CLASS DESCRIPTIONS—WEEK 1, MATHCAMP 2008

Contents

Classrooms and other notes

Our classrooms are in the following buildings:

- Physics (building 38 on your campus map)—Rooms H121, H122, H123, and H240A.
- Psychology (building 44)—Rooms S102, S103, and S105
- Vollum (building 36)—lecture hall.

Recall that our dorms are building 13, 14, and 15, and the computer lab is in building 42.

The times listed in this packet are correct for Tuesday–Friday. Monday and Saturday are different; see the attached Week 1 schedule for details.

9am Classes

Things You Need to Know: Methods. (∗, Nina, Dan, week 1 of 1)
This class covers many of the topics and material that will be assumed in all the other classes at camp. Please see the orange "Things You Need To Know" sheet in your folder!

Prerequisites: None.

Homework: Required.

Related to: Most classes at camp.

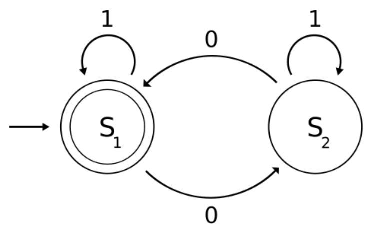
Required for: Every class at camp!

Finite Automata. ($*$–$**$, Alice, week 1 of 1)

Computer scientists use a variety of different models to think about how computers work and what they can do. Many of these models were actually invented *before* computers themselves—as early as 1822. (When they finally built the 1822 model in 1991, it worked just as described!)

One theoretical computer is the Turing machine, a long tape containing a series of symbols and a machine that reads and writes symbols to the tape. What's remarkable about a Turing machine is that despite its simplicity *it can solve any problem solvable by a modern computer.*

In this class, we'll look at "finite automata", which are the first step to understanding Turing machines. Here's what a finite automaton might look like:



We will then look at an alternate representation called regular expressions, and finally, we'll work our way up to Turing machines and what it really means to "compute".

Prerequisites: None

Homework: Required

Related to: Computability and Complexity (Weeks 1–3); Boolean circuits (Week 2)

Introduction to Group Theory. ($**$, Mark, week 1 of 2)

How can you analyze the symmetries of geometric figures, like regular or star polyhedra, or the workings of Rubik's cube? How do physicists predict the existence of certain elementary particles before setting up expensive experiments to test those predictions? Why can't fifth-degree polynomial equations, like $x^5 - 3x + 17 = 0$, be solved using anything like the quadratic formula, although fourth-degree equations can? The answers to all these questions depend on group theory; knowledge of some group theory is at least helpful and often crucial in other areas of mathematics, such as number theory and topology. So come find out what group theory is all about! Week 1 of this class will provide a basic introduction; we'll try to at least cover fundamental concepts (and examples), permutation groups, and Lagrange's theorem. In week 2, Nina will be using some of the ideas from week 1 to work in detail on the very first question above!

Prerequisites: None.

Homework: Recommended.

Required for: Noneuclidean geometry (Superclass, Week 4); Algebraic topology (Superclass, Week 4); 3rd week of Knots, Labelings, and Algebra (Week 3)

Graphs on Surfaces. ($**$–$***$, Marisa, week 1 of 2)

Take five points (vertices) on the plane and connect them with curves (edges) so that each vertex is connected to every other vertex. Move the vertices around until they're in a position to give you the least possible number of edge crossings. Can you get the number down to zero, or is there always a crossing? The answer comes in the form of Kuratowski's Theorem. Would it help to draw them on the torus instead of the plane? What about on the projective plane?

In these two weeks, we'll talk about embeddings (a "successful" drawing), minimum number of crossings (a drawing that's "good enough"), and colorings (does the four-color theorem work on the torus?).

Prerequisites: I'll define terms as I use them, but you'll get more out of the class if you're already familiar with basic graph theory vocabulary and facts: Euler's formula, for instance.

Homework: Strongly encouraged.

Related to: Basic Graph Theory (Week 4); Point-set Topology (Weeks 1–2); Imagining the Real Projective Plane (Day 1); Noneuclidean geometry (Superclass, Week 4)

Measure Theory and Lebesgue Integration. (∗∗∗∗, Miranda, week 1 of 1)

Riemann integration can do lots of things, but not everything. For example, what happens if we want to integrate a function which is discontinuous everywhere? Or what if, instead of integrating over an interval, we want to integrate over the Cantor set? There are many functions that we come across that we can't integrate with a Riemann integral. In this class we will learn a more abstract kind of integral called the Lebesgue integral. This is a powerful, yet beautiful construction that lets us integrate a much broader class of functions. In order to define the Lebesgue integral we will learn about measure theory, which will provide a rigorous definition of what it means for something to have a "length". Beware: this class will look a lot more like a set theory class than a calculus class: although we will learn how to integrate almost anything, we won't actually integrate anything at all!

Prerequisites: Some prior experience with calculus will be helpful, but is not required

Homework: Required.

Related to: The Vitali Set (Day 1); Real Analysis (Weeks 1–2)

10am Classes

Things You Need to Know: Theory. (∗, Dan, Nina & others, week 1 of 1)

This class covers many of the topics and material that will be assumed in all the other classes at camp. Please see the orange "Things You Need To Know" sheet in your folder!

Prerequisites: None.

Homework: Required.

Related to: Most classes at camp.

Required for: Every class at camp!

Linear Algebra. (∗∗, Mira, week 1 of 1)

Linear algebra is the area of math that deals with vectors and matrices. It is one of the most useful methods in mathematics, both within pure math and in its applications to the real world. One could argue that most of what mathematicians (and physicists, and engineers, and economists) do with their time is try to reduce hopelessly complicated non-linear problems to linear ones that can actually be solved. Thus for many applied fields, the most important math to know is not calculus, but linear algebra.

We're going to start out on the plane, where linear algebra springs out of geometry. We'll define linear maps and give an intuitive preview of one of the central themes of linear algebra—eigenvectors and their eigenvalues. Then we'll leave our two-dimensional pictures behind and introduce the more general concepts of vector space, linear independence, dimension, inner products, orthonormal bases, and diagonalization. (If you don't know what any of these words mean, that's great: come to the class! If you know all of them, then you don't need this class—but you might be interested in the class on applications of linear algebra next week.)

The class will culminate in a big theorem about eigenvectors of symmetric matrices, the Spectral Theorem. This result is fundamental to a variety of applications. We'll explore a few of them—such as population genetics and image processing—in the "Cool Applications of Linear Algebra" class in Week 2.

Prerequisites: None.

Homework: Required, daily.

Required for: Differential equations and mathematical modeling (Weeks 2–3); Cool applications of linear algebra (Week 2); Quantum Mechanics (Week 3); Quantum Computation (Weeks 3–4); Linear Programming (Week 3); Planar Algebras (Superclass, Week 4); p-adic numbers (Weeks 2–3)

Numbers of the form $x^3 + y^3$ modulo p. ($**$–$***$, Noah, Mon)

Which numbers are cubes modulo 7? Well, we can easily compute that $1^3 = 2^3 = 4^3 = 1$, that $3^3 = 5^3 = 6^3 = 6$, and that $0^3 = 0$. So which numbers are the sum of two cubes modulo 7? Well, only $0, 1, 2, 5, 6$ can be, 3 and 4 cannot. It turns out that 7 is very special this way. For any other prime p, every number can be written as a sum of two cubes modulo p. There is a very cute proof of this fact due to Dan Shapiro that I'll be explaining in this talk.

Prerequisites: You should know when a is invertible modulo m.

Related to: Number Theory.

John Conway. (Anywhere from $*$ to $****$, Tues–Sat)

Real Analysis. ($***$, Mike, week 1 of 2)

Suppose you wanted to define a function that's continuous, but nowhere differentiable, find a 1-dimensional curve that fills up n-dimensional space, or define the fractal dimension of a set? What if you want to add up $\sum_{n=1}^{\infty} \frac{1}{n^2}$, or find sums that can be rearranged to add up to anything? What if you want to study the convergence of Fourier series, or define what it means to be half-differentiable? If you've had some calculus, you've learned how to *compute* limits, infinite sums, derivatives, and integrals, but defining them rigorously can be tricky business.

To do these things (and prove what you say!), you need the basics of real analysis. In this class, we'll build the real number system from scratch, and investigate sets, sequences, limits, and functions. We will answer questions like: What does it mean for a sequence of numbers to converge? How about a sequence of functions, or an infinite sum or product? What does it mean to be a continuous function? A differentiable or integrable one?

If you aren't fluent in ϵ-δ proofs, this class is the place to learn!

Prerequisites: None.

Homework: Required.

Related to: Measure Theory and Lebesgue Integration (Week 1); Dynamical Systems (Week 3)

Required for: Almost All (Week 4); Dynamical Systems (Week 3)

Advanced Problem Solving. ($****$, Gregory Galperin, week 1 of 4)

See the "Problem Solving" section on page 10.

Visualizing 4D. ($*$, Mira, Mon)

On Monday afternoon, we're all going to be making a huge Zometool structure in the main lounge: a three-dimensional projection of a four-dimensional polytope. But what does this actually mean? How do we think about geometry in higher dimensions at all? We'll start by focusing on n-dimensional cubes and ask questions like: How many vertices does a 17-dimensional cube have? How many edges? How many faces? How many 3- or 4- or 13-dimensional faces? Then we'll say a few words about how different kinds of projection work and what we would expect a 3D projection of a 4D polytope to look like.

Prerequisites: None.

Homework: None.

Related to: Monday's Zometool Workshop; George Hart's 4D geometry (Fri)

Mechanical Puzzles. ($*$, George Hart, Tues)

I will bring a variety of original geometric assembly puzzles. Some are made of plastic on a rapid prototyping machine. Others are paper constructions made with a robotic paper cutter. See if you can discover the underlying mathematical ideas and assemble these puzzles! The paper ones are visually interesting and yours to keep.

Prerequisites: None.

Homework: None.

Related to: Platonic Solids; the two Zometool workshops

Platonic Solids. ($*$, Marisa, Weds)

Tetrahedron. Hexahedron. Octahedron. Dodecahedron. Icosahedron. What is it, exactly, that makes these the Platonic Solids—the only five convex regular polyhedra? We'll describe their elegant and simple classification using an observation from topology and some clever counting. And probably some chalk.

Prerequisites: None.

Homework: None.

Related to: George Hart's Zometool Workshops; Basic Graph Theory (Week 4); Graphs on Surfaces (Weeks 1–2); Basic Group Theory (Weeks 1–2)

Zometool Workshop. ($*$, George Hart, Thurs)

If you don't know a truncated icosahedron from a stellated dodecahedron, then come and learn about 3D geometry and polyhedra in this hands-on Zometool Workshop. We'll make lots of cool models along the way.

Prerequisites: None.

Homework: None.

Related to: Friday's Zometool workshop; Platonic solids (Weds); Archimedean Solids (Sat)

Four Dimensional Geometry. ($*$, George Hart, Fri)

Learn about hypercubes, simplexes, and why there are only six regular polytopes in 4D. We will use Zometool to make many kinds of 3D models of 4D polytopes. By the end, you'll also have a deeper appreciation for Monday's large polytope construction.

Prerequisites: None.

Homework: None.

Related to: Thursday's Zometool workshop; Visualizing 4D (Mon)

Archimedean Solids and Beyond. ($*$–$**$, Anti, Sat)

After the Platonic Solids, the next simplest convex polyhedra are the *semi-regular* ones, whose vertices are all identical, and whose faces are regular polygons but not all identical. They were discovered by Archimedes, except for one (of somewhat questionable status) which wasn't discovered until the 20th century. There are between 13 and 16 of them (depending on how you count) plus two infinite families. Using some easy tricks from counting and geometry, we'll describe all of them and prove that there aren't any more.

Prerequisites: Platonic Solids (Weds)

Related to: Zometool workshops.

Homework: None.

$SL_2(\mathbb{Z})$**.** ($**$, David, Mon–Tues)

What do lattices, elliptic curves, modular forms, hyperbolic surfaces, tessellations and fractals have in common? $SL_2(\mathbb{Z})$! It is the set of 2×2 matrices $\left(\begin{smallmatrix} a & b \\ c & d \end{smallmatrix}\right)$ with a, b, c, d integers and $ad - bc = 1$. We will begin the process of understanding how $SL_2(\mathbb{Z})$ ties all of these topics together by looking at how it acts on the complex plane.

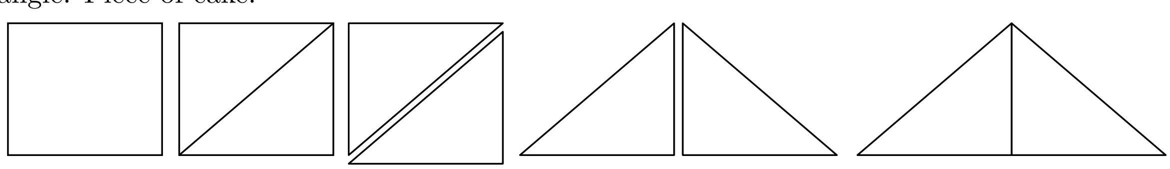
Prerequisites: None.

Homework: None.

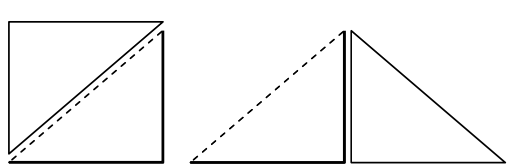
Required for: Helpful for The Banach-Tarski Paradox (Wed–Sat)

The Banach-Tarski Paradox. ($**$–$***$, Emina Alibegovic, Wed–Sat)

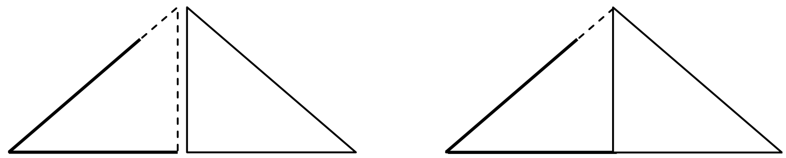
I got a square piece of paper and was asked to cut it any way I wanted to and make an isosceles triangle. Piece of cake:



You might say "Hold on, there. Maybe cutting with scissors makes it all fine, but mathematically there are things you're not telling me. For instance, each point in the square is just one point. If I cut along the diagonal where do these points go? To which triangle are they assigned? The picture should really be:



But here we also have a problem, because if we glue these two sides together, we have lots of pairs of points that become one!" Well, fine, I'll take one of those lines and move it over so that it covers the missing diagonal. "Nonsense", you say "You don't have enough points":



It may appear so. But, there are plenty of points there. Some reshuffling may be necessary. And no magic will be involved. In fact, I could take a pea and cut it up, reassemble it and make a sun. At least theoretically! We'll find out how.

Prerequisites: $SL_2(\mathbb{Z})$ (Mon–Tues) would be helpful.

Homework: Required.

Combinatorial Calculus: from Taylor Series to Feynman Diagrams. ($***$, Theo, week 1 of 1)

A Feynman diagram is many things (a picture, a process, an event, a morphism). For me, a Feynman diagram is a combinatorial integral. This class will explain some of the beautiful combinatorics that underlies calculus, beginning with derivatives and Taylor's theorem, and concluding with integrals and Feynman Diagrams. For example, the generalized Chain Rule ($d^n[f(u(x))]/dx^n$ in terms of df/du and du/dx) also generalizes the number of partitions of n objects. Along the way, we will develop some multi-variable calculus—certainly not a whole course, but whatever is needed to get at the full combinatorial elegance.

Prerequisites: High school calculus is strongly recommended.

Homework: Recommended.

Rational numbers . . . in space! (Or, Diophantine approximations via geometry). ($**$, Noah, Mira, Dave, week 1 of 4)

The most exciting mathematics is often the result of surprising and unexpected relationships between completely different subjects. Exploiting such a connection, mathematicians attack problems in one field using the intuitions and results from another field. Sometimes this translation will turn a difficult question into an easy one. Here we'll study one such connection between a topic in number theory known as Diophantine approximation and ordinary plane geometry. That is, you'll answer questions like "How well can you expect to approximate a number like π using a fraction?" with geometric techniques. Similarly you'll prove some fundamental results in elementary number theory and the theory of continued fractions using geometry.

Homework: Required—this is a Moore Method Class. This means that instead of us explaining math to you during class, you'll be explaining math to us during class! You will be given a series of problems, and although we'll be around to help, you'll be expected to figure things out yourself! We've already handed out the first problem set, so make sure you get a copy if you're interested in taking the class.

Prerequisites: You should understand the Euclidean Algorithm, or you should simultaneously enroll in Intro Number Theory.

Related to: Intro Number Theory.

Point-set Topology. (∗∗∗∗, JR, week 1 of 2)

We see sets everywhere in mathematics. One familiar example is the set of points lying one unit away from the origin in 3-dimensional space (the sphere). The points making up such a set are not just strewn about randomly; they are stuck together in a very delicate fashion. Some of them are very close together, and others are farther apart. Sets with such an organization are called topological spaces.

What does it mean to say that a space is connected (that is, all in one piece)? How can we make sure a function on a space is continuous (that is, does not tear the points of the space apart)? When we ask these sorts of questions, we are asking about the topology on our space. Come to this class to learn what a topology is, what it can do for you, and how to build your very own topological spaces!

Prerequisites: None.

Homework: Recommended.

Required for: Algebraic topology (Superclass, Week 4); Almost All (Week 4)

Related to: Graphs on surfaces (Weeks 1–2)

1:10pm Classes

Introductory Problem Solving. (∗∗, Gregory Galperin, week 1 of 4)

See the "Problem Solving" section on page 10.

Introduction to Number Theory. (∗∗, Mark, week 1 of 2)

How do you find the GCD of two large numbers without having to factor them? What postages can you get (and not get) if you have only 8 cent and 17 cent stamps available? What is the mathematics used when you send confidential information, such as your credit card number, over the Internet? 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 modern-day theoretical physicist Dyson, are not to be underestimated!) and chances are that you, too, will enjoy it quite a bit.

Prerequisites: If you haven't seen modular arithmetic, you should also go to "TYNTK: Modular Arithmetic" on Thursday.

Related to: Almost anything related to number theory or abstract algebra.

Required for: Analytic Number Theory (Week 3); Rational numbers… in space! (Weeks 1–4; see its description)

Homework: Recommended.

Computability and Complexity. ($***$, Dan, week 1 of 3)

What can a computer do? What can't a computer do? We're going to explore the limits of computation by setting up a mathematical framework that encapsulates computers' abilities.

You might be surprised to learn that there are simple, easy-to-state problems that no computer can solve, no matter how fast. No matter what program you try to write, you computer might never get an answer. We'll explore these limitations, prove their intractability, and take the first step towards developing a hierarchy of unsolvable problems.

The second question we'll try to answer is what problems computers can solve when they have limited resources. If you want an answer to a problem in a reasonable amount of time, can a computer do it? This leads to some of the deepest questions of mathematics, including the millenium P vs. NP problem (it's worth a million dollars, but that's not why it's interesting!). This fundamental question captures not just important mathematics, but also a philosophical point about the difference between *finding* a solution efficiently and *verifying* someone else's solution.

This will all be accomplished through *Turing machines*, mathematical models of computation that allow us to formalize computation and prove fascinating theorems.

Although the class has no prerequisites, you should set aside plenty of time for homework. Past students have reported that they got the most out of working these graduate-level questions, and they'll be essential to keeping up with the material.

Prerequisites: This class has no actual prerequisites, but the material gets somewhat technical, and Finite Automata (Week 1) may be helpful for dealing with the notation and details.

Homework: Required.

Related to: Finite Automata (Week 1), Quantum Computing (Weeks 3–4), Boolean circuits (Week 2), graph theory classes (Weeks 1–2, 4)

Required for: None.

Knots, Labelings, and Algebra. ($**$, Susan, week 1 of 3)

Take a piece of string. Put it into your washing machine. What comes out, not surprisingly, is a tangled mess. If we then glue the ends of the string together, this tangled mess becomes a mathematical object we call a **knot**. In this course, we will explore how our seemingly messy knots are related to highly structured algebraic objects. We will see how systems of linear equations can be used to differentiate between knot types, and how each knot can be labeled with group elements which generate the fundamental group of its complement in the 3-dimensional sphere.

In week one, we will be getting a feel for what knots are and how we work with them. We'll start by manipulating actual, physical knots. Over the course of the week, we will develop the tools we need to study knots on a deeper level. For instance, how can we prove that a given knot can not be untied? We can try to untie a given knot for hours and fail miserably, but that doesn't mean it's impossible. Maybe if we put in ten more minutes of effort, we would succeed. We can often solve this kind of problem with a special class of properties called knot invariants.

If you're looking for a one-week introduction to knot theory, feel free to hop in for just the first week. If you've had an introduction to knot theory and are interested in doing some more exploring, join us starting in week two.

Homework: Recommended.

Prerequisites: None for week one. For week three, some background in group theory is needed; attending Intro Group Theory (Week 1) should be sufficient.

Required for: Some exposure to knot theory, such as provided by week one, will be required for Javier Arsuaga's Superclass on DNA Topology in Week 4.

Related to: Algebraic topology (Superclass, Week 4)

Reflection Groups. (∗∗∗∗, David, week 1 of 4)

How can one describe a group with 696729600 elements using only an 8×8 matrix? Come see how to describe symmetries as products of reflections, and learn about the fascinating structures that one can find using this structure. We will use the tools of group theory and linear algebra to study reflection groups, learning a ton along the way.

This course is Moore Method. In other words: you will do all the work. You will receive handouts with definitions, motivation, and a list of theorems and exercises, but without a single proof. You are expected to work daily on preparing those proofs, which you will then take turns presenting in class. The class will then discuss the proofs together until we get a completely rigorous proof for every statement, with (hopefully) minimal help from us. Group work is encouraged, and we will be always available for help at TAU, but you are forbidden from consulting any book. I want to allow you the pleasure of "discovering" the results on your own, even if other people have done it before.

We will begin with a review of basic linear algebra and group theory. Since we will want to cover these topics relatively quickly, having seen them before will be useful. We proceed then to some needed linear algebra and group theory topics and then use our newfound tools to classify all finite reflection groups. With the classification theorem in hand, we will move on to topics of interest to the class, which may include infinite Coxeter groups and affine reflection groups, polynomial invariants or Weyl groups of Lie algebras.

Prerequisites: None, but some exposure to linear algebra and/or group theory would be helpful.

Homework: Required.

Problem Solving Classes

In Week 1, both the advanced and the introductory problem solving courses will cover similar topics; the problems presented to students on these topics will differ. The topics this week are:

(1) Introductory problems: Finding a one-to-one correspondence between finite sets (logical problems); True/False statements: liars, knights, dodgers; Pouring; Weighings; Pigeon-Hole Principle (PHP): (a) divisibility; (b) additional considerations; (c) geometry. More problems.

(2) Unusual Examples and Constructions: glue a polyhedron with given faces; the sum equals the product; increasing geometric progression with rational and irrational numbers; big/small triangles; intersection of two polygons; the "×" and "+" in geometry (a "deformed check board"); four pills $ABAB$ and nine pills $ABCABCABC$; Egyptian fractions; dissection of polygons; an unusual pyramid; one figure inside another (a triangle inside a triangle; a pyramid inside a pyramid; nested convex polygons; a luggage problem; an impossible calendar; the Conway's sequence. More examples.

(3) One Step Problems: dancing; engaged parallelograms; a trapezoid with angles $37°$ and $53°$; sticks; a tetrahedron and two disjoint triangles; which angles is bigger?; a bent strip inside a circle; a digital cube; a property of a trapezoid; pierced napkins; make a parallelogram from a given quadrilateral; the area of a regular octagon; the sum of 13 integers; the "quazi-Gelfond" problem; $ax + by + cz$; "the game of gods"; one map on the top of another. More problems.

(4) Integers and Algebra: Problems from different Olympiads.

(5) Geometry: Problems from different Olympiads.

(6) Problems from the Moscow and the St. Petersburg math Olympiads, from the "Tournament of Towns", and from the USAMO of different years.

(7) "Impossible Problems" and some ideas from modern mathematics.

Colloquia (4–5pm)

The Reeb Foliation of the 3-Sphere. (Dan, Mon)

The *one-sphere*, S^1, lives inside two-dimensions, and is defined by the equation $x^2 + y^2 = 1$. The *two-sphere*, S^2, lives inside three-dimensions, and is defined by the equation $x^2+y^2+z^2 = 1$ (this is the sphere you know and love; it is called the two-sphere because, up close, it just looks like a curved plane). What if you generalize this? You get the *three-sphere*, S^3, defined by $x^2+y^2+z^2+w^2 = 1$, which lives inside *four* dimensions. If you look up close, it looks like a curved... well, a curved three-dimensional space, just like the one we live in.

So how do you study an object that you can't really see? That will be our motivating question, and from there we'll find all kinds of crazy things. In one hour, I'll take you on a wild tour of this fascinating space. Thanks to lots of careful pictures, you should get a good intuition for generalizing to the strange world of "3-manifolds."

John Conway. (Tues, Weds, Fri)

NTBA.

Playing Pool with π. (Gregory Galperin, Thurs)

I will construct a very simple "billiard machine" (created by the speaker) that calculates the number π with any precision you wish. The billiard machine consists of two billiard balls located on a semi-line.

If the time allows, I will describe the two Sinai's billiard problems concerning the topic.

Monday's Zometool Workshop

Zome Polytope. (George Hart, Mon)

We will attempt to build the world premiere of the four-dimensional object sometimes known as the "canti-truncated 600-cell". Actually, we will make just a three-dimensional shadow of this 4D object. This will be a five-foot diameter construction containing 10800 plastic parts. It is one of fifteen uniform polytopes in the H4 symmetry group. The other fourteen have been constructed previously and this is the one remaining which has never physically existed. Everyone can drop in and participate for any length of time!

Visitor Bios

Emina Alibegovic. (University of Utah)

Emina Alibegovic works on geometric group theory, a field of mathematics that lies at the crossroads of geometry, algebra, and topology. However, Emina uses geometric group theory to solve problems in... logic! You might think this is backwards: certainly, logic can help us solve problems in algebra and geometry, but what can algebra or geometry tell us about logic itself? Well, it turns out that problems don't care which methods you use to solve them, as long as they get solved!

Emina is very interested and invested in education and spends time doing mathematics with high-school teachers. She is looking forward to working with high-school students as well.

John Conway. (Princeton University)

One of the most creative thinkers of our time, John Conway is known for his ground-breaking contributions to such diverse fields as knot theory, geometry of high dimensions, group theory, transfinite arithmetic, and the theory of mathematical games. Outside the mathematical community, he is perhaps best known as the inventor of the "Game of Life."

Gregory Galperin. (Eastern Illinois University)

A professor of Eastern Illinois University; Ph.D. in 1979 at Moscow State University (under A.N. Kolmogorov's supervision); an author of more than 50 publications in mathematics and about that number of publications on "elementary math" and education in "Kvant", "Quantum", "Focus", and some other journals; an author of math books, among which are "Moscow Mathematical Olympiads", "Billiards", "Chaos and Billiards"; a former member of Russian Math Olympiads (Moscow and National: 1970–1990); a member of the problem committee of the USA MO (1999–2008); a deputy leader of the USA team for the IMO in 2003 (Japan).

George Hart. (SUNY Stony Brook—computer science)

George Hart is both a professor of computer science and a mathematical sculptor. At Mathcamp, he leads hands-on workshops in which participants explore the geometry of three- (and four-) dimensional space using the mathematical construction set Zometool.

Theo Johnson-Freyd. (UC Berkeley)

Theo, a former Mathcamp staff member, studies mathematical physics: he does a little analysis, a little combinatorics, a little topology, and not enough of any of these to call it his focus. He's also an avid cook and an occasional (these days) dancer. Ask him about quantum mechanics, west-coast swing, and vegetarian cuisine.