Class descriptions—Week 3, Mathcamp 2006

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Attention! Continuing classes in the 9am and 1pm slots have switched places for this week. This is out of fairness to the 9 am teachers, since they lose one class day a week to Tuesday morning assembly.

Classes beginning in Week 3

"Convex cones" (∗∗∗, Ellen, 10am, week 1 of 1 (no class on Sa))

Suppose we have a set X of points in the Euclidean space $\mathbb{R}^n$ such that the distance between any two points in X is no more than 1. What is the smallest number m such that we can cut X into m different pieces so that the distance between any two points in each piece is strictly less than 1? Many mathematicians believed the answer to be $n+1$ until a pointed, scaly creature peeked around a corner and proved them wrong. In this class, we will explore many qualities of this fascinating creature, which happens to be the cone of positive semidefinite quadratic forms. We will observe this animal's many faces, and the varying guises under which it can appear. Along the way, this animal will reveal to us some aspects of the other beasts who live in its ecosystem.

Prerequisites: linear algebra.

Related to: "Linear programming" (Week 2), "Semidefinite programming" (Week 4), "Polytopes" (Week 4), "The fifteen theorem" (Week 2).

Homework: optional.

Fermat's dream II (∗∗∗∗, Miljan, 9am, week 1 of 2)

Let us consider the two circles $x^2 + y^2 = 1$ and $x^2 + y^2 = 3$ in the coordinate plane. How many rational points does each one of them have? (A rational point is a point both of whose coordinates are rational numbers). The first one has infinitely many, the second has none.

Can you tell that by looking at their equations or graphs in the coordinate plane? I suspect not. Human vision cannot distinguish such a thing. In these figures rational numbers are hidden completely by real numbers, and under these circumstances it is very difficult to tell something about rational numbers. Rational numbers must be seen under different lights, namely, under "the lights of prime numbers".

It turns out that, for any prime p, there exists "a world of p-adic numbers $\mathbb{Q}_p$" analogous to the world of real numbers. We can understand rational points on a quadratic curve if we consider it not only in the world of real numbers but also in the world of p-adic numbers for each prime number p.

Just as the stars shine in the night sky but we cannot see them during the day because of the sun, $\mathbb{Q}_p$ emits "the light of prime number p", but it is frequently obscured by "the light of real numbers" emitted by $\mathbb{R}$. Just as there are countless stars in the night sky, there is one $\mathbb{Q}_p$ for each p. What each star is to the sun is what each $\mathbb{Q}_p$ is to $\mathbb{R}$.

Come and join us in seeing the profound mathematical universe through the p-adic numbers!
Homework: optional.
Prerequisites: Fundamentals of groups, rings, and fields.
Related to: "The fifteen theorem" (Week 2), "Fermat's dream I" (not a prerequisite).

Finite fields ($***$, Dave S, 10am; week 1 of 1 (no class on We))
A *field* is a set in which you can do the four basic operations of arithmetic: you can add and subtract elements in the set, you can multiply elements in the set, and you can divide by elements in the set (except, of course that you must still obey rule 4!). There are some obvious examples of fields: the set of rational numbers; the set of real numbers; the set of complex numbers. Less obviously, the integers modulo p are a field, for any prime number p: this is an example of a *finite field*, because the set of integers modulo p is finite (it has size p).

In this class, we're going to find all finite fields. Here's one good reason for studying finite fields: if I give you an equation like $x^2 + y^2 = 1$, you can try to describe the solutions in all sorts of fields, like the real numbers (the solutions form a circle), the rational numbers (the solutions are related to Pythagorean triples), or the solutions in a finite field. Information about the solutions in finite fields can give information about solutions over other (very different!) fields, such as the rational numbers; this will be one of the themes of the course in Week 4 on the Birch and Swinnerton-Dyer conjecture (7MP).

We'll also be able to see why the recursive formula that Mira gave in her magic trick digestif in Week 1 has the amazing property that she claimed it does.
Related to: "Fermat's dream II" (Weeks 3–4), "7MP: The BSD Conjecture" (Week 4).

Matrix game theory ($*$, Ari, 9am, week 1 of 1)
In this course, we will examine simple 2-person games, both zero–sum and nonzero–sum. We'll find that the most interesting questions about strategy arise from nonzero sum games, where the other player is not necessarily an enemy. We'll investigate several example of such games, including the famous Prisoner's Dilemma. The class will end with a tournament, where every student will submit a strategy for a certain game, and we'll toss them all in a computer and see how well they do against each other!

Matrix game theory is a branch of game theory completely different from Alfonso's "Combinatorial Game Theory" class.
Prerequisites: none.
Homework: submit a strategy for the tournament at the end of the class.
Related to: Nash equilibrium, in case you have seen "*A beautiful mind*".

Pathway to analytic number theory ($***$, Miljan, 11am, week 1 of 1)
Don Zagier, one of the finest mathematicians of our time, commented in one of his lectures in 1975:
"There are two facts about the distribution of prime numbers of which I hope to convince you so overwhelmingly that they will be permanently engraved in your hearts. The first is that, despite their simple definition and role as the building blocks of the natural numbers, the prime numbers grow like weeds among the natural numbers, seeming to obey no other law than that of chance, and nobody can predict where the next one will sprout. The second fact is even more astonishing, for it states just the opposite: that the prime numbers exhibit stunning regularity, that there are laws governing their behavior, and that they obey these laws with almost military precision."

This class is going to be devoted to some elementary remarks about the distribution of primes and should serve as an invitation to deeper study of analytic number theory.
Homework: optional
Prerequisites: "Intro to number theory" (Week 1).
Related to: number theory, analysis, "Prime number theorem" (Week 4), "7MP: The Riemann hypothesis" (Week 4).

Representation theory of finite groups (∗∗∗∗, Mark, 1:10pm, week 1 of 1)

It turns out that you can learn a great deal about a group by studying homomorphisms from it to groups of linear transformations (if you prefer, groups of matrices). Such "representations" of groups have been used in areas ranging from the physics of elementary particles and quantum chemistry to the famous classification of all finite simple groups. As you might expect, those topics are far beyond the scope of this class, but you *will* get to see some unexpected, elegant, and important facts about finite groups, and proofs of most if not all of them.

Homework: optional, probably.

Prerequisites: Group theory and linear algebra. (If your linear algebra is rusty, you might consider going to day 1 of "Trail mix".)

Related to: "Symmetric functions" (Weeks 3–4).

Symmetric functions (∗∗, M@ and Sam, 1:10pm, week 1 of 2)

Symmetric functions are polynomials, such as $xyz^3 + xy^3z + x^3yz - 2xyz$, which remain the same under every permution of the variables. There is surprisingly rich structure here – notice for example that if you add or multiply such functions, you get another one. You can decompose any symmetric function in several distinct ways: into monomial symmetric, elementary symmetric, complete homogeneous symmetric, power sum symmetric, or Schur functions, for example. In some sense, this last decomposition is the right one, and you will find out in this class why we say, "*Schur* functions? More like *sure* functions."

Part of the class will involve the study of partitions and Young tableaux, and certain ways of manipulating them – including bumping and sliding, and the RSK algorithm. These help us understand the underlying algebraic structure of symmetric functions. On the last day or two of class we will touch upon some deep connections to representation theory and/or topology.

Related to: "Combinatorics" (Week 1), "Intro to group and group actions" (Weeks 1–2), "Representation theory of finite groups" (Week 3), "Archimedes school of rock" (Week 2) , "Moore method topology" (Weeks 1–4), linear algebra.

Homework: optional.

Prerequisites: none.

Topological graph theory (∗∗∗, Marisa, 1pm, week 1 of 2)

What is Topological Graph Theory, anyway? "Topology", among other things, includes the study of surfaces. "Graph Theory" you already know about, for instance because you took last week's intro. So, putting one and two together: "Topological Graph Theory" is the study of graphs drawn on interesting surfaces, like the sphere, the donut or the Klein bottle.

We'll spend Tuesday studying my favorite graphs on the sphere: the platonic solids. We'll prove Euler's formula for the sphere ($V - E + F = 2$) and then generalize to other surfaces. For the rest of the two weeks in TGT, we'll be asking lots of questions, stemming from one fundamental question: "Can this graph be drawn on this surface without edge crossings" If not, how many crossings are the minimum? What is the simplest (in some sense to be defined later) surface on which we can draw the graph without edge crossings? What is the most complicated (again, we'll make this precise) graph that we can draw on the surface?

Mostly, we'll spend two weeks drawing lots and lots of neat pictures.

Note that I have not listed Topology as a prerequisite; I will define all the material I need as it comes up. Some previous topology wouldn't hurt, though, and might help you see more deeply into the questions, so you might consider this course a 'combinatorial application' of Topology.

Prerequisites: "Intro to graph theory".

Homework: optional

Required for: "Topological graph theory" in Week 4.

Related to: "A random walk from the marriage theorem", "Topology", "A topological smorgasbord".

Trail mix (Mark, 10am)

This series consists of five independent lectures on different topics.

Would you like a snack on your mathematical journey? Try one or more of these classes, which are one-time offerings without homework (but if you are intrigued by things in them, we can definitely talk more during TAU or some other time).

- *Hard core linear algebra* (∗∗∗∗, Tu)

  We'll start with the basic definitions but very quickly develop the theory of bases, dimension, linear transformations, and if time permits, eigenvalues and eigenvectors. Unless you enjoy being seriously lost, this is not a good introduction to linear algebra, but it may be a good review if you want to take another class (such as "Representation theory of finite groups") in which linear algebra is used somewhat abstractly.

  Prerequisites: Some prior exposure to linear algebra; comfort with abstraction and with going fast.
- *Continued fractions* (∗∗, We)

  If you start writing down the numbers

  $$1,\ 1+\frac{1}{1},\ 1+\frac{1}{1+\frac{1}{1}},\ 1+\frac{1}{1+\frac{1}{1+\frac{1}{1}}},\ \ldots,$$

  what happens if you decide not to stop, that is, to continue? What numbers can be represented by "continued fractions" similar to this one, and by more general ones? What do such things have to do with Pell's equation $x^2 - Dy^2 = 1$? We'll try to answer some, and maybe all, of these questions.

  Prerequisites: none.
- *The nine–point circle* (∗, Th)

  This class will feature some more or less familiar special points that can be found in any triangle, quick proofs that those points exist, and some beautiful geometric relationships between them. In particular, we'll look at the nine–point circle (or Feuerbach circle); you can probably guess how many noteworthy points are on that circle.

  Prerequisites: none.
- Transformations of the plane (∗∗, Fr)

  If you have a figure in the plane, how can you move it around? What if you're allowed to take it out of the plane and put it back in? These questions will lead us to certain transformations of the plane; we'll get others by thinking of the plane as the set of complex numbers, and sending each complex number z to $\frac{az+b}{cz+d}$, with one choice of a, b, c, d per transformation. However, if you think about the rules of Mathcamp, you'll realize that there might be a problem ...

  Prerequisites: Basic knowledge of complex numbers. Knowing a little group theory would help, but is not required.
- A quick tour of Hensel's world (∗∗–∗∗∗, Sa)

  Suppose you start with the formula for the sum of an infinite geometric series:

  $$1 + x + x^2 + x^3 + x^4 + \ldots = \frac{1}{1-x}$$

  and you substitute in $x = 3$ to get

  $$1 + 3 + 9 + 27 + 81 + \ldots = -1/2.$$

  Can you imagine such a result ever making sense? By the end of this class you will, and you might also believe in a world where all triangles are isosceles!

  Prerequisites: Understanding of convergence of infinite series; modular arithmetic.

Tropical curves (∗∗∗∗, Sam, 11am, week 1 of 1)

This class will explore some of the deeper properties of the tropical algebraic curves that appeared in my tropical geometry colloquium – if you missed colloquium, that's okay, we'll start from the

beginning. This is a new area of mathematics, so there are very few big theorems, and even few good definitions. Many basic questions remain completely open. Toward the end of the week, I will discuss some unsolved problems, and there will be possibilities for research projects for those who may be interested.

Prerequisites: none.

Homework: none.

Related to: everything.

Continuing classes that welcome new students

Applied linear algebra, Part II (∗∗, Mira, 10am, Week 2 of 2 (no class on Th))

This week, we'll look at some actual applications of linear algebra to Web search, image processing, and genetics. If you know some linear algebra, come join us, even if you weren't around in Week 1.

Prerequisites: You should be comfortable with the sentence "Every symmetric matrix has an orthonormal basis of eigenvectors" and have a pretty solid understanding of what every term in it means.

Homework: required.

Related to: real life.

Projective geometry (∗∗∗, D.A., 9am, week 2 of 2)

The second week of this two–week course is a natural entry point for anyone who's seen the real projective plane and wondered what happens if you replace the real numbers with something else – the complex numbers? the quaternions? something even wackier? Our main focus will be non-standard projective planes, and their connection with non-standard number systems. Time permitting, we'll also discuss the topology of projective planes, partly in preparation for the Week 4 course on singularities. Please talk to me if you're interested in joining.

Prerequisites: Linear algebra, in the form of vector spaces and matrices. Having seen non-commutative numbers like the quaternions might help, too. If the audience chooses so, the last day (only) may require some topology.

Homework: some required.

Related to: "Applied linear algebra" (Weeks 1, 3), "Complex analysis" (Week 2), "Vectors and matrices, tensors and spinors" (Weeks 1–4), "Topology" (Weeks 1–4), "Hyperbolic geometry" (Week 1), "Intro to groups and group actions" (Weeks 1–2), "Knots and singularities" (Week 4).

Marathon classes

A marathon class is a chance to learn material in greater depth and continue to keep up a good work ethic as it gets later in camp. Marathon classes typically run for up to six hours per day (including time for group work or homework), taking up most of the class periods (so you do have to miss normal classes). On the other hand, you get closer interaction with a mentor and learn a great deal about what you're studying. You also have a chance to focus on one topic at a time, which will let you improve your learning of that topic. Marathon classes have in the past been extremely well received by the students that took them. When the marathon class is done, you can return to a normal class schedule, or try another marathon class.

Noah's marathon class in "Quantum topology" is happening in Week 3. Noah held an informational meeting on Friday night. If you want to attend, and have not talked to Noah yet, talk to Ari by the end of Monday. (Noah is gone for the weekend. Ari will be here from Saturday evening).

Kenny's marathon class in "Cardinals and ordinals" will take place in Week 4. An informational meeting will be held during Week 3. Again, if you want to attend this class, you *must* talk to Kenny in advance.

Quantum topology (Noah, $****$, marathon on Week 3)

Category theory has a reputation for being quite abstract. One reason for this is that many of the examples of categories that you may have run across are enormous, difficult to describe, and full of complicated objects. For example, the category of groups, of category of rings, or of manifolds.

This week we'll discuss much smaller more concrete categories, starting with the category of matrices (a.k.a. the category of vector spaces) and moving on to some topological examples like the category of tangles, the category of 2-dimensional manifolds with boundary.

We'll give several examples of "maps" between categories (which are called functors), and we will use these functors to construct topological invariants.

No knowledge of anything in this blurb will be assumed. We have all day every day for a week, so there will be plenty of time to discuss these topics in depth. This course is $****$ because it covers material that is typically at the second or third year graduate level However, because we have a lot of time it won't need to move as quickly as many $****$ classes.

Prerequisites: linear algebra.

Ordinals and Cardinals (Kenny, $***$, marathon on Week 4)

You've probably heard by now that there's more than one kind of infinity. In fact, there's even at least two different ways to measure the sizes of infinity, depending on whether you're counting how long a sequence is (ordinal) or how big a set is (cardinal). In this class, I'll cover enough set theory to help you calculate with these kinds of infinity, when you combine sets or sequences of the appropriate size. We'll figure out what all these $\aleph$'s and ω's that set theorists talk about mean, and come up with more types of infinity than you could have possibly imagined before, and see where familiar sets like $\mathbb{N}$ and $\mathbb{R}$ fit in among them.

Prerequisites: A fair amount of rigor and some experience with very abstract mathematics. A willingness not to flinch when we discuss the details of how the Axiom of Choice works.

I will hold an informational session in Week 3 for everyone who is interested in the class. If you can't make it to this, then you need to talk to me at some point during the week.

Right now I'm thinking that the class will be organized with alternating hours of lecture and problem time. This may change depending on interest and how things progress. We can discuss this at the informational session as well.

Visitor classes

Automatic dreaming: Can computers make (interesting) conjectures? ($****$, Noah G, 11am, Tu–We)

Can computers make mathematical conjectures? I'll talk about different ways to automatically construct mathematical statements – each a possible conjecture – then try to understand how conjectures should be evaluated. What does it mean for a conjecture to be interesting, anyway? I'll base our discussion on several current research directions in artificial intelligence.

Error–correction codes or, "How to figure out what I mean, not what I say" ($**$, Megan, 11am, Tu)

When people talk about codes, often they are referring to schemes for concealing information. However, there are also codes designed to do the exact opposite: they make sure that you can read a message someone sends you, even if some small parts of that message have been garbled along the way. Such codes are called error-correcting or error-detecting codes, and examples are all around, from the International Standard Book Number assigned to every book, to the numbers assigned to credit cards, to the way information is sent out over the internet.

In some sense, people have been using error-correcting methods since the invention of language, although mathematicians didn't start looking at the problem until after World War II. Chances are that, if somoone zends yuo an eamil witj tols of tippos and missspelings, you'll still be able to

figure out what they meant, because human languages have so much redundancy built into them. When people are designing new error-correcting codes, though, they generally want to make them as efficient as possible, so that it doesn't take an unreasonably long time to send out a small amount of information. We'll talk about some of the (often surprisingly good!) theoretical limits on just how efficient codes can get, and give some examples of good codes that have been used over the years.

Prerequisites: Basic probability theory, basic modular arithmetic. It would be helpful if you've seen a little bit of linear algebra, but it's not necessary.

Related to: "Information theory".

Estimation and white lies (∗∗, Theo, 11am, Tu–We)

An atom, you probably know, is the smallest possible unit of matter. And atomic properties determine the properties of the materials they make up. For instance, a mountain is mostly made of rock atoms — using just this fact we will calculate how tall a mountain is. We'll figure out how big raindrops are just by knowing that they're made of water atoms. We'll also answer questions like "How fast do I need to drive into a brick wall to total my car?" and "How high can a person jump?", as well as develop tools you can use and lies you can tell for just about any quick estimation.

Mind and brain Q&A (Rebecca Saxe and Josh Tenenbaum, 11am, Sa)

Got questions about the mathematics of the mind and brain? Come ask, and we'll do our best!

Probability and the mind (∗∗, Josh Tenenbaum, 11am, Th–Fr)

Computation in the brain is all about making smart guesses. In perceiving visual scenes based on retinal images, or learning new concepts from examples, there is never enough information in the inputs to deduce logically the correct structure of the world. Rather, the brain appears to have some expectations about the likely targets of learning or perception – what kinds of concepts or visual scenes are most likely – and then to use sophisticated forms of statistical inference in order to make the best possible guesses about what the world is like given the data it observes through the senses. In this class, I will consider some simple examples of statistical inference in perception and cognition, showing how the basic mathematics of probability theory can be used to explain the remarkable guesses that your brain makes all the time without you having to "think" about it. Come for the cool visual illusion on the first day!

Prerequisites: Some calculus may appear, but will not be essential to enjoying the course

TBA (Allan Adams, 11am, We–Sa)

Colloquia

Note: Colloquia do not have star ratings: speakers try to make colloquia interesting and accessible to all Mathcampers. In addition to regular colloquia by visitors and regular staff, we have various special series, including *The Seven Millenium Problems*, and *Digestives*.

TBA (Allan Adams, 4pm, We)

Integers in the mind (Rebecca Saxe, 4pm, Th)

Some numbers are obviously hard to understand: π, e, the square root of minus fifteen... But surely there's nothing complicated about the number 7? I'll try to convince you otherwise. All human infants, like many other animals, can think about very small numbers (1, 2 and 3), and have a sense of the approximate magnitude for bigger number. But getting from these initial concepts to the uniquely human concept of exact integers - like precisely 7 - depends on an amazing inferential leap, and a cultural invention. Come hear how it works.

Proofs that really count, Part I (Jennifer Quinn, 4pm, Fr)

Counting leads to beautiful, often elementary, and very concrete proofs. As human beings we learn to count from a very early age. A typical 2 year old will proudly count to ten for the coos and applause of adoring parents. Although many adults readily claim ineptitude in mathematics no one ever owns up to an inability to count. Counting is one of our first tools, and it is time to appreciate its full mathematical power. Every proof in this talk reduces to a counting problem – typically enumerated in two different ways. While not necessarily the simplest approach, it offers another method to gain understanding of mathematical truths. To a combinatorialist, this kind of proof is the only right one. Hopefully when you encounter identities in the future, the first question to pop into your mind will not be "Why is this true?" but "What does this count?"

The Seven Millenium Problem Series

On May 2000, in order to celebrate mathematics in the new millennium, The Clay Mathematics Institute of Cambridge, Massachusetts selected the Seven Millenium Prize Problems. They focused on important questions that had resisted solution over the years, and allocated an award of $1M for the solution of each one of them. In this series of colloquia we will present these problems to you, in the hope that you will some day solve them and endow Mathcamp with the award!

Quantum Yang–Mills theory (Anti, 4pm, Tu)

One of the greatest insights of twentieth century physics is that the structure of the universe is determined by symmetry. One instance of this is that symmetries give rise to conservation laws: for example, momentum is conserved because the universe is translation-invariant. But more powerfully, we can use symmetry to predict the form of physical laws. For example, the rotational symmetry of the plane can be used to predict the existence of electromagnetism, using a tool called a 'gauge field theory'. Yang-Mills Theory is a gauge field theory whose 'symmetry group is nonabelian'.

Quantum gauge field theories have been confirmed by experiment to a high degree of accuracy, so they must be doing something right. Unfortunately, however, very few of them have been shown to exist mathematically, and there's something unsatisfying to a mathematician about making numerical predictions with a theory which might be contradictory. Some people found it so unsatisfying that they offered a million dollars to anyone who could show that it's all okay.

In this colloquium, we'll blaze through the history of physics until we get to quantum gauge field theories, so that we can state the Yang-Mills millenium problem. We'll wave our hands a lot and draw lots of pretty pictures to avoid the horrific equations. Then we'll talk a little bit about why you should, or maybe shouldn't, care, and end with some remarks about some related frontiers in physics, like the search for quantum gravity.

Digestif

A *digestif* is a crispy, exciting thirty–minute minicolloquium to keep you from napping on Saturday after lunch!

The two-envelope paradox (Kenny, 2–2:30pm, Sa)

Bill Gates has decided to give you some money. So he's written two checks, one of which is for twice as much as the other, and put them in sealed envelopes in front of you, and said you can take whichever you like. After you open it, he gives you a chance to switch envelopes if you want. You see that this check is for $\$x$ and reason that the other check has a 50% chance of having $\$2x$, and a 50% chance of having $\$x/2$, so overall it's a better bet, and you switch. The next day, Bill Gates makes you the same offer again. But this time, before you even open your check, you reason that whatever number you see, you're going to want to switch, so you might as well switch now.

Is there something crazy about this? The moral of this story is that decision theory is hard, especially when infinity is involved. (Where does infinity even come in here?)

Brief visitor bios

Allan Adams (Harvard University – physics)

Allan Adams studies quantum versions of algebraic and differential geometry that play a fundamental role in string theory, and uses these tools to explore the fate of tachyons, moose diagrams, and other puzzles involving black holes and spacetime singularities. Allan believes that everyone should understand quantum mechanics, which is as beautiful and strange as it is true, and looks forward to discussing it at Mathcamp.

Noah Goodman (MIT – cognitive science)

Noah Goodman (Mathcamp mentor in 1999–2001) initiated the Mathcamp sarong tradition. He went on to receive a PhD in topology from the University of Texas, and now works on computational cognitive science at MIT.

Megan Guichard (University of Chicago – mathematics)

Megan is a Mathcamp alumna and veteran JC who has just finished her second year of graduate school at the University of Chicago. (She is the girl on the Mathcamp brochure with the Zome polyhedron in her hair.) Megan is probably going to specialize in algebraic topology. When she is not doing math or modeling polyhedral hair fashions, she enjoys getting thoroughly lost while taking random bike rides through unfamiliar cities.

Theo Johnson-Freyd (Stanford University – mathematics)

Theo Johnson-Freyd is a Mathematics major at Stanford University, where he also dabbles in dance and theoretical physics. His ambition is to simultaneously revolutionize calculus education and string theory, by successfully marrying nonstandard analysis and non-commutative geometry, about which he knows very little. Theo also enjoys baking, ballroom, and long walks by the — darn, UPS doesn't even have a lake.

Jennifer Quinn (Association for Women in Mathematics)

Jennifer Quinn thinks that beautiful proofs are as much art as science. Simplicity, elegance, and transparency should be the driving principles. Simply understanding mathematical truth is not sufficient. Instead, strive to put mathematics into a concrete framework where truth becomes apparent and ideas quickly generalize. In week 4, Jenny and her co-author, co-editor, and friend Arthur Benjamin will guide together Mathcampers in an exploration of mathematical truths by the basic combinatorial techniques of counting and matching.

Rebecca Saxe (MIT – cognitive science)

Rebecca Saxe studies the neural and psychological basis of social cognition, in the Brain and Cognitive Science department at MIT. In this work, she asks: Do we have special mechanisms, designed by evolution for recognising and/or reasoning about other minds, or does social cognition share the general-purpose machinery we use for recognising chairs and reasoning about falling apples? How and why does the human brain succeed so easily where computers and logicians fail? But since she doesn't yet know the answers to these questions, Rebecca will spend her time at MathCamp talking about something completely different: how children learn the concept "integer".

Josh Tenenbaum (MIT – cognitive science)

Josh Tenenbaum is a professor in MIT's Department of Brain and Cognitive Science. 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.

New staff bio

Ari Nieh (UC Berkeley – mathematics)

Ari Nieh is a graduate student at UC Berkeley, working on low-dimensional topology. He loves nature and early music. He also mantains the Sarong Theorem Archive (google it!) Please introduce yourself to him, because he's two weeks behind on learning names!