts with a vowel."

[1]Note that I do not say "easy," because some of these integrals are pretty hard.

- Given two sets of real numbers A and B, we say that A dominates B when for every $a \in A$ there exists $b \in B$ such that $a < b$. Find two disjoint, nonempty sets A and B such that A dominates B and B dominates A.
- Prove that there are infinitely many prime numbers.
- Let $f : A \to B$ and $g : B \to C$ be maps of sets. Prove that if $g \circ f$ is injective then f is injective.
- Define rigorously what it means for a function to be increasing.
- What is wrong with the following argument (aside from the fact that the claim is false)? On a certain island, there are $n \geq 2$ cities, some of which are connected by roads. If each city is connected by a road to at least one other city, then you can travel from any city to any other city along the roads.

  Proof. We proceed by induction on n. The claim is clearly true for $n = 1$. Now suppose the claim is true for an island with $n = k$ cities. To prove that it's also true for $n = k + 1$, we add another city to this island. This new city is connected by a road to at least one of the old cities, from which you can get to any other old city by the inductive hypothesis. Thus you can travel from the new city to any other city, as well as between any two of the old cities. This proves that the claim holds for $n = k + 1$, so by induction it holds for all n. □

- Mathcampers can message each other privately on Slack over the course of camp. Prove that there are two campers who messaged the same number of people throughout camp.

If you would not be comfortable writing down proofs or presenting your solutions to these problems, then you can probably benefit from this crash course. If you found this list of questions intimidating or didn't know how to begin thinking about some of them, then you should definitely take this class. It will make the rest of your Mathcamp experience much more enjoyable and productive. And the class itself will be fun too!

Homework: Required

Class format: Lecture

Prerequisites: None

Formal proof verification in Lean (🌶🌶🌶, Aaron, TWΘFS)
The proof of the 4-color theorem in graph theory is really long. So long that no human could write out all the cases, or even check all of them. So how did this proof ever get written or checked?

Rather than getting written up in paragraphs, a large part of that proof is written in computer code, so that a computer can not only generate a symbolic proof of each case, but actually check all the logic. (You can see a modern version here.[2])

These days, there are several proof languages that computers understand, but in this class, we'll learn a bit of a language called Lean, where math looks rather like this:

```
theorem fermats_last_theorem (n : N) (n_gt_2 : n > 2) :
  not(exists x y z : N, (x^n + y^n = z^n) and (x > 0) and (y > 0) and (z > 0)) :=
begin
  sorry,
end
```

In the past few years, hundreds of people (including a few Mathcampers!) have translated a bunch of math[3] into Lean. Let's join them, and learn how to write computer-verifiable proofs.

Homework: Required

[2] https://github.com/coq-community/fourcolor
[3] https://leanprover-community.github.io/mathlib-overview.html

Class format: Computer-based IBL. We'll be spending most of the time at keyboards, actively coding up proofs to exercises.

Prerequisites: You should be comfortable with basic logic terms and proof techniques (and, or, not, for all, there exists, contradiction, induction).

We will be programming, but you do not need experience programming. This programming can be done in a browser, but you may want to install Lean ahead of time[4]

Jacobi sums (🌶🌶🌶🌶, *Dave Savitt*, TWΘFS)

Let's count the number of solutions (x, y) to the equation $x^3 + y^3 \equiv 1 \pmod p$, where p is a prime congruent to 1 modulo 3. For $p = 7$ there are 6 solutions. For $p = 13$ there are 6 solutions again. But for $p = 19$, there are 24. Here's a table for a few small values of p.

p	$\#\{(x,y) : x^3 + y^3 \equiv 1 \pmod p\}$
7	6
13	6
19	24
31	33
37	24
⋮	⋮
379	348

It looks like there are around p solutions, but why fewer than that for some primes p, and more for others? Here is another table of numbers. In the second column I've written $4p$ in the form $A^2 + 27B^2$ and chosen the sign of A so that $A \equiv 1 \pmod 3$.

p	$4p$	$=$	A^2	$+27 \cdot B^2$	$p - 2 + A$
7	28	$=$	1^2	$+27 \cdot 1^2$	6
13	52	$=$	$(-5)^2$	$+27 \cdot 1^2$	6
19	76	$=$	7^2	$+27 \cdot 1^2$	24
31	124	$=$	4^2	$+27 \cdot 2^2$	33
37	148	$=$	$(-11)^2$	$+27 \cdot 1^2$	24
⋮		⋮		⋮	⋮
379	1516	$=$	$(-29)^2$	$+27 \cdot 5^2$	348

Coincidence? I think not. We will prove this observation in general, and explain what it has to do with some very special sums of roots of unity, called *Jacobi sums*.

Homework: Recommended

Class format: Lecture

Prerequisites: Comfort with modular arithmetic, including Fermat's Little Theorem and the existence of primitive roots modulo p. Comfort with complex numbers. Familiarity with basic group theory is not necessary, but some arguments will be more intuitive if you have this background.

[4] `https://leanprover-community.github.io/get_started.html#regular-install`

Learn topology with PALs! (🌶🌶, Arya, TWΘFS)
Roughly speaking, topology is the study of the "shape" of an object, except when all objects are made of play-doh! So you're allowed to mold objects into different shapes, but you're not allowed to cut the object, or glue two objects together. For example, topologically a triangle is the same as a square. But is it the same as a cube? A square with a hole punched out? A donut? In this class, we shall work through classifying one and two dimensional objects topologically. And the "objects" we work with are built using our good old PALs - polyhedra!

Homework: Required

Class format: Lecture

Prerequisites: None

Martingales (🌶🌶, Yuval, TWΘFS)
Suppose we play the following game: at every turn, I pick some number m, and then we flip a fair coin. If it comes up tails, then I give you m M&M's, but if it comes up heads, you give me m M&M's. This game is completely fair, since at every turn, we both have equal odds of winning or losing m M&M's.

However, I might implement the following strategy: on the first turn, I pick $m = 2$. If I win, then I end the game. If not, then on the second turn I pick $m = 4$, and if I win, I end the game. If not, I pick $m = 8$, and so on; on the nth turn, I set $m = 2^n$, and only stop when I finally win. I'm bound to win eventually (since there's no chance we'll keep getting tails forever), and if I win on the nth turn, then I will get 2^n M&M's on that turn. Also, if we add up how many M&M's I gave to you over all the turns I lost, we get

$$2 + 4 + 8 + \cdots + 2^{n-1} = 2^n - 2.$$

In other words, I won 2^n M&M's and only lost $2^n - 2$, meaning that I swindled you out of 2 M&M's! So how can this be a fair game?

The answer to this question can be found with martingales, which are arguably the most powerful tool in all of probability. In this class, we'll use them to solve many problems (including the one above), and see many examples where they can convert a seemingly intractable problem into a two-line computation.

Homework: Recommended

Class format: Lecture

Prerequisites: None

Colloquia

Applied game theory (*Po-Shen Loh*, Tuesday)
At first glance, it looks expensive to solve real-world problems. The scale is just enormous. There are many units of good that need to be produced, and each unit of good has net cost x to produce. There's a trick: find a way to do this where $x < 0$. However, that isn't good enough if the net cost $x = a + b$, where $a > 0$ and $b < 0$ but a is paid by Person A, and $|b|$ is earned by Person B. (Then, Person A won't want to participate.) Real world applications of game theory focus on ways to design infrastructure that produce a negative net cost for every individual participant: a win-win situation.

The speaker has invented solutions to some large scale real world problems over the past 2 years, in healthcare (`https://novid.org`) and in education (`https://live.poshenloh.com`). This talk will share stories of creating and scaling up these ideas, catered to a Mathcamp audience. It will be informal, approachable, and fun.

Three-term arithmetic progressions (Yuval, Wednesday)
$9, 11, 13$; $100, 200, 300$; $37, 52, 67$; $a, a + d, a + 2d \ldots$ There can't be any interesting math about three-term arithmetic progressions, right?

Wrong! As it turns out, three-term arithmetic progressions are at the center of one of the most important and interesting mathematical stories of the 20th and 21st centuries, beginning with a question of Erdős and Turán in 1936, through remarkable results of Behrend in 1946 and Roth in 1953, and culminating (for now!) in a major breakthrough by Bloom and Sisask in 2020. All these results concern the following innocuous question: how many elements can there be in a subset of $\{1, 2, \ldots, N\}$ without a three-term arithmetic progression?

In this talk, we'll see various different ways to think and prove theorems about this problem, including perspectives coming from combinatorics, number theory, probability, and high-dimensional geometry.

Counting things with bad maps (Zoe, Thursday)
Certain mathematical insights come about when mathematicians practiced in one discipline decide to take a look at mathematics from other distinct disciplines. My entirely biased favorite example of this is using the existence (or non-existence) of a combinatorial object to construct a mapping that can't exist! Aside from being my favorite, a good property of this example is that there are many questions that can be answered in this way. A few examples are fair division of rent, splitting necklaces, graph colorings, and there are many more. Come to this colloquium to hear about how to solve these questions or about the unexpected connections between combinatorics and topology.

1,2,5,14...FRIEZE 🥶 (Kayla, Friday)
It's a hot summer here in Waterville, Maine. Come hide from the heat with this colloquium on 🥶 frieze patterns 🥶! In the 70's, Conway and Coxeter showed a bijection between frieze patterns of positive integers and triangulations of polygons. After this bijection was shown, interest in frieze patterns stayed dormant for many years. But due to the birth of 🤩 cluster algebras 🤩 in the early 2000's, people have now become very interested in friezes again. Come learn about finite frieze patterns of positive integers and their generalizations! Time permitting, I can give an overview of open research problems on frieze patterns people are thinking about today (including some Mathcamp alumni).