Virtual Mathcamp Sneak Peek 2021

All times are Mathcamp Standard Time (MCST) = Pacific Time (GMT -7)

Saturday, May 8: 9:00 am: Mathcampus opens

Enter from your account on appsys.mathcamp.org. (There'll be instructions there on the basic commands you'll need to navigate.) Enjoy exploring!

Saturday, May 8, 9:10 am: Quick Mathcampus orientation (Main Lounge)

If you happen to be on campus, you should come. (Click on the tablet in the Main Lounge to join the Zoom call.) But if you're not around at this time, you should be able to figure everything out on your own. You can always ask questions in #tech-support on Slack if you're having trouble.

Saturday, May 8, 9:30 am: Speed-friending (Nonagon)

Meet your fellow Mathcampers! We'll keep forming and re-forming two-person breakout rooms every few minutes, so you get to chat briefly with lots of different people one-on-one. (If you want to keep talking, you can DM them on Slack afterwards.) You're welcome to come and leave at any point.

Saturday, May 8, 6 pm: Speed-friending again! (Nonagon)

Same as the morning speed-friending event, but probably with some new faces. You can come to one or the other or both.

Saturday and Sunday, May 8–9: Student-organized events?

At Mathcamp itself, every free hour filled with a huge variety of activities, run by both students and staff. Let's see if we can make it happen during Sneak Peek as well! If you're thinking of organizing something, check out the sign in the Main Lounge with suggestions on how to advertise it.

Sunday, May 9, 4 – 6:15 pm: Sneak Peek main event!

4:00 pm: Welcome / info session (Main Lounge)

Among other things, we'll talk about improvements coming to Mathcampus this summer!

4:30 pm: Mini-classes (please arrive on time!)

All classes will be in the classroom building. See pages 2 – 3 for detailed descriptions.

- **How to Juggle** (Ben, 🌶, Classroom Arch)
- **Tait's conjecture, or How a 19th Century Scottish Physicist Tried to Color Maps** (Misha, 🌶– 🌶🌶, Classroom Douglas)
- **How Gauss discovered the normal distribution** (Mira, 🌶🌶– 🌶🌶🌶, Classroom Oxbow)
- **Solving cubic equations using origami** (Eric, 🌶🌶🌶, Classroom Mint)
- **Infinite Ramsey's Theorem** (Mia, 🌶🌶🌶, Classroom Union)

5:10 pm: Mini-Activities (please arrive on time!

All activities will be in the dorm building. See page 4 for detailed descriptions.

- **Fictionary** (Ben & Phoebe, with a brief guest appearance by GPT-2; Arcade by the Games Lounge)
- ***Romeo and/or Juliet*: a chooseable-path adventure** (Eric, Library)
- **Team trivia** (Mia & Kalina, Front Lawn)
- **Let's solve some Bongard problems!** (Samantha, Academics Lounge)
- **The public goods game: a classic experiment** (Mira & Natali, Games Lounge)

6:00 pm: Q & A (Main Lounge)

You bring the Q, we'll provide the A.

Sunday, May 9, 9:00 pm: Mathcampus closes

We hope to see many of you again when it reopens this summer!

Math classes at Sneak Peek 2021

All classes will take place in the classroom building and will start promptly at 4:30 pm MCST. Please arrive on time!

When choosing a class, we suggest you pay attention to:

- ***Chili peppers (🌶).*** *The "spiciness" of a Mathcamp class can range from 🌶 to 🌶🌶🌶🌶. It tells you, roughly, how difficult a class is and how fast it will go. Important note: spicy classes are not more, or less, interesting than mild classes! We suggest choosing based on topic and on how much of a challenge you're up for at the moment.*
- ***Prerequisites.*** *These tell you what mathematical background you need in order to understand the class. Prerequisites are, in general, uncorrelated with chili peppers: you can have a very spicy class with no prerequisites or a very mild class that happens to require some knowledge of calculus.*

For more information on chilis and prerequisites, see https://www.mathcamp.org/math/how_it_works/.

Class descriptions

How to Juggle (Ben, 🌶, Classroom Arch)

Come learn about juggling sequences, which have been described as "a mathematical model for juggling that revolutionized the juggling world!" We'll talk about what these sequences are, how to tell if a sequence is juggleable, and maybe even how to use one juggleable sequence to generate more.

Here's one juggling pattern: . If you put in other sequences of natural numbers, sometimes you will see lovely animations of a stick figure juggling, and sometimes you will see "invalid siteswap." What makes a "siteswap" invalid? What is a "siteswap" anyways? Come and find out!

If time permits, Ben will demonstrate a bit of juggling, and a lot of dropping things while trying to juggle them.

Prerequisites: None.

Tait's conjecture, or How a 19th Century Scottish Physicist Tried to Color Maps (Misha, 🌶-🌶🌶, Classroom Douglas)

There is a theorem that the regions on any map can be colored with four colors without using the same color on adjacent regions. It had to be proven in 1976 by computer, because it was too hard for humans. Appel and Haken's computer proof might be cool... but some of the failed ideas people had along the way were even cooler.

In 1884, Peter Tait had an idea for how to color maps, but he couldn't prove that you can always make it work. It's not just an abstract idea: we'll see how to use it to color a map of the United States! It wasn't until 1946 that a map was found that Tait's method couldn't color.

Prerequisites: This class will not assume any formal knowledge of graph theory. If you have seen graphs before, some of the concepts we work with in this class will be familiar (but the things we do with them will be new!) I'd think of this as a 🌶 class if you're comfortable with graph theory and a 🌶🌶 class if it is new to you.

How Gauss discovered the Gaussian (or normal) distribution (Mira, 🌶🌶🌶, Classroom Bow)

In 1801, astronomer Giuseppe Piazzi observed a new celestial object between Mars and Jupiter, which he called Ceres. Piazzi was able to make 24 more observations of Ceres over the next month, before it disappeared into the sun's glare. The European scientific community was aghast: did Piazzi just discover a potential new planet[1] and immediately lose it again? When and

[1] Ceres is now classified as a dwarf planet. The solar system contains many dwarf planets (e.g. Pluto), but Ceres is the only one within the orbit of Neptune.

where will Ceres appear next? Many prominent astronomers tried to figure this out, based on Piazzi's limited data. Then a cheeky 24-year-old named Carl Gauss published a prediction that was completely different from everyone else's. You can probably guess how this story ends: Gauss was right and everyone else was wrong.

To make his prediction, Gauss had to develop several new methods in both math and physics. One of these was the celebrated normal distribution ("the bell curve"). Gauss derived it from a simple empirical observation that scientists had known about for centuries without ever realizing its significance. You know it too, and I bet you have no idea how important it is! Come and find out.

Prerequisites: You need to be totally comfortable with derivatives and should be at least vaguely familiar with integrals. This class is 🌶🌶 if you've seen continuous random variables before (e.g. in AP Stats), 🌶🌶🌶 if not.

Solving cubic equations using origami (Eric, 🌶🌶🌶, Classroom Mint)

You likely know how to find the roots of any quadratic equation using the quadratic formula. There is also a cubic formula for solving cubic equations, but it's a huge mess. Fortunately there's an easier[2] way to solve cubic equations using nothing other than a piece of paper! I'll present a simple method for using origami to compute[3] the roots of any cubic equation. Secretly, this method relies on some ideas from the algebraic geometry of plane curves, so after presenting the method we'll dive into why it works and what lines at infinity, dual curves, and Bézout's theorem have to do with it.

Prerequisites: I'll try to keep things self-contained, but having seen a definition of the projective plane before will increase your comfort level. (Wikipedia-level knowledge is fine.) The content of this Sneak Peek class is a subset of the content of my VMC20 class "solving equations with origami".

Infinite Ramsey's Theorem (Mia, 🌶🌶🌶, Classroom Union)

Perhaps you, like me, like graph theory. Perhaps you, like me, like coloring. Perhaps you, like me, *really* like infinity. We are going to see what happens when we throw these three things together.

The classical version of Ramsey's Theorem states that given any number r, one can always find a set of r vertices such that every edge between them is the same color, for *any* coloring of a sufficiently large complete graph. A rather remarkable result! However, we'll take this theorem two steps further and ask: What happens when we have infinitely many vertices? What happens when we generalize our notion of an edge? Come to this class and find out!

Prerequisites: Familiarity with graphs is helpful but not required.

[2] for some definition of easy
[3] for some definition of compute

Activities at Sneak Peek 2021

All activities will take place in the dorm building and will start promptly at 5:10 pm MCST. Please arrive on time!

Fictionary (Ben & Phoebe, with a brief guest appearance by GPT-2; Arcade by the Games Lounge)

Have you ever read a new word and come up with a wonderful guess about its meaning, only to discover that it actually meant something completely different? Fictionary gives you the chance to convince people that no, actually, your definition is the right one. We'll give you a strange and obscure word, then your teams will have a few minutes to cook up a fake definition for it. All the definitions (fake and real) will be put to a vote. Your goal is to guess the right one – and to fool everyone else into guessing yours!

***Romeo and/or Juliet*: a chooseable-path adventure (Eric, Library)**

We'll play the book *Romeo and/or Juliet* by Ryan North. Yes, you read that right: we're going to play a book about a play! This is a chooseable-path adventure[4], where the reader gets to make choices for the characters in the story, score points, unlock new characters[5], and explore the more than 46 quadrillion possible storylines[6]. This event will be very low-key socially; if you want to just relax, listen to a crazy story, and occasionally vote by Zoom chat, that's totally an option. But there will also be space for people to debate which choices we'd like to make.

Team trivia (Mia & Kalina, Front Lawn)

Answer obscure questions! Dredge up arcane knowledge! Hang out with new people! Trivia has it all.

(Teams will be formed at the beginning of the session, so it is particularly important to arrive on time! The questions will be different from last year's Sneak Peek.)

Let's solve some Bongard problems! (Samantha, Academics Lounge)

A Bongard problem consists of various diagrams (usually diagrams of mathematical objects), which are sorted into two piles based on some "rule". For example, maybe Pile #1 contains diagrams whose largest shape is a circle, whereas Pile #2 contains all other diagrams. To solve a Bongard problem, you need to figure out the rule for sorting. If you like visual puzzles, come join me and let's solve some Bongard problems together!

The public goods game: a classic experiment (Mira & Natali, Games Lounge)

Four players (or, in our case, four teams of players) receive $20 (or, in our case, "$20") each. Each team is given the option of contributing some portion of their money to a common project. The total amount contributed to the project is multiplied by 2, then split equally between the four teams. The more everyone contributes, the more money gets doubled, so it's in everyone's interest to contribute $20, right? Unfortunately, that's usually not what happens, and you can probably see why.

This game is called the "public goods game." The more you think about it, the more you realize that it can serve as a metaphor for ... well, just about everything. Many experiments in behavioral economics have studied different variations of this game, to see which conditions lead to group cooperation and which lead to disaster. In this activity, we will split into two groups. Each group will play a different version of the game for several rounds, with different (random) teams in each round. Then we'll come back together to compare results.

[4] Not a Choose Your Own Adventure book, as that term is trademarked, and the company that owns the trademark is notably litigious

[5] Apparently the book has unlockable characters?!?

[6] Ae won't make much of a dent in them during Sneak Peek.