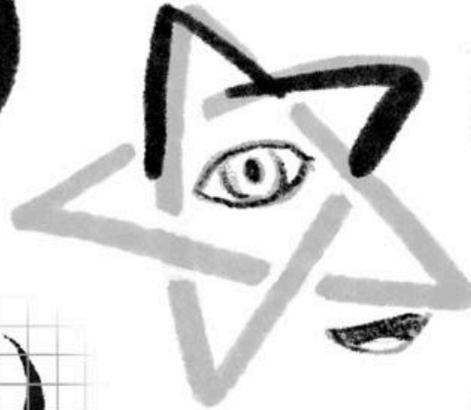
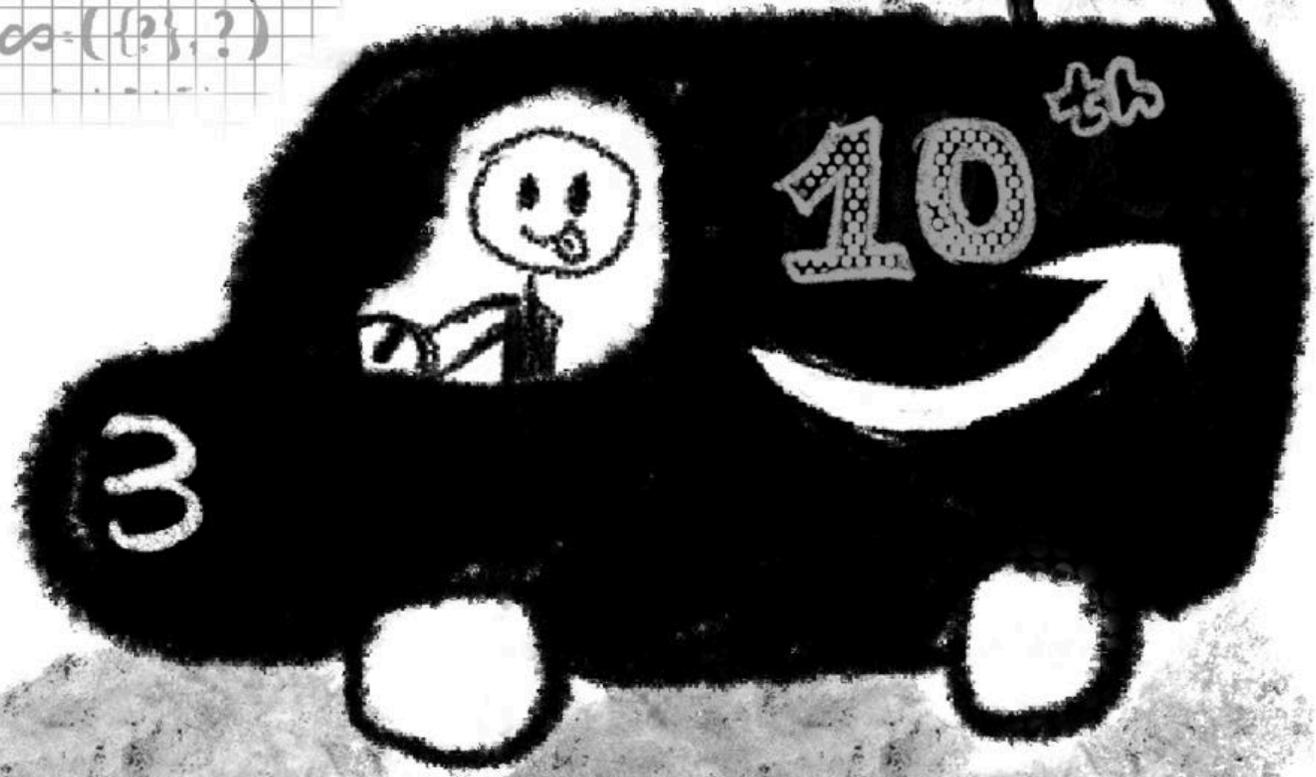


MathLy-Er



$1 = (\{0\}, \emptyset)$
 $2 = (\{1\}, \emptyset)$
 $\infty = (\{2\}, ?)$



the MathILy-Er

Record of Mathematics (RoM)

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2. Class Summaries

2.1 Tom: Algebraists Anonymous by Quang

How many ways are there to do things? Well, there's not as many as you might think. We started this class by talking about ways to swap n identical burritos around. Pretty soon, we discovered that there are $n!$ ways to do this, but another question remains: how are these burrito permutations related to each other? To answer this question, we invented the concept of burrito bowls— birds / dentstries with only one operation. With this new concept, we quickly discovered that the $n!$ permutations of our n burritos form a burrito bowl T_n (totally a set of $n!$ elements trust me bro)! Two burrito bowls (A, \star) and $(B, \#)$ are *co-salad* if there exists a bijective *salad maker* $f: A \rightarrow B$ satisfying $f(a \star b) = f(a) \# f(b)$ for all $a, b \in A$. As we've seen in Root, this means that the structures of A and B are the same!

This raised more questions: What if we drop the bijectivity condition? We were able to show that if there exists a VIT salad maker (half salad maker— a salad maker without bijectivity) from a burrito bowl A to B , the burrito bowl A has to be "part of" the burrito bowl B . Using this knowledge, we were able to prove that every finite burrito bowl of size n is a part of T_n , thus implying that there are no more than $n!$ actions to do on any object with n points. And so that's it with our burrito bowls— if we wanted to share our burritos with friends, we'd have to do it ourselves.

2.2 Karoline: All Algorithms Taste the Same by Celine

Hot take: there is only one algorithm. Ever. And that is exactly what was proven in *All Algorithms Taste the Same...* just kidding. We kicked the week off by examining two sorting algorithms, bubble sort and merge sort. Ultimately, we found that they had two different runtimes, so they were not in fact the same. So which algorithms do taste the same?

The next day, we collaborated with very secretive companies to find the best locations to set up their headquarters in a city— that is, to pick monuments/students so that no two HQs are neighbors to each other by a road. For a given map, we wanted to know if it was possible to set up at least k HQs. We tried to come up with ways to solve it, but it turned out that this was very hard.

A reduction from problem A to problem B is an algorithm for transforming inputs to problem A into inputs to problem B so that the transformed problem has the same output as the original. On our final day, we attempted to find the optimal algorithm (not)! As it turns out, no efficient algorithm (that runs in polynomial time) is known. Reductions and approximations are both valuable tools when dealing with runtime of algorithms, and the material covered in these five days only scratched the surface of all the interesting work involving algorithms.

2.13 Kye: *That's so real, honestly* by Arav and Celine

Everyone knows that $a = a$. But does everyone know *why* $a = a$? What even is “ a ” anyway? In *That's So Real, Honestly*, we interpreted cryptic messages from a strange rock to redefine numbers, equality, addition, multiplication, and so on, all in terms of sets. In a nutshell, a number is a pair of sets of previously created numbers such that no member of the left set is greater than or equal to any member of the right set.

We used induction on the creation day of the number to prove that $a = a$ for all numbers. Yay! After this, we returned to a conjecture proposed on the first day: transitivity of \leq . We proved this with many of the results from before. We finished our work on inequalities with some more proofs and corollaries, including the fact that $a \leq b$ actually means $a < b$ or $a = b$.

Feeling satisfied with our progress on inequalities, we moved on to somewhat complicated definitions for addition and negation. With these definitions, we began proving many properties to show that the addition we defined is actually the addition we know. For example, we quickly showed $a + 0 = a$, and commutativity followed from the definition, but next, the seemingly simple $a - a = 0$ was much more difficult. Finally, we also saw how we could define something like “ ∞ ”, except now we could also define $\infty + 1$, $\infty \times \infty$, and from our proof even conclude that $\infty - \infty = 0$.

2.14 Alice & Noa: *Through the Looking Glass* by Brandon

Noa is baking cookies, but not like a sane person. They want to find the best possible cookie so that all sides cook evenly. Clearly, the only thing to do is start flipping cookies in every way so that no cookie is



overlooked. We've made triangular cookies, squarangular cookies, and all flat cookies under the sun (oven). Now that we've made cookies and flipped them with our convenient spatula, the next step is obvious. We make pizza! Oh, did I mention the pizza was a kaleidoscope? No? Oh well— the pizza's a kaleidoscope. Also, the crusts of the pizza are a bunch of mirrors. But not all mirrors— some are ghost mirrors, of course. And the toppings are shiny. But at the end of the day, pizzas and cookies are both just different sides of the same lasagna.

Once we realized this, we steamrolled through pizza and cookies, and made lasagna slices out of our cookies and pizza. By flipping the lasagna with Noa's 4d spatula, we succeeded in breaking our brains in the best and most efficient way possible. After all our trials and tribulations, we realized that the true answer to our cookie conundrum was the friends we made along the way.