Wizards, Hats, Fireworks, and The Axiom of Choice: How the Worlds Best Logicians Play the Worlds Best Logic Game

by Andrey Boris Khesin

Suppose some wizards are in a line looking forward and they must guess the colour of the hat on their head starting from the back. Only the last person is allowed to guess incorrectly. At this workshop we will discuss and try many forms of the classic wizards and hats (also frequently called hat guessing) problems and their (literally) endless variations. We will talk about how this relates to the wonderful game of Hanabi, a cooperative game where you hold your cards towards your teammates and give them clues about what they hold. Time permitting, well cover why the wizards will need to invoke the axiom of choice to solve the harder hat-guessing problems.

Wedding Cake and Divorces: A Guide to Fair Division

by Andrey Boris Khesin

What does cake have to do with the number of 1s in the binary digits of a number? What can divorcees learn from pirate treasure? How can we divide something fairly? In this workshop, we will cover how to divide things fairly when not everyone values them the same way. We will talk about what it means for a division scheme to be fair and envy-free. We will try to come up with our own division schemes and explain how the Thue-Morse sequence ties into it all.

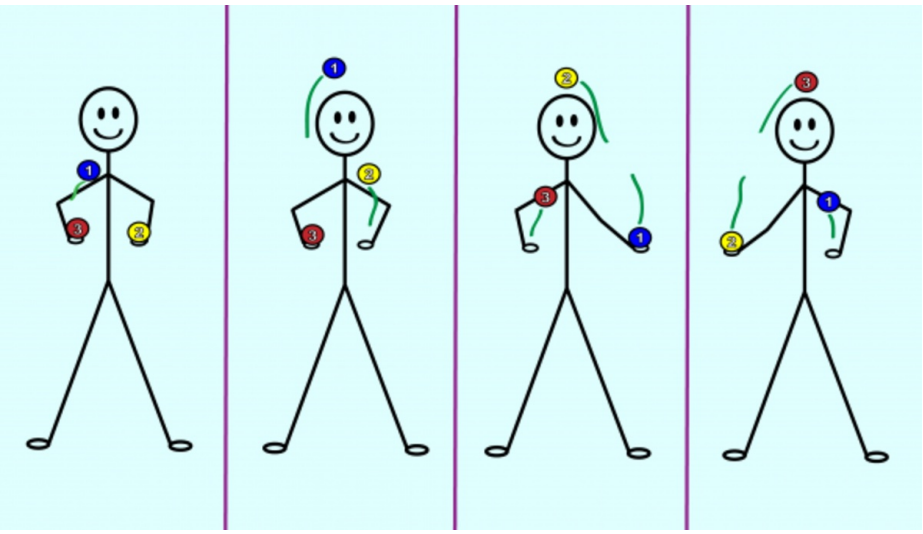
Time Travel Chess: A Surprisingly Reasonable Game (Not the 5D one!)

by Andrey Boris Khesin

There have been many attempts at making a version of chess that involves time travel, including many horrible computerized versions, such as 5D Chess with Multiverse Time Travel. At last, a reasonable version of this game has been created. A piece can step into a time machine and disappear, traveling to the future, only to reappear at a later date, which is very useful for developing your rooks. A piece can emerge from a time machine, having travelled here from the future. But beware, if you make a bunch of extra queens this way, the pawns that made this commitment are now more valuable than your king: if your opponent captures them, they won't be able to travel back to the past, so you will have created a time paradox, at which point you immediately lose the game. At this workshop you'll learn the rules of time travel chess, some basic strategies, and will get the chance to play a game or two!

Juggling

by Adam Smith



Have you ever wanted to juggle watermelons in the supermarket, but felt awkward about spattering people with juice as you practice? This workshop is for you. Well cover two basic skills: passing hand to hand, and three-ball juggling. If we get good enough, well try passing between jugglers. We'll have other objects to try juggling, like pins and scarves and flaming torches.* No tasty fruit will be harmed.**

Note: This workshop is aimed at beginners. Experienced jugglers are welcome but may be pressed into service as teaching assistants.

* We won't actually have flaming torches.

** Unless you count lemons as tasty.

Veggie Orchestra

by Deniz Erdag

Ever forget your instrument at home while you were away and wished you could still practice? Me neither, but let's learn to make instruments from common vegetables! We will primarily work on a recorder-like instrument.

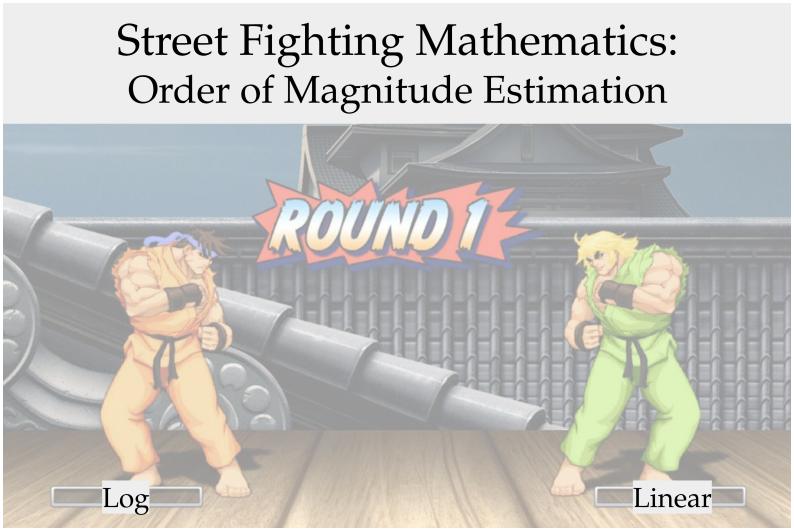
Friendship Bracelets

by Iana Podobedov

Come to this workshop to make friendship bracelets with and for your friends!

Street Fighting Mathematics: OOME

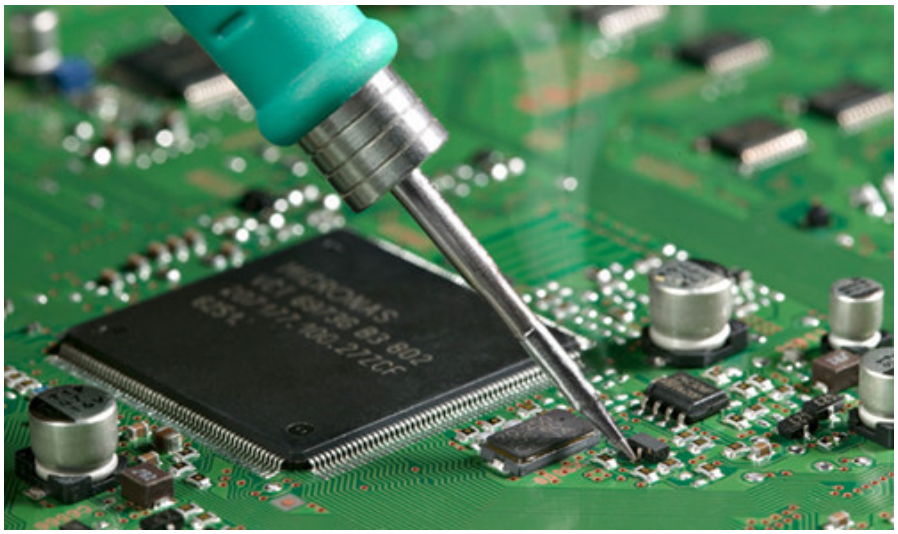
by Valentin Skoutnev



Street fighting mathematics teaches you that a cow is a sphere and pi equals 3. We will first go over the basics of order of magnitude estimation (OOME): What is OOME? When and why to use the geometric mean? What are some tips and tricks? Then we will try out both some prepared questions and any participant suggested questions. By the end you should easily be able to tackle problems such as: Are pencils a million or billion dollar industry? Are there more trees on Earth or stars in our galaxy? How many micromorts do you accumulate over...a skydive?...a day in NYC during COVID-19?

Learn to solder SMT components

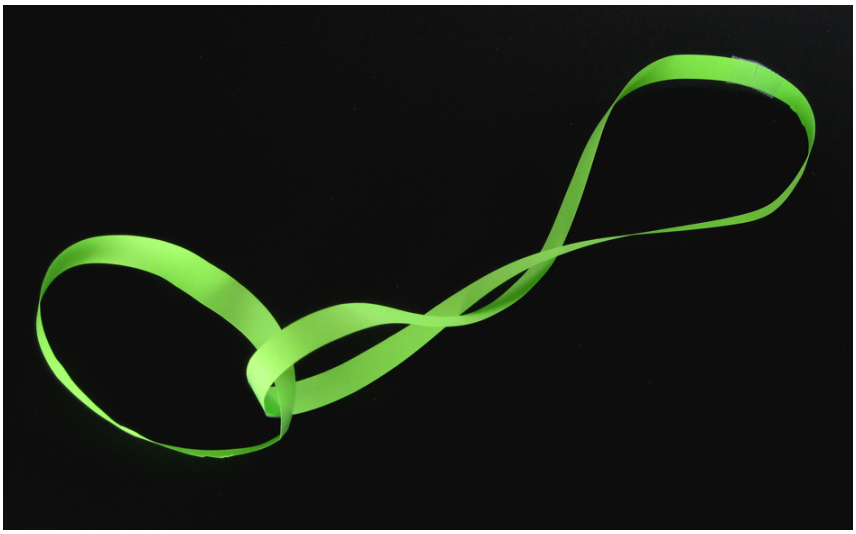
by Alexander Kirillov



Soldering is easy - but nowadays, more and more components are only available in Surface Mounted (SMT) versions, which can be intimidating to beginners. We will show you different techniques for soldering SMT components and complete a simple project.

Fun with Mobius Strips

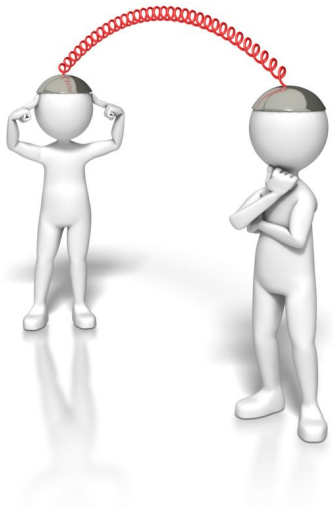
by Matvey Borodin



If you know what you're doing, it takes approximately 5 seconds to make a two-sided piece of paper into a shape that only has one (called a Mobius strip). Then, you could cut this shape down its "center" and end up with a two sided shape again, but one completely different from the first. However, if you cut it "off-center", you would end up with two separate shapes which are linked. In this workshop, you will learn how to make a Mobius strip and all the cool things you can do with one. Along the way, we'll talk about some of the math behind a Mobius strip and what it means for a surface to be non-orientable.

MindFlex

by Katya Donetski



"What does a thought without language sound like?" Continuing on this topic of thoughts in the brain, we can discuss some of the attempts at synthesized telepathy, or the "ability for two brains to communicate with each other using a computer as an intermediary." Unfortunately, I dont have the resources or knowledge (yet) to demonstrate a brain-brain interface but we can observe the next best thing, a brain-computer interface. Come to my workshop where well talk about the mechanisms of a BCI (and BBI) and you can compete against your fellow campers using only the power of your mind!

Rockets and Propulsion

by Nikita Podobedov

During this workshop we will be flying powerful model rockets and discussing some basic principles of propulsion (reactive motion) and stability.

Boomerangs

by Katya Donetski and Iana Podobedov

Come make your own boomerang with us!

A smart home starts with smart lights

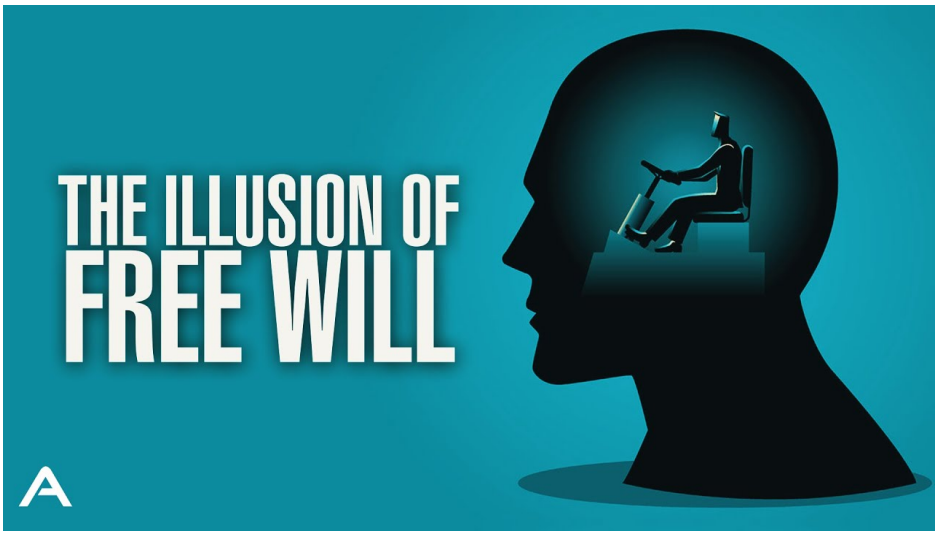
by Boris Barron

Ever notice how turning on or off the lights takes entire seconds out of your day? Well explore the elegant (and fairly cheap) solution of changing your light switches to control all your dumb lights. Multi-switch, dimmer switch? Line wire, ground wire, neutral wire? No problem. Give your home those lightbulb moments, one switch at a time.

...Alexa, lights 20%

A Debate: Does Free Will or The Self Actually Exist?

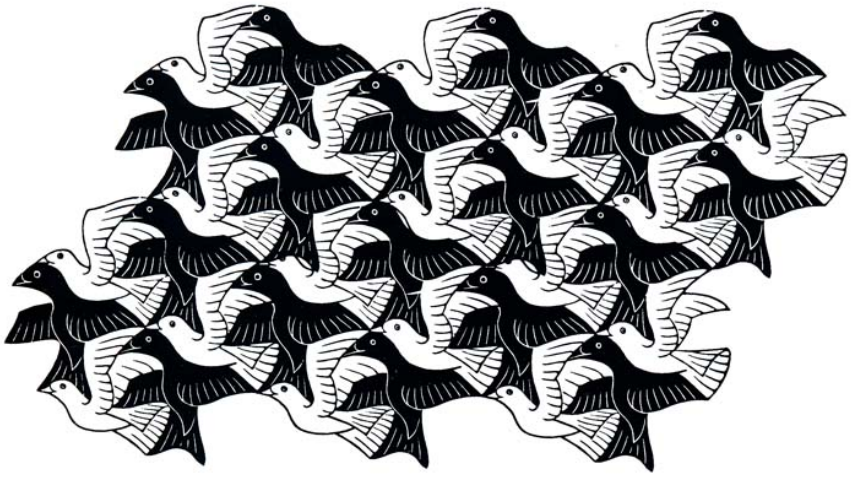
by Nestor Tkachenko



In our western ideology we live under the assumption that we have a "soul", or at the very least, some sort of "conscious self". During this workshop we will have a roundtable discussion about the topic of a self - what that means, whether it exists, and what the consequences of that are in our own lives.

Tessellations

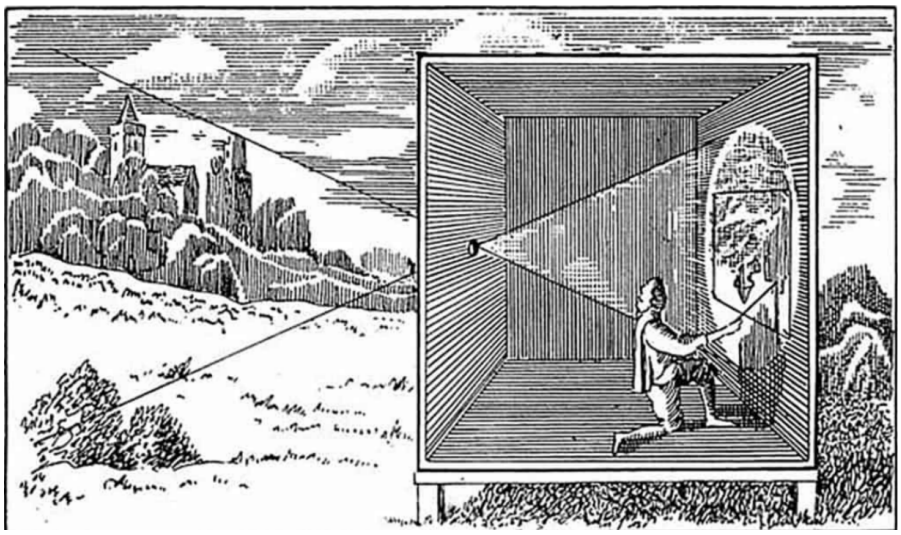
by Polina Zavyalova



Embark on an artistic journey delving into the mesmerizing world of Tessellations, Tilings, and Wallpaper Patterns! Discover the captivating blend of art and mathematics as you explore intricate geometric designs of M. C. Escher. Learn to identify diverse wallpaper patterns and unleash your creativity by crafting your own unique designs. Perfect for art and math enthusiasts alike, this workshop will leave you inspired by the magical interplay between art and science.

Camera Obscura

by Victoria Bershadsky



Discover the very first HD camera in the world! Build your own highly low tech but fully functioning version, and see the world upside down through your own pinhole camera.

Design Your Own Parachute

by Stasya Selizhuk

Ever wondered how parachutes work? In this workshop youll discover the science behind parachutes and different designs. You will also get to create and test your own parachute. May the best parachute win!

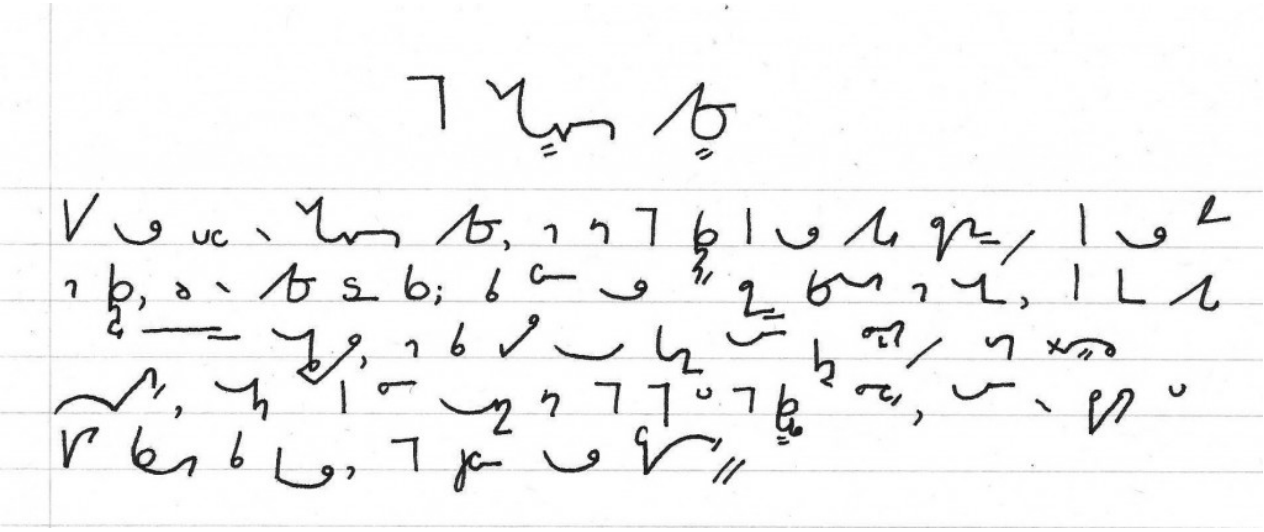
Card tricks, matrices and marriages

by Krerley Oliveira

In this workshop we discuss three things: a magic trick, permutation matrices and perfect marriages. The story starts with a trick created by Fitch, the magician. Fitch was the first student to earn a PhD in Mathematics in MIT. Inspired by his trick, we discuss the connection between perfect marriages and decomposition of magical square matrices (i.e., matrices that its row and column sum is constant). Time permitting, we discuss how to use this stuff to send secret codes or compress data.

Learn Shorthand

by Mark Shapiro



Have you ever wondered how journalists are able to transcribe an interview in real time? Would you like to learn a faster method to take notes in your classes, semilabs, and lectures? Well be learning the basics of Teeline, the shorthand system used by the UKs National Council for the Training of Journalists.

Rubiks Cubes, Matrices, and Group Theory

by Daniel Salkinder

A Rubiks Cube has over 43 quintillion combinations. But how did mathematicians get this number? What does it have to do with some of the most fundamental abstract mathematical objects? Come to hear about how mathematicians think about problems, learn the axioms that define groups and other important objects, and use this to do actual computations!

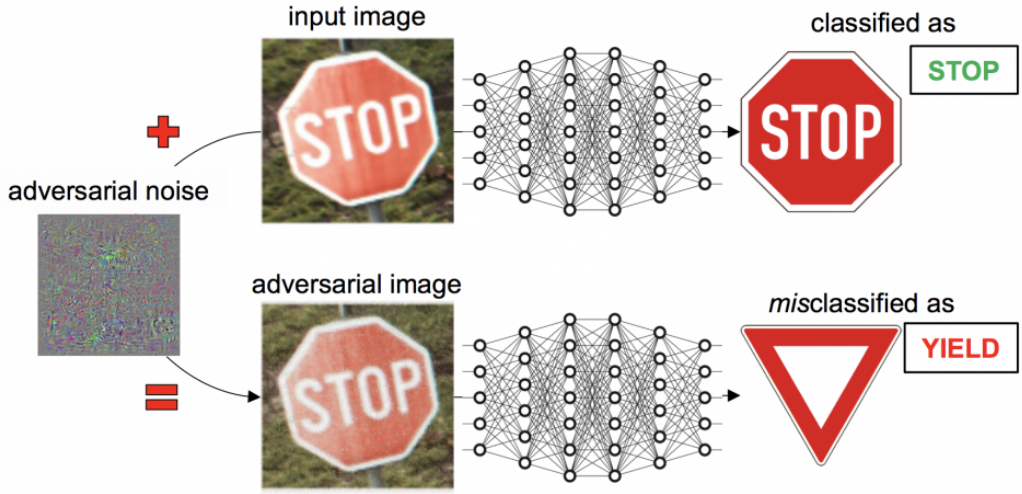
Stream Music without the Internet

by Lev Bershadsky

Have you ever wanted to listen the music, but then realized that Spotify doesnt work without internet? In this workshop we will build a replacement for Spotify using a software defined radio, so you can listen to any music you want* without internet. *Music you want not guaranteed

Fooling Deep-Learning AI

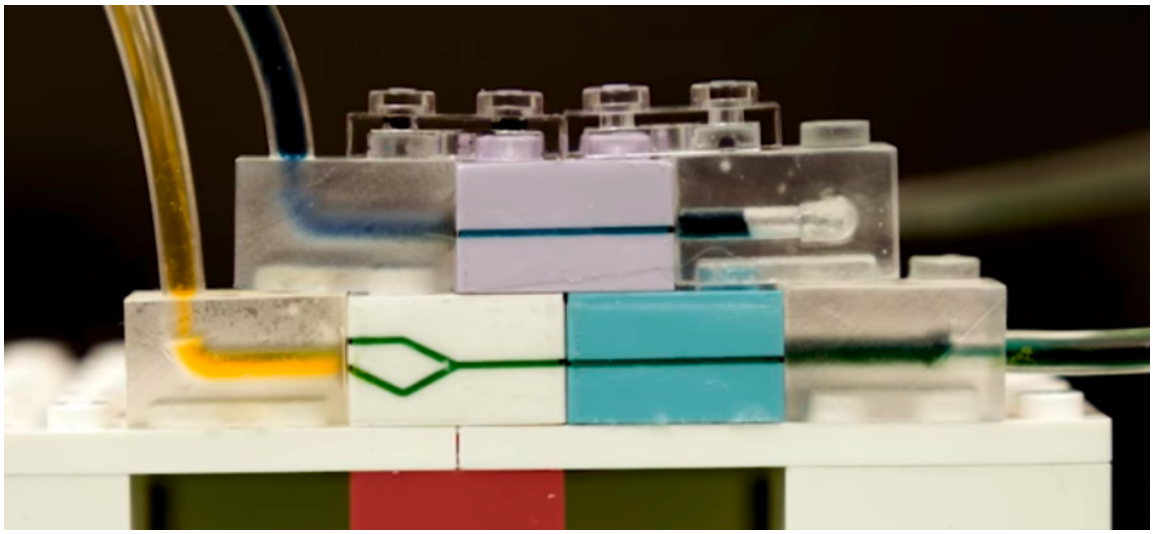
by Andrew Mata



Deep-Learning Artificial Intelligent Systems becomes more advanced and prevalent with every coming year, as seen with ChatGPT this year. However, they have also been shown to have a potentially catastrophic weakness against adversarial attacks. While most worry about the moral and ethical dilemmas associated with AI, the real ones present much sooner issues. We will learn how adversarial attacks are crafted, why these systems are so vulnerable to them, and how defenses against them have improved over recent years.

Lego Microfluidics

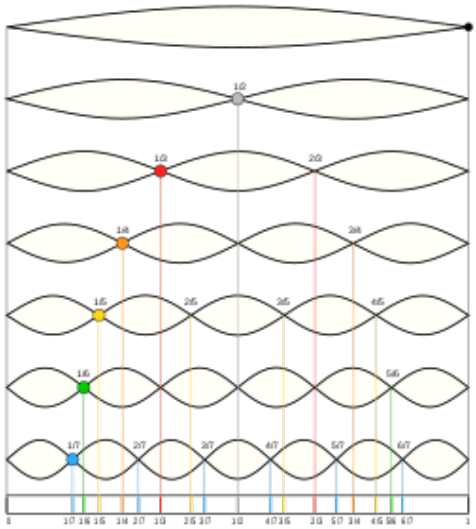
by Nikita Podobedov and David Bershadsky



Microfluidics is a technology where small volumes of liquid are controlled to perform experiments. Some microfluidic devices can take million dollar facilities to manufacture, but at this workshop well be building them with custom Lego pieces. Weve 3D printed Lego bricks for you to create your own device designs.

Music Theory 1Oh1

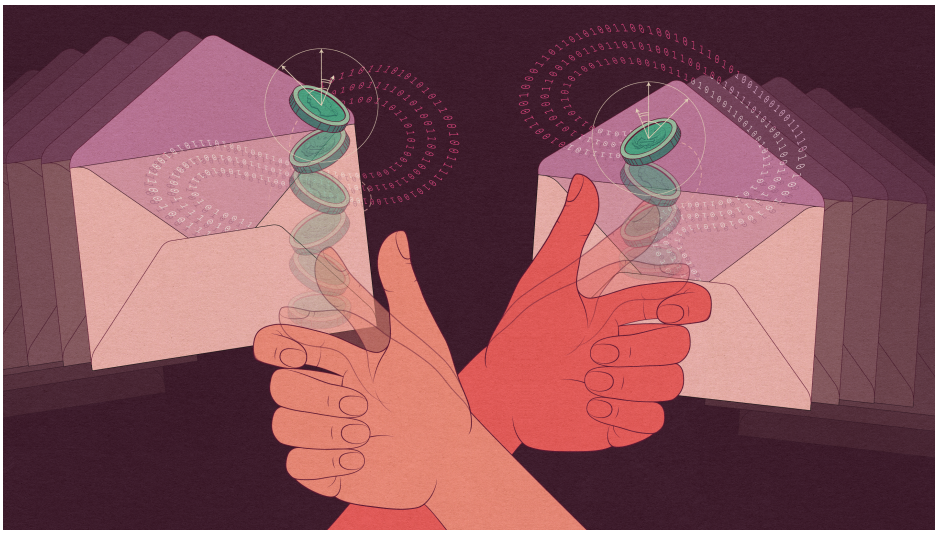
by Juan Gerardo Gutierrez Bravo



What is music?
What's in a song?
Why is Taylor Swift so famous?
These and many more questions will be addressed in the Music Theory 1Oh1 workshop.
By the end of this workshop, you will know:
Mathematics in music, What is a note, what is a key, what is a scale, what is a chord, basic chord progressions, the circle of fifths, and how to write a song! Some guitars and other instruments will be available, but feel free to bring your own. Be prepared to sing and play with your friends!

A First Principles Derivation of Entropy

by Boris Barron



We often hear entropy described as 'randomness', 'disorder', or 'chaos' - anyone else find that confusing? In this workshop, we will derive entropy from first principles, following the path set out by Claude Shannon in his seminal work, 'The Mathematical Theory of Communication'. The derivation will be conducted at the level of advanced high-school math, a process we will go through step-by-step together. However, the implications go much further: from machine learning to physics, data compression to even measures of residential segregation - understanding entropy truly opens up a world of insights.

Depending on the time available, we may then explore some applications of entropy, from maximum entropy distributions to Bayes' theorem, discuss it's monotonicity, and demonstrate the relation of entropy to the ubiquitous maximum-likelihood estimation. Come and explore the concept that has been at the heart of my PhD.

Legal Guidelines for Covert Surveillance Operations in the Private Sector

by Sophie Strey

One afternoon, you may be taking a gander through the U.S. Department of Justices Office Training Programs Website when you find a 200 page guidebook on Convert Surveillance Operations. It just so happens that determining what private agents can legally do, in terms of surveillance, is very difficult There are many ways in which public sector laws regarding surveillance are a good guide for private sector operations, but this is not necessarily the case and many legal technicalities and loopholes are scattered throughout statutes dictated by various state legislatures and court decisions. In this workshops, we will be reading through some of these rulings and looking at the legal consideration of this topic. You will be presented with several scenarios and charged with determining the legality of the case.

Welding

by Sophie Strey

Welcome to welding! This will be by no means comprehensive but it will at least give you ability to, if handed a welding helmet, grinder, wire brush, and a pair of pliers, create a slightly uneven fabrication of joint metals using heat, which is, after all, the goal. There are many different types of welding and which type you choose to use will depend on the types of metals you would like to fuse together. We will be learning Stick or Arc Welding, short for Shielded Metal Arc Welding, which uses rod electrodes. In principle, almost all materials can be we welded in this way. It is therefore the process used mainly in metal trade and industry (e.g. pipeline construction).

Balancing Act

by Sofiya Filippova

Have you ever wondered how balancing eagles and other similar toys work? In this workshop, we will talk about the simple and genius design of balancing toys and create some of our own!

Mastering Table Tennis: Fundamentals Workshop with a Pro

by Maximilian Strey

Join us for an exciting Table Tennis Fundamentals Workshop led by a former professional player (Helmut Strey) and myself (former sigma table tennis champion). Learn essential skills such as serves, forehand, and backhand strokes through interactive exercises and personalized coaching. Gain a solid foundation in table tennis and leave inspired to take your game to the next level.

Build your own kinetic sculpture!

by Alexander Suponya

Learn about kinetic sculptor Reuben Margolin and recreate one of his 'wave' sculptures. You WILL take your sculpture home!

What is Computer-Aided Drug Design?

by Alexander Suponya

For centuries, chemists were bound by their acumen and their slowly evolving instruments. Nowadays, we stand at the precipice of an era where high-power computing and machine learning are causing a seismic shift in all walks of life - including drug design. Together, with cutting-edge ingenuity and technological prowess, we will unlock limitless possibilities and assume our roles as actors in a relentless march of progress. Join us on a journey to unveil some of nature's own therapeutic secrets and become the architects of salvation.

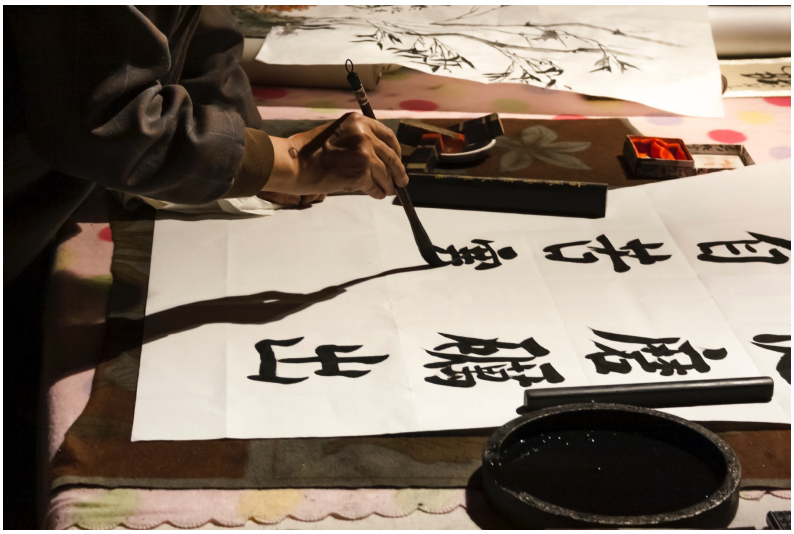
How do online games deal with lag?

by Anatoly Zavyalov

How do most online games feel so smooth and responsive, and why do some feel so laggy? And why do I sometimes miss my headshots, even though my aim is perfect? We'll explore the techniques that online games use to prevent cheating and hide the effects of latency and lag, showcase their strengths and drawbacks, along with an interactive demo!

Intro to Chinese

by Ivan Lvovsky



At this workshop, you will be introduced to the Chinese language, learn about Chinese culture, and do calligraphy. Campers will learn about the basic structure of the language, a few words, and more. Come learn, relax, and drink some tea with us!

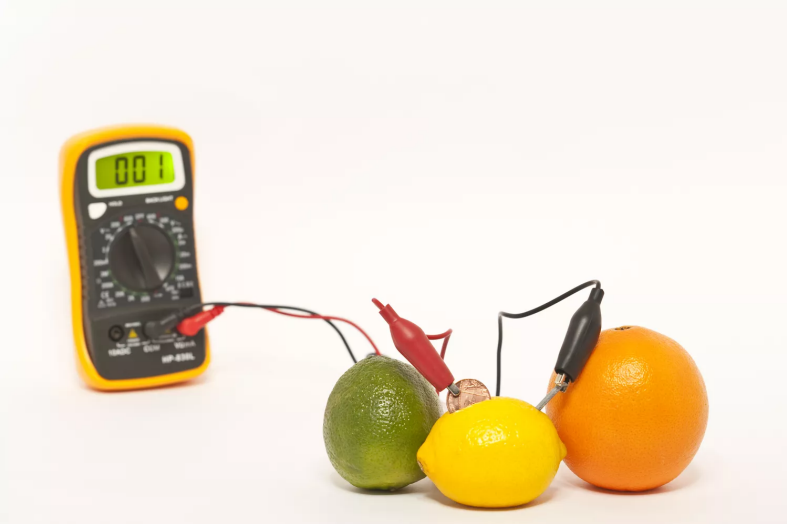
Meditation and Relaxation

by Ivan Lvovsky

Breathe. Relax. Flow. In the midst of all the semilabs and lectures and tournaments, this workshop gives you time to calm your mind. We will focus on our breathing, and we will stretch and move to loosen our bodies.

Fruit batteries are back!

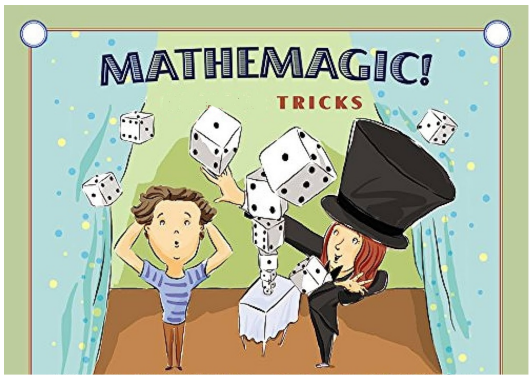
by Arina Nikitina



When life gives you lemons - you make electricity! Find out how batteries work and which will make a better battery - a potato or an orange?

Making Props for Mathemagical tricks

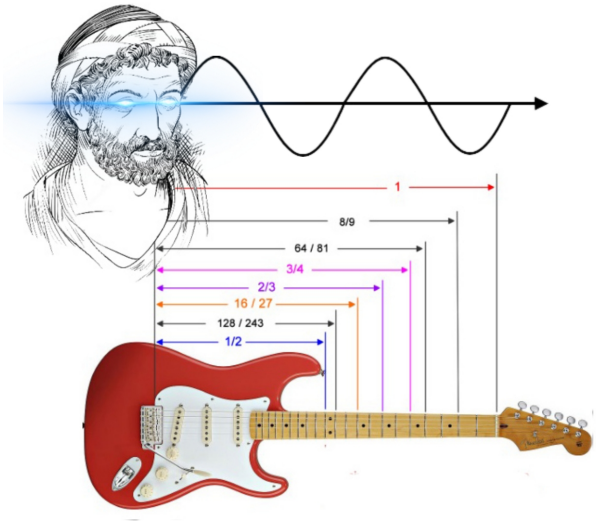
by Sofya Raskhodnikova



Watch magical tricks based on math, try to guess the principle, and then make your own props so that you can amuse your teams and friends at home.

Build and tune your own musical instrument!

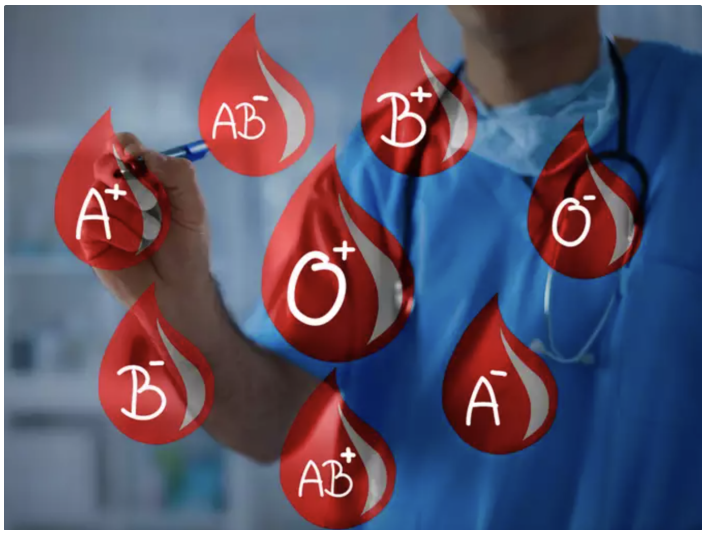
by Ethan Abelev



Music is magical, beautiful, and often inexplicable. In this workshop, we will combine theory and practice to explore the physics behind sound, how math makes harmonies in music, and the design principles behind various musical instruments. We will create our very own panflutes out of household materials and tune them to create clear, accurate, and "professional-sounding" instruments. Finally, we'll take some time to practice our homemade instruments and make some music!

What your blood type says about you?

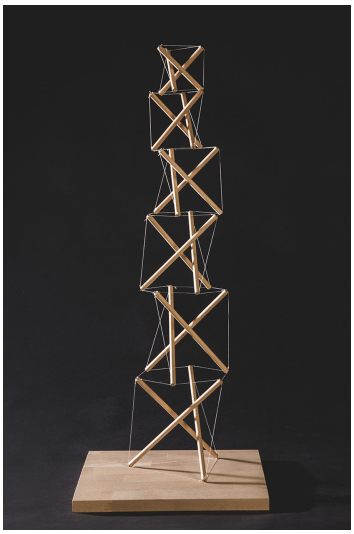
by Lena Yakubovskaya



Your blood type is based on whether or not certain proteins are on your red blood cells and depends on what types your parents passed down to you. When you know your blood type, you can safely give blood or get blood from someone else. It is also important to see if your red blood cells have something called Rh factor on the outside of them. You need a sample of your blood to find out what your blood type is. And yes, at this workshop, you will take a real sample of your blood, mix it with antibodies against different blood types, and check to see if the blood cells stick together. We will also take a look at your blood under the microscope to see all the components of it.

Tensegrity tower

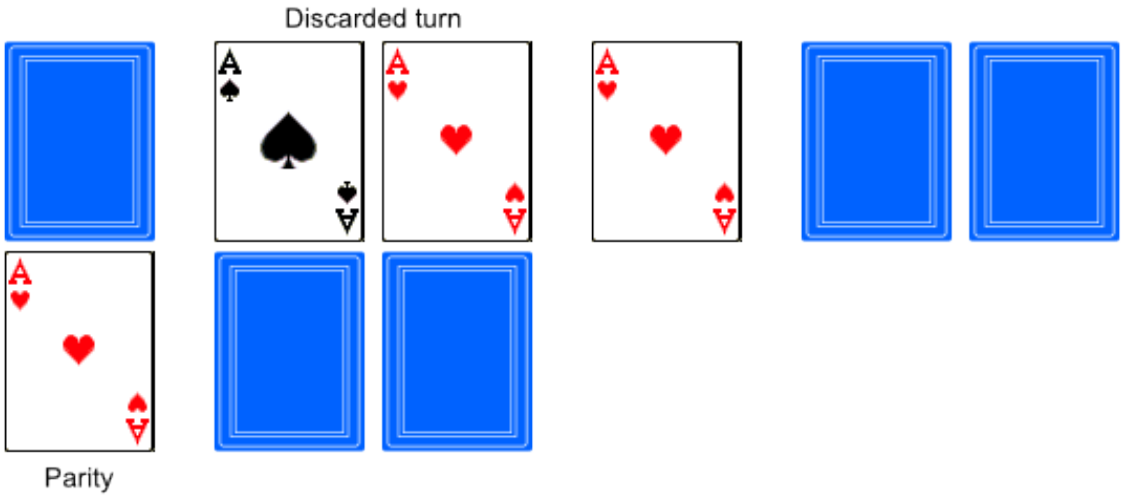
by Mark Lukin



We will build a tower of sticks and ropes so that none of the sticks touch each other. They hang freely, but the tower is stable.

Cryptography with Playing Cards

by Adam Smith



Cryptography doesnt just keep messages secret. It allows mutually distrusting parties to do calculations together while keeping their inputs secret.

For example, two people might be able to figure out if they are interested in dating in such a way that if both are interested, then both find out, but if one of them is not interested then the others level of interest remains secret. Well talk about what this sort of secure computation means and then learnand try outa protocol for it that just uses playing cards. Come and learn how a little bit of secrecy goes a long way.

Predatory plants and you

by Misha Zorya

We have always thought of plants, the decorative green stalks that photosynthesize on our window sills. However, in areas of low nutrients, like bogs and swamps, some plants grow to hunt for their food. In this workshop, we will learn how these plants function and hunt and what impact they can have on our lives.

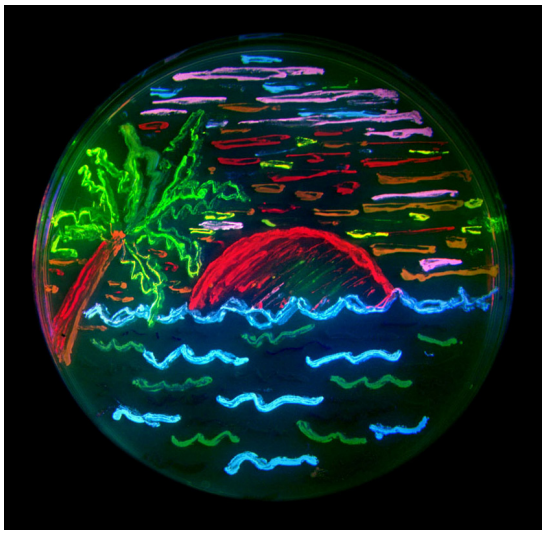
Strings: When Math and Art Meet

by Alina Aminova

String art is an art made of thread or yarn strung between points - hammered nails. At first sight, it is just a beautiful and intricate geometric pattern. But if you look at it deeper you will see one of the main ideas in calculus: the use of straight lines to represent curves. So any curve can be made with a set of its tangent lines. In this workshop, you will learn how to do string art and discover how it is connected with caustics, microphones, and car automatic transmission.

BioArt: paint your own bacterial canvas!

by Alexander Suponya

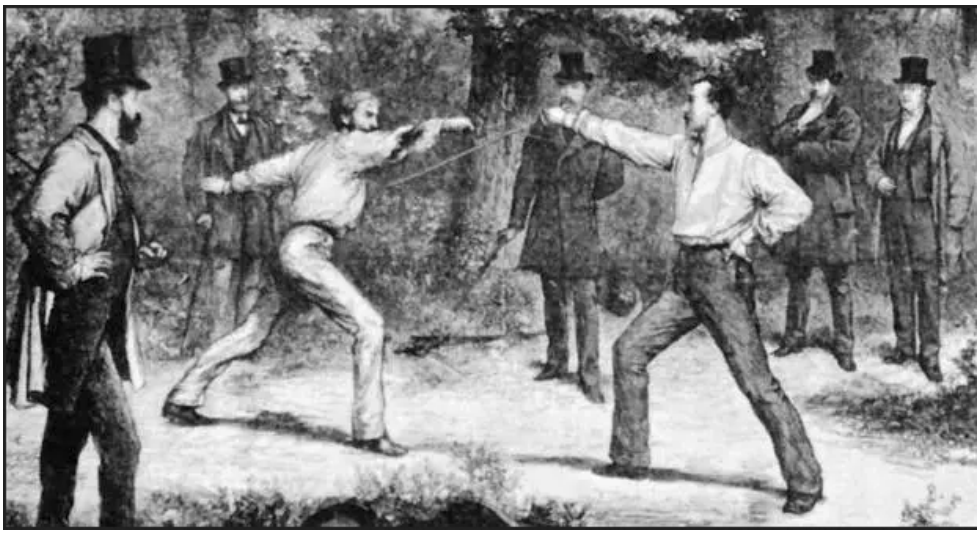


Alexander Fleming, the pioneer who revolutionized medicine with his discovery of penicillin, was also famous for teaching his patients about the mesmerizing world of microbial pigments and delving into the world of bacterial painting. Together, we will delve into this enchanting art medium for ourselves. Step into the enthralling world where art and science interplay on your very own agar canvas!

Note: You can keep your creation BUT results may not appear until 24-48 hours after the workshop!

Math: A Tale of no Letters

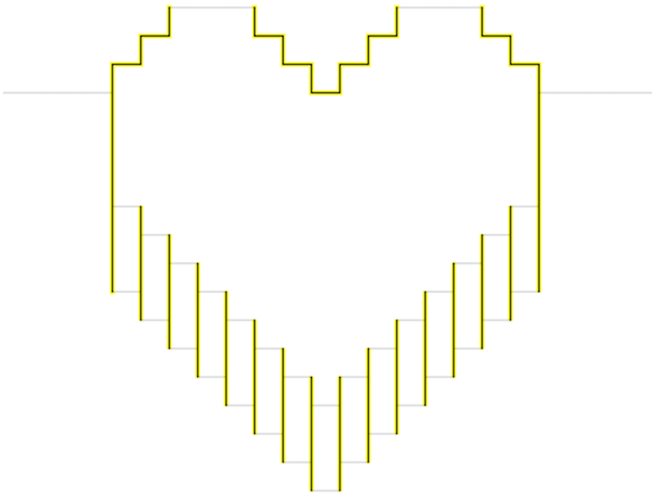
by Boyan Litchev



If you've ever been in an algebra class, you're probably used to seeing symbols like "x" and being forced to solve for them. Yet, this notation – and the formulas that go with it – are surprisingly modern, having only been invented a few centuries ago. In this workshop, we will explore what "math" was before the letters we know today, and will discuss how algebra was developed despite a lack of notation. At the end, we will engage in a series of duels between mathematicians for the greatest prize of all: chocolate.

Pop-up Cards

by Maya Smith



On a budget but want to make a personalized gift for your friends, family, or Sigma counselor? Fear not ... pop-up cards are here to save you. Combine your art, engineering, and scissor skills to make cards using a variety of techniques.

Film Development

by Tim Pinkhassik and Tarika Mane

Before the digital age, photography was a chemical process. In this workshop, we will develop the film from the Film Photography workshop. We will also discuss the chemistry behind film development.

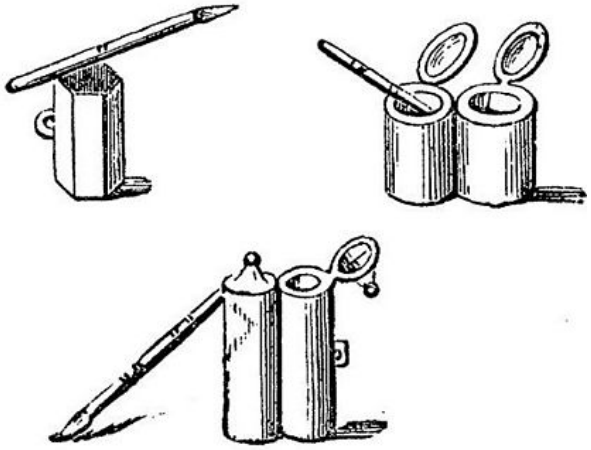
Film Photography

by Tim Pinkhassik and Tarika Mane

Before the digital age, photography was a chemical process. In this workshop, we will learn how to get properly exposed photos on film. We will also discuss the chemistry behind film photography.

Ancient Ink

by Tim Pinkhassik

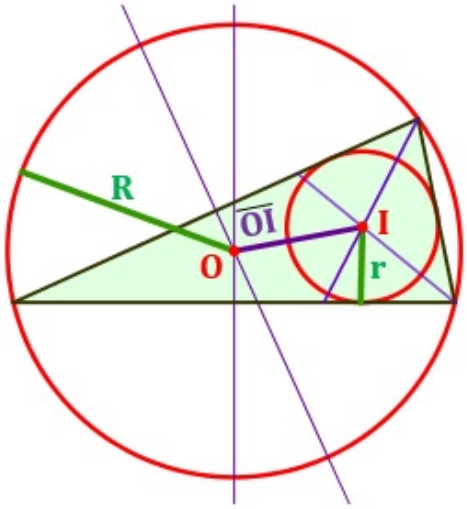


Inkstands from Pompeii.

From antiquity to the mid-20th century, the most common ink was made according to the same basic recipe. In this workshop, we will recreate this recipe to create some of our own ink (you will get to keep it) and discuss the chemical rationale behind this formulas global persistence for over one thousand years.

Triangle Centers

by Maya Smith



Where is the center of a triangle? I hope you know, because I don't. In this workshop, we will discuss the wide variety of points people have defined as the center of a triangle. Incenter, centroid, circumcenter, orthocenter, ... the list goes on. There is even a whole Encyclopedia of Triangle Centers. In the last 10 minutes of this workshop, we will be having a discussion about where the
emphreal center of a triangle is, so come ready to debate. Note: No knowledge of geometry required, although you do have to know what a triangle is.

Paper Lanterns Folded From Origami Tessellation Pattern

by Alina Aminova

The Schwarz lantern is named after German mathematicianHermann Schwarz. It can be folded from a flat piece of paper using the Yoshimura crease pattern - tessellation of the plane by triangles of the same shape. In this workshop, you will learn how to fold these paper lanterns with a nice geometrical surface design and flameless LED candles; and discover how it is connected with Renaissance paintings of the 15th-16th centuries, including the Mona Lisa.

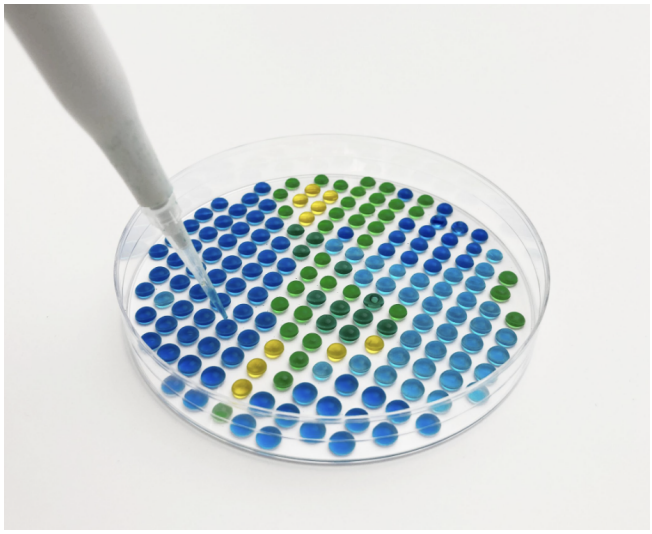
Best ever chocolate chip cookies

by Eugene Pinkhassik

In this day and age, everyone should know how to bake something. In this workshop, we will learn the basics of a simple recipe that consistently produces delicious cookies. No prior baking experience is needed. This recipe can be used as a foundation for making classical favorites, such as white chocolate macadamia or peanut butter cookies, or for designing a unique yummy creation of your own.

Artistic Precision: Mastering Micropipetting Through Creative Expression

by Natasha Butkevich



In this hands-on workshop, you'll learn about the inner workings of a micropipette, a precision instrument used in scientific research, and discover how it accurately measures and transfers tiny amounts of liquid. You will gain practical skills in micropipetting while creating a unique artwork of your own design.

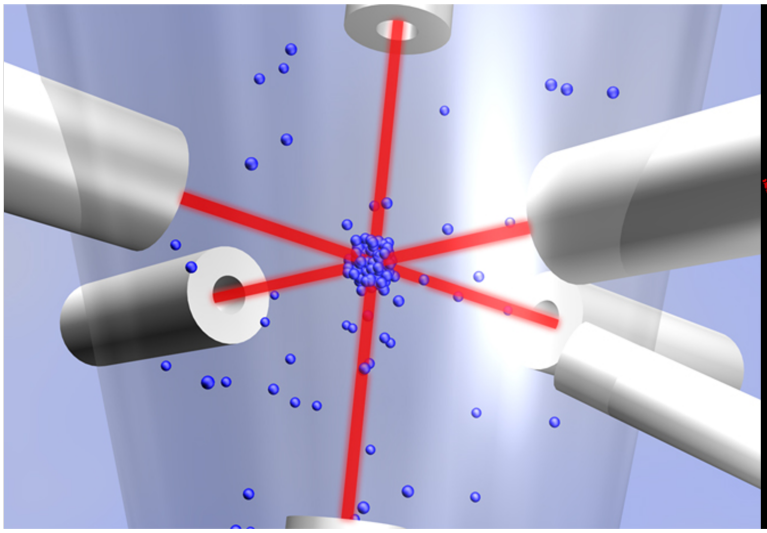
Andy Murray and the Big 4

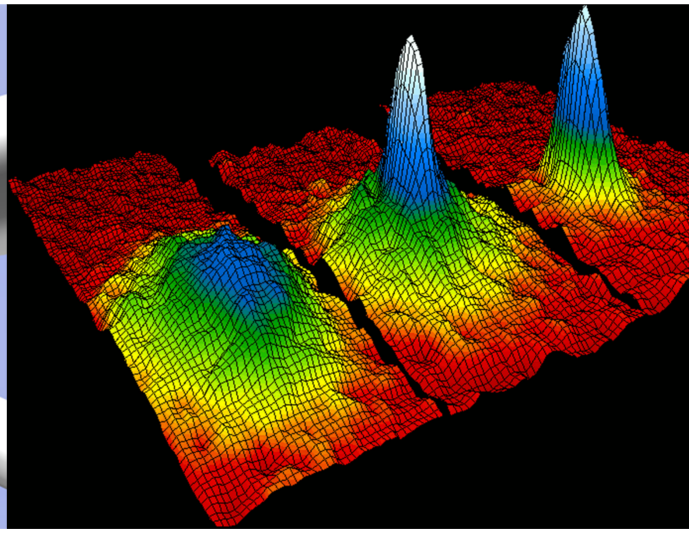
by Alex Frenkel

A certain counselor, who will not be named, has wildly incorrect opinions about tennis and Andy Murray's place in the echelon of tennis legends. I prove them wrong with cold hard math, and along the way provide a historical introduction as to why the term 'Big 4' came to be.

Toward the Extreme Coldness: Laser Cooling and Bose-Einstein Condensates

by Michelle Wu

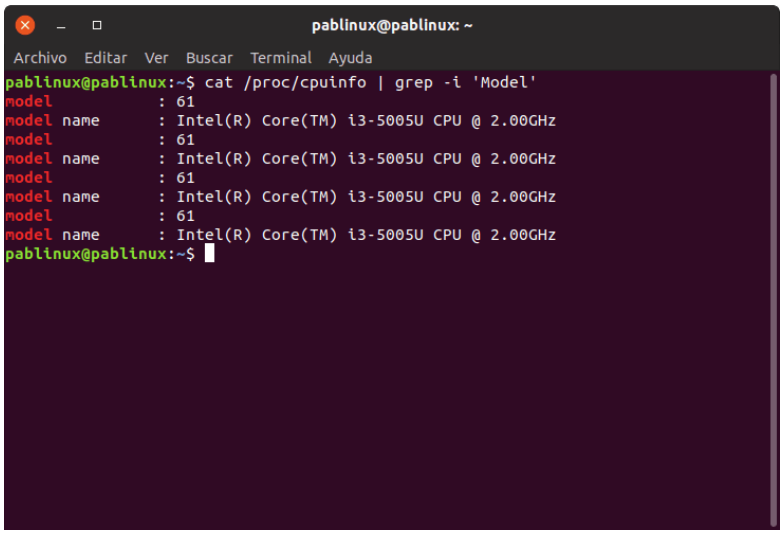




Have you ever thought about how matter behaves near the absolute zero temperature? In this workshop, we will talk about the coldest matter in the universe the Bose-Einstein Condensates and the technique required to control, trap, and cool atoms down to this state. As part of our demonstration, we will have fun with balloons and liquid nitrogen.

grep: finding the lines you need

by Stan Mach



Grep is a software tool found in most Linux/MacOS terminals that allows you to search a file for lines matching a given pattern. As simple as it may sound, grep is an extremely useful general-purpose utility.

In this workshop we present its features through a series of hands-on exercises.

SQL: the database query language

by Stan Mach

```
dvdrental=# select title, release_year, length, replacement_cost from film
dvdrental-#   where length > 120 and replacement_cost > 29.50
dvdrental-#   order by title desc;
          title          | release_year | length | replacement_cost
-------------------------+--------------+--------+------------------
 West Lion               |         2006 |    159 |            29.99
 Virgin Daisy            |         2006 |    179 |            29.99
 Uncut Suicides          |         2006 |    172 |            29.99
 Tracy Cider             |         2006 |    142 |            29.99
 Song Hedwig             |         2006 |    165 |            29.99
 Slacker Liaisons        |         2006 |    179 |            29.99
 Sassy Packer            |         2006 |    154 |            29.99
 River Outlaw            |         2006 |    149 |            29.99
 Right Cranes            |         2006 |    153 |            29.99
 Quest Mussolini         |         2006 |    177 |            29.99
 Poseidon Forever        |         2006 |    159 |            29.99
 Loathing Legally        |         2006 |    140 |            29.99
 Lawless Vision          |         2006 |    181 |            29.99
 Jingle Sagebrush        |         2006 |    124 |            29.99
 Jericho Mulan           |         2006 |    171 |            29.99
 Japanese Run            |         2006 |    135 |            29.99
 Gilmore Boiled          |         2006 |    163 |            29.99
 Floats Garden           |         2006 |    145 |            29.99
 Fantasia Park           |         2006 |    131 |            29.99
 Extraordinary Conquerer |         2006 |    122 |            29.99
 Everyone Craft          |         2006 |    163 |            29.99
 Dirty Ace               |         2006 |    147 |            29.99
 Clyde Theory            |         2006 |    139 |            29.99
 Clockwork Paradise      |         2006 |    143 |            29.99
 Ballroom Mockingbird    |         2006 |    173 |            29.99
(25 rows)
```

So, you have just finished your latest physics experiment with Lesha and Igor, and you now have two pages of neatly (or perhaps not so neatly) written measurements.

Now, how do you store them for later use?

While for many small experiments, a simple spreadsheet might do nicely – in more complex cases (many researchers/experiments/years) it might be better to keep the records in a so-called database.

In this workshop, we will introduce the database query language SQL through a series of try-it-yourself exercises.

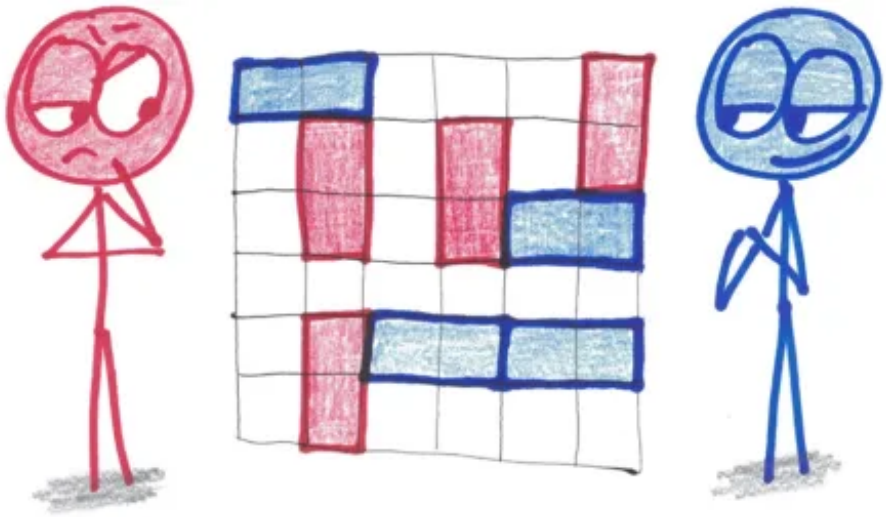
SET competition! And the math behind the game

by Iris Brook

Come compete in the SigmaCamp SET championship! SET is an addictive card game based on pattern recognition and fast reflexes. Though it wasnt designed to be a mathematical game, SET touches on geometry, group theory, and representation theory, as we play the game we will discuss the math behind it.

Paper and Pen Games

by Nikita Korobkov



Tired of always ending in a draw during tic-tac-toe and seeking thrilling alternatives to battleship? Look no further! Join the workshop where you'll discover a collection of exhilarating paper and pen games that will have you engaged in intense battles of wits with your opponents.

During this workshop, we will explore 3-4 captivating games that require nothing more than paper and pen, yet deliver deep and exciting gameplay experiences. Say goodbye to boredom and embrace the challenge as you dive into these captivating worlds!

If time permits, we will put your skills to the test in a short tournament featuring one of the games we've learned.

Chemical Glassware

by Alec Douglas and Gleb Aminov

In many films, you can frequently see various glass setups with some (usually coloured) liquids inside, but it is totally unclear what those apparatus are needed for, and how they work. During this workshop, we will play with some of them, discuss how they work.

Control Someone Else's Arm!

by Anna Bloch

The nervous system uses electrical signals to communicate with the rest of the body. What if those signals could be translated to somebody else? In this workshop, we will go over how nerves and muscles work, and then see it in action using a microcontroller to send electrical signals from one person's arm to another's and cause their hand to move involuntarily!

How to do an oil change (and why we do it).

by Ivanka Tkachenko

Have you ever wondered why we need oil changes? In this workshop, you will learn about proper jack points, safety procedures, and how to do an oil change from start to finish. We will be explaining the basic components of an engine, and why oil changes are so important.

Imagining the Future with AI

by Betsy Barton

Discussions in the business world are full of hype about AI. What might it be able to do soon? We will critically examine some new products and uses of AI in business. After hearing a bit about realistic (!!) projections for what AI might do, we will brainstorm about putting these things together and imagining a changed world. Let's put on our business hats and answer questions like, "What would you do if you had to start a company that used AI right now?" and "What company would you avoid starting now because AI will do it all better very soon?"

Permutations, Rubik's Cube, and the Enigma Machine

by Robert Beals

What are permutations, and what do they have to do with anything?

We'll start with some examples and see some of their basic properties. Then we'll see how these properties relate to the Rubik's cube. When solving the cube, it gets harder and harder to make progress. We'll see how properties of permutations allow us to invent sequences of moves which only affect the cube in a small number of positions, which is exactly what you need to finish the job of solving it. These techniques apply to lots of similar puzzles.

Then we'll see how these same properties of permutations led to weaknesses in the Enigma cipher, and how these weaknesses were exploited by allied cryptanalysts.

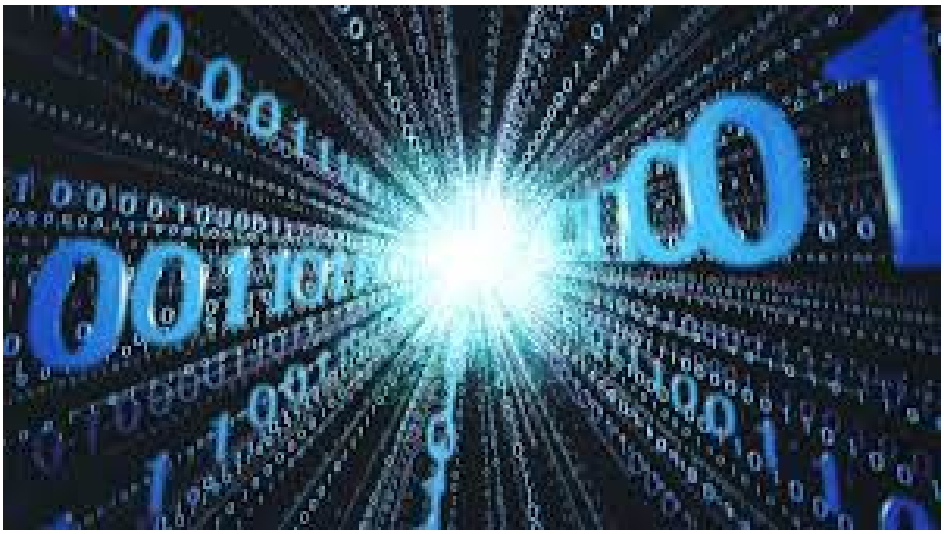
Cyanotype Printing: create your own print or tote bag!

by Iris Brook and Anat Dubinsky

A cyanotype is the precursor to modern photography discovered in 1842 by Sir John Hershel. Come learn more about this incredible art form and the science behind it while creating your own tote bag or print!

Discover Quantum Cryptography

by Julia Kempe



You have probably heard that quantum cryptography is unconditionally secure and uses quantum states at their core. Come to this workshop to get a hands-on demonstration of quantum key distribution to understand the difference between classical and quantum states and how they help share a secret key securely. This workshop is a mini piece of the quantum computing semilab, so only suitable for campers that *don't* attend the semilab.

Will it Carbonate

by Lev Bershadsky

In this workshop we will answer the age old question will it carbonate. We will take some common liquids such as water, milk, watermelons, smoothie and beans and try to carbonate them. We will also go over the science of carbonation and its various health effects.

Bang! How and why to use a nail gun.

by Alexander Brook

After discussing pneumatic tools in general, and familiarizing ourselves with a brad nailer, we will use it to shoot as many nails as we can.

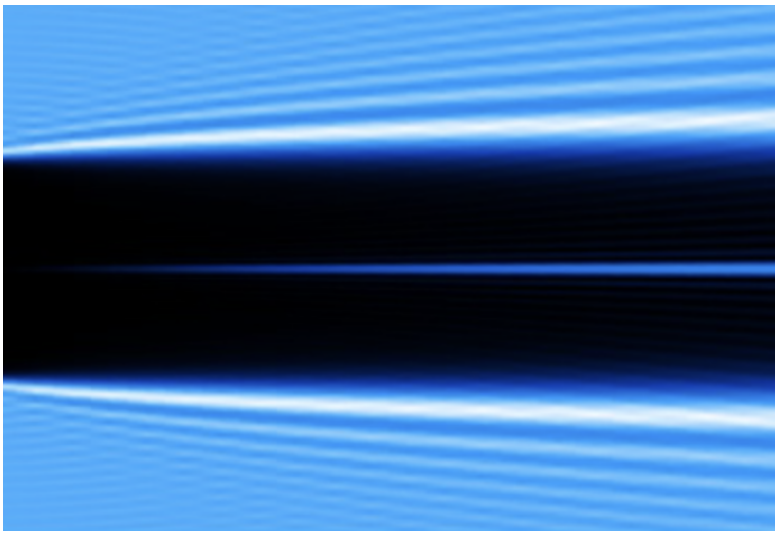
Diagnose your fruit: perform a biopsy!

by Olga R Brook

How can we know what is inside the body without making an incision? Learn how to do a biopsy (taking a sample) through a pinhole using a hand-held ultrasound device.

Aragos spot: how a tiny shadow proved Fresnel's wave theory of light

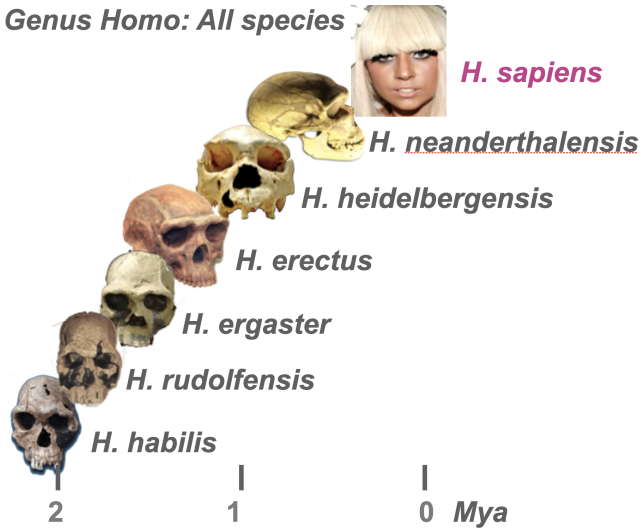
by Daniil Lukin and Melissa Guidry



We will reproduce the experiment conducted in the French Academy of Sciences in 1818 by Dominique-Jean-Francois Arago that settled a heated debate about the wave nature of light. When Augustin-Jean Fresnel submitted his wave theory of light to an academic competition, Simeon Poisson claimed it was nonsense: "If Fresnel hypothesis was true, then in the middle of a shadow cast by a circular object, there would be a ——-!" We will observe the surprising and elusive phenomena and appreciate the simple but effective theory for diffractive optics.

How did human brains outpace all other brains?

by Richard Granger



a) Whats in a human brain, and how did it get there? b) What can human brains do differently than other brains? c) Were our big brains selected for? d) How come we can use language and reasoning, while other animals cannot? Answers: a) The same things, almost exactly, as in other mammals, such as a mouse. b) There are no important differences that we can detect. c) Nope. d) The answers are surprising, and there is a lot of disagreement among experts.

Exploring and Creating Ecosystems

by Natalia Ulbin

In "Exploring and Creating Ecosystems", we will create our own mini ecosystems using soil, plants, rocks, and items we find around Sigma! We will learn about the concept of ecosystems and the interdependence of organisms within them, along with natural cycles that occur. Lastly, we will take away the importance of maintaining a balance in nature and the impacts of disrupting that balance.

How to Overtake an F1 Car

by Joel Brook

The best racing drivers in the world are able to utilize the science in cars to beat their opponents. In this workshop, I'll take you through how this science works and analyze some real overtakes

Personal Financial Management with Jelly Beans!

by Tina Lin

Finance? And with jelly beans? Sounds like a fun way to learn life-long skills about money management! While money is a powerful tool that can be used to buy almost any good or service you dream of, be careful with it. Squandering money solely on the things you want can lead to poor habits and consequences later down the road! In this workshop, you will learn about important financial terms and concepts, such as types of utilities, insurances, investments, and savings accounts that will play an important role in adulthood. Test your new skills by playing a fun game with your friends to create a budget of jelly beans in order to pay for common monthly expenses. So snack on a few jelly beans, make some important financial decisions, and may the team with the most remaining jelly beans win!

How to calculate the Jones Polynomial of a knot

by Anthony Phillips

The Jones Polynomial, discovered by the late Vaughan Jones in 1984, is a knot invariant that is complicated to derive but easy to calculate. We will work it out it together for the right trefoil knot, and check that it comes out differently for the left trefoil, proving that there is no way to deform one of those knots to the other. Time permitting we will also calculate the Jones Polynomial of the Figure-8 knot.

The Closest We Have Ever Been to a Theory of Everything

by Cavon Hajimiri

In this workshop you will learn about The Standard Model of Particle Physics. You will learn how each of the proven and hypothetical particles affect our universe and about their peculiar traits.

Diving into Brazilian Education: Math Competitions and the Cool New Education Program

by Krerley Oliveira

Come and join us in this fun, quick workshop where we'll take a look at education in Brazil, especially the big math competitions like the Brazilian Public Schools Mathematics Olympiad (OBMEP) and the Brazilian Mathematics Olympiad (OBM).

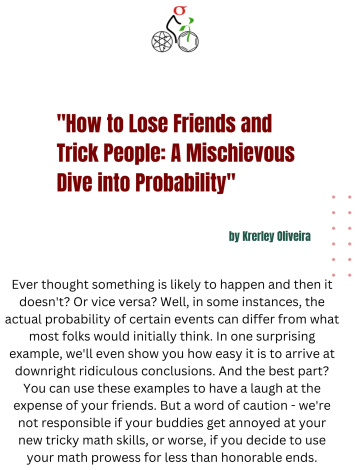
We're going to start by giving you a glimpse of what school in Brazil is like, specifically looking at how math is taught and what challenges it faces. Then, we're going to explore how OBMEP and OBM are getting people across the country excited about math, talk about what these competitions are like, and how they select teams for international math challenges. One or two math problems of each competition will be sampled.

The coolest part? We'll introduce you to the New Supplementary Education (NES), an amazing program for 15-year-olds that spends three years diving into Mathematics, Artificial Intelligence and Data. You'll see how this program fits into the bigger picture of education in Brazil and gets students ready for math competitions like OBMEP and OBM.

To wrap up, we'll chat about how these math competitions can change the way math is taught, make students want to dig deeper into math, and find and help students who are really good at math. This workshop is perfect for high school students and anyone interested in making math education more fun and meaningful.

How to Lose Friends and Trick People: A Mischievous Dive into Probability

by Krerley Oliveira



In this mind-boggling workshop, we're going to present some simple scenarios where probabilities might not be what they seem.

Ever thought something is likely to happen and then it doesn't? Or vice versa? Well, in some instances, the actual probability of certain events can differ from what most folks would initially think. In one surprising example, we'll even show you how easy it is to arrive at downright ridiculous conclusions.

And the best part? You can use these examples to have a laugh at the expense of your friends. But a word of caution - we're not responsible if your buddies get annoyed at your new tricky math skills, or worse, if you decide to use your math prowess for less than honorable ends.

Get ready for an exciting session filled with mathematical twists and turns that will leave you questioning what you thought you knew about probability!

Fiber Analysis in a Crime Scene

by Ada Langford

Join us for an engaging workshop where we delve into the fascinating world of fibers! During this session, we will explore the characteristics and properties of various types of fibers, providing a comprehensive understanding of their importance in forensic investigations. You will learn how to conduct a burn test, a crucial technique for fiber identification, and interpret the results accurately. In the second part of the workshop, we will immerse ourselves in a captivating crime scene scenario. As we unravel the mystery, we will present the suspects and their potential involvement in the crime. By examining the burn tests and microscope pictures, participants will actively engage in analyzing the evidence.

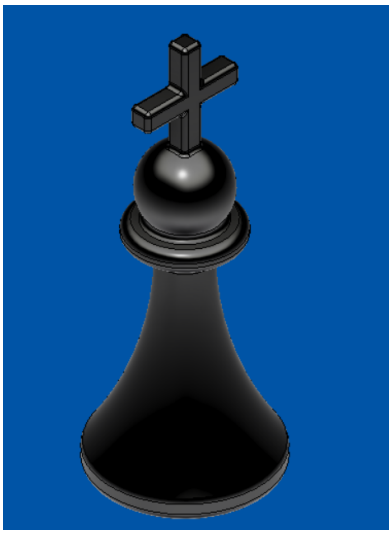
Introduction to Remote Sensing

by Nicholas Smirnov

Embark on an journey into the realm of remote sensing in our workshop. Join us as we explore the world of satellite technology and its applications. While unraveling the secrets of our planet, participants will discover how remote sensing revolutionizes communication, aids in discoveries, and so much more. No prior knowledge is required; all you need is your curiosity and a passion for uncovering the marvels of remote sensing. Come and join us on this thrilling adventure as we uncover the power of satellite-based observations!

CAD Your Way To Victory

by Sasha Portnoy



Design your own custom chess piece on a computer and get it in real life! Here you can learn how designs are made for 3d printers and any other digital manufacturing method, a useful and fun skill in the current day and age. We will be making a custom chess piece from scratch on a computer in CAD, computer aided design, and then you can get it made in person. You will learn every skill you need to design whatever you want in the future, while making something cool now!

What Expands Faster: The Universe or Masha's Kasha?

by Kristina Shterengas and Emily Snyder

In this workshop we will mathematically figure out how quickly Mashas kasha (oatmeal) expands and if it indeed expands quicker than the universe. Afterwards we will test how real kasha expands in comparison to the virtual version, via cooking experiments.

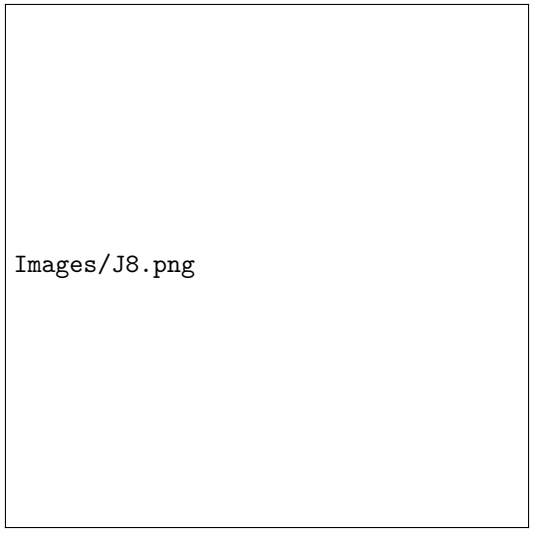
Mystery Bead Bottle

by Nikolai Styrkas

In this workshop I will introduce the concept of intermolecular forces that dominate the world of chemistry. After the mini lecture we will create an experiment to showcase these forces in action with a project that you will get to take home.

Duplicate Chocolate Using the Force of Mathematics!

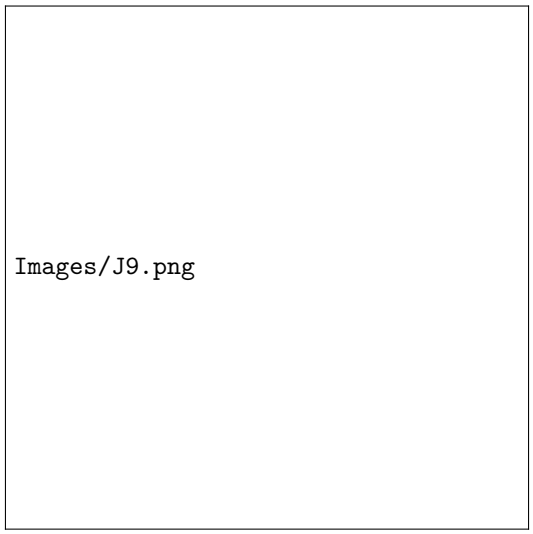
by Sophia Tatar



We will perform two experiments: one with a chocolate bar, and one with an imaginary chocolate sphere. We will take a sphere, cut it up into 6 pieces, and rearrange the pieces using only rotations and sliding to form TWO spheres of the same size as the original. Yes, you read that right. Its not magic. Its the axiom of choice, the most controversial yet fundamental axiom of mathematics. To duplicate our chocolate, we will have to split it into non-measurable pieces (sets of points). Non-measurable sets have no size (not measure 0 or infinity but rather actually no size). Come explore these fascinating consequences of infinity and the axiom of choice to learn how to generate infinite chocolate (at least computationally) and work in a world with non-measurable objects.

Topology, map coloring, and modular origami

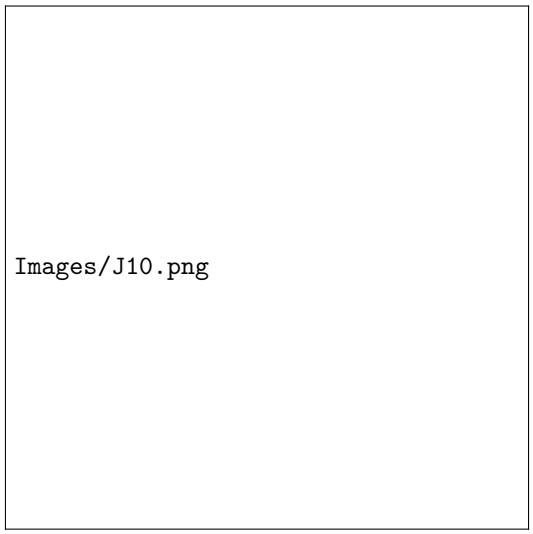
by Noemi Kempe Regev and Belranco



Come and make a three-dimensional mathematical sculpture that demonstrates a theorem that took over 100 years to prove! The Four-Color theorem was first conjectured by South African mathematician Francis Guthrie in 1852. This theorem states that maps on any plane or sphere can be filled in with 4 colors, such that regions sharing a common boundary do not share the same color. However, it was not until 1976 when this theorem was proved by Wolfgang Haken and Kenneth Appel with the assistance of a computer. Why was this theorem so challenging to prove, and why have we not yet discovered an elegant solution? Moreover, what happens to the map-coloring properties of a surface when we change its topology? In this workshop, campers will be introduced to topology, learn about the Four-Color theorem and its milestones, learn about modular origami, and create their own map coloring models for a torus using origami sonobe bases.

An Introduction to Propositional Logic

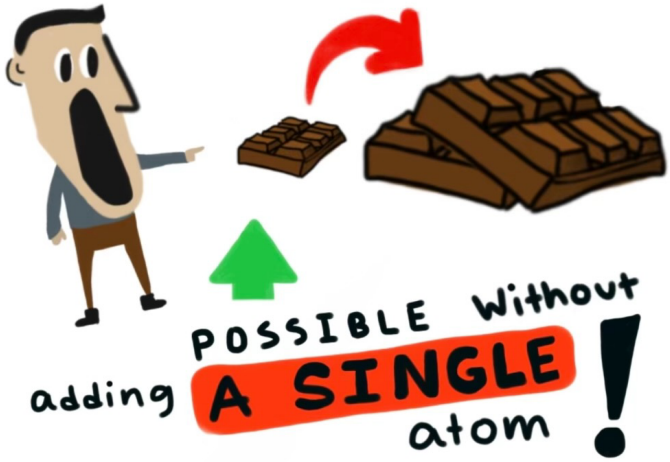
by Arjun Raj



Logic is useful for many things, from making better decisions, to doing better in school, to designing circuits and computer programs. It is an incredibly fascinating subject that often gets overlooked, but in this class, we'll delve into its wonders and show you just how exciting it can be. No prior knowledge is neededlogic is a subject that welcomes all curious minds! Through engaging lectures, interactive discussions, and hands-on problem-solving, you'll grasp the fundamental components of logic, including truth tables, logical operators, and logical validity. You'll even have the chance to tackle challenging logical proofs and witness how ordinary language transforms into a thrilling mathematical puzzle. So, come unlock your mind's superpowers and embark on a journey of intellectual discovery like never before!

So you want to be a professor?

by Olga Troyanskaya



We will have an informal, and hopefully informative, discussion of life as a STEM faculty member. What is it like to be a professor? What does it take to be successful? Why is it fun and why is it hard? Work/life balance and does it exist? And any other questions you might have! I'll draw on my experience as a Computer Science and Genomics professor at Princeton since 2003 and do my best to answer any questions and tell you the good, the bad, and the awesome about life in academia.