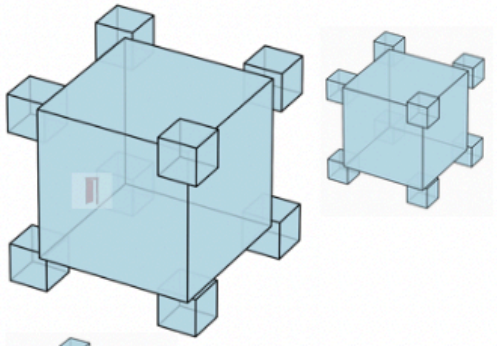

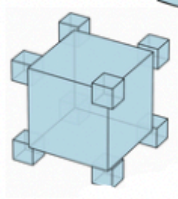

...earlier...

MathILy-Er

serious mathematics infused with levity...

RM #3

Week of CHAOS

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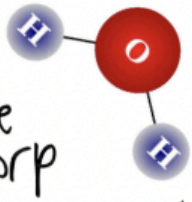
decroissant



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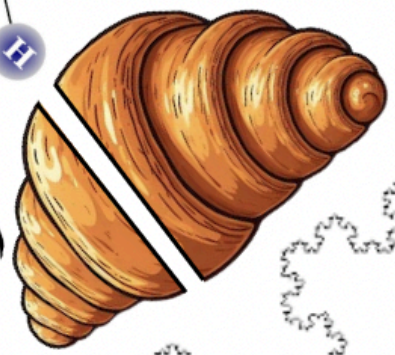


the MathILy-Er Record of Mathematics (RoM)

Issue 3: July 14, 2025

Contributors: Pranav, Victoria, Fiona, Dawson, Alex, Anna, Anne, Chloe, Leo, Zach, Klea, Fayzan, Ranbeer, Minjoo, Kevin, Allison, Naina, Andy, Aaron S., Eric, Aaron C., Joongi, Adam, Lucas, Amelia, Snayhin, kat, Sophia
Editors: Lydia Choi, Adam Smith, Joongi Min, Andy Zhuang
Cover by: Naina, Klea, Satya, and Eric

In this issue...

Calendar for Week 4, the first week of Branch at MathILy-Er:

Our Weekday-ly Schedule:
Breakfast 7:30-8:25am in Walton
Morning class 8:30am-12:30pm in HHC 104, 106
Lunch 12:35-1pm in Walton
Daily Gather 4-5:15pm in HHC 106
Dinner 5:15-6pm in Walton
Evening class 6:30-9:30pm in HHC 104, 106

Monday at 1:30pm: MathILy-Er RoM meeting in the dorm lounge

Daily Gathers:
Monday: *Contain Yourself* by Lindsey Styron
A mad scientist does some strange experiments on shapes.
Tuesday: *Fun with Primes* by Yael Davidov
Prime numbers, the building blocks of numbers, are fun and unpredictable creatures. Together we will explore the world of prime numbers, learning about some patterns and unsolved mysteries along the way.
Wednesday: *Capturing the Bug* by Matthew
Eastern has an interesting idea of pest control for their dorms: They fill the hallways with concrete until the bug has no options left. We will not answer such questions as: where did they get so much concrete?
Thursday: The 184th Annual MathILy-Er Film Festival
Friday: *Stolen Treasure* by Lixin
Despite being rick-rolled, you've used the map to steal the pirates' treasure. But how will you bring it back?

Saturday:
Breakfast 8-8:25am in Walton
Morning class 8:30am-12:30pm in HHC 104, 106
Lunch 12:35-1pm in Walton

Sunday:
Life Seminar at time TBD.

Also, talent show?? TBD.

Look forward to Week 5, more Branch!

Class Summaries

Alternating Sign Musicboxes/Meowboxes (Jonah) – by Pranav

We began the week by looking at citrus crates, $n \times n$ grids of blank spaces and pomelos. Citrus crates have to follow some rules: a green pomelo starts and ends each row and column, and green pomelos and red pomelos alternate in every row and column.When we counted these $n \times n$ citrus crates, we got the sequence $(1, 2, 7, 42, 429, ...)$. To organize our thoughts, we differentiated crates into cases based on the index of the position of the green pomelo in the first column. After arranging these new numbers into a triangle and trying to spot patterns, we conjectured about a "naive addition" like pattern appearing in ratios between consecutive terms of each row. Afterwards, we showed how pomelo crates, electrical wiring, and functioning A/Cs generate the same sequence of numbers and drew many pictures in the process. Finally, on Friday we discovered that electrical wirings that have the same outlets connected under rotation have the same number of ways to solve them. We also looked at Jonah's satsuma diet at the end of class and learned that rotationally symmetric 3D representations of it also count like citrus crates. Many of the questions relating to Alternating Sign Musicboxes/Meowboxes have puzzled mathematicians for decades, so we couldn't prove all our conjectures; however, the process of discovery was nonetheless enjoyable.

Parties and Queues (Brian) – by Fiona and Victoria

Brian has a party with an infinite number of friends, each assigned a number tag: 1, 2, 3, ….

We began by investigating the relative sizes of sets, postulating that two sets are the same size if there is an OTOC between them. We also defined $|A| \leq |B|$ to mean that there is an injection from A to B and $|A| \geq |B|$ to mean that there is a surjection from A to B.

Now, Brian wants to invite his new friend, Lixin. Is there a way for him to reassign the number tags to include Lixin? We made OTOCs between parties and the natural numbers, proving we can include Lixin, Lixin's friends, the MathIGy instructors, the MathILy-Er staff and their friends, and even Kye's infinitely many students and their infinitely many friends.

Corrine organizes a meta-party, where every subset of people in Brian's party is an individual "guest" at Corrine's party. But can Brian invite all the members of Corrine's party and assign each of them a number tag? Well, suppose we task each person in Brian's party with taking the picture for a set in Corrine's meta-party. Who takes the picture for the set of people whose picture is not a selfie? Uh oh, there is no one left to take this picture! So Corrine's party is actually larger than Brian's party.

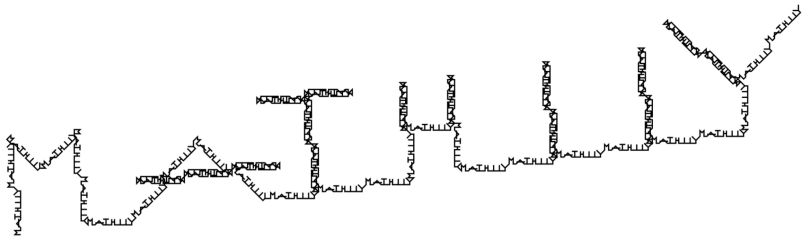
Finally, we considered the queue of people waiting in line to enter the party. Define ω as the queue composed of 0 followed by the natural numbers, and queue addition by combining two queues. We showed that $1 + \omega$ has the same size as ω, but $\omega + 1$ is longer than ω. Infinity is weird.

What is the shape of a sentence? (Kye) – by Alex, Anna, and Dawson

What differentiates grammatically sentences like "the old man the boat" from incorrect ones like "one backwards a is this"? To keep things simple, we focus solely on the word order/structure of sentences (as opposed to agreements and other aspects of grammar). We say a *sentence* comprises a I (the "subject") followed by a *verb phrase* (the "predicate"), where a noun phrase contains a noun, sometimes preceded by adjectives and/or articles; a verb phrase contains one verb, maybe preceded by some adverbs, and sometimes another noun phrase (the "object" of the verb). Then we devised an algorithm to randomly generate sentences following the grammar rules we wrote, and through experimenting with it we refined our rules to deal with other complications such as helping verbs, verb [in]transitivity, prepositions, etc.

Then we looked at a bunch of other languages. For example, we came across a language whose grammar produces sentences with alternating nouns and verbs; we also found a language that generates roller-coaster a.k.a. parentheses sequences (e.g. NNVNNVVV).

Finally, we explored special languages in which sentences actually describe sequences of movements for tracing/drawing pictures. For example, we analyzed a language that produces one side of Koch's snowflake, and came up with several languages to produce our own pictures:



Algebraists Anonymous (Noa) – by Anne and Chloe

How can we jumble our brains while keeping them upright? A brain is an equilateral triangle. To jumble this brain, we perform *brain surgery*, which consists of rotating by 0°, 120°, or 240°, or reflecting the brain across one of three "medial axes" of the triangle. We define a *biscuit* as a set B with a binary operation with associativity, identity, and inverses. Then, we showed that brain surgery operations under composition, meowboxes under multiplication, real numbers or $\mathbf{Z}_n$ under addition are biscuits. We also noticed that some functions have the interesting property that produces the same result before or after applying the function— it "splits" across the operation, $f(a)\ {}_a f(b) = f(a\ {}_b b)$. Two biscuits are equivalent if there's a SOTOC, i.e. a *split bijection*, between them. Next, we defined Bake_n to be the biscuit made of bijections on $\{1,2,3,\ldots,n\}$ under composition. We found that the brain surgeries are equivalent to Bake_3 and furthermore noticed that in general every biscuit is equivalent to a subset of some Bake_n.