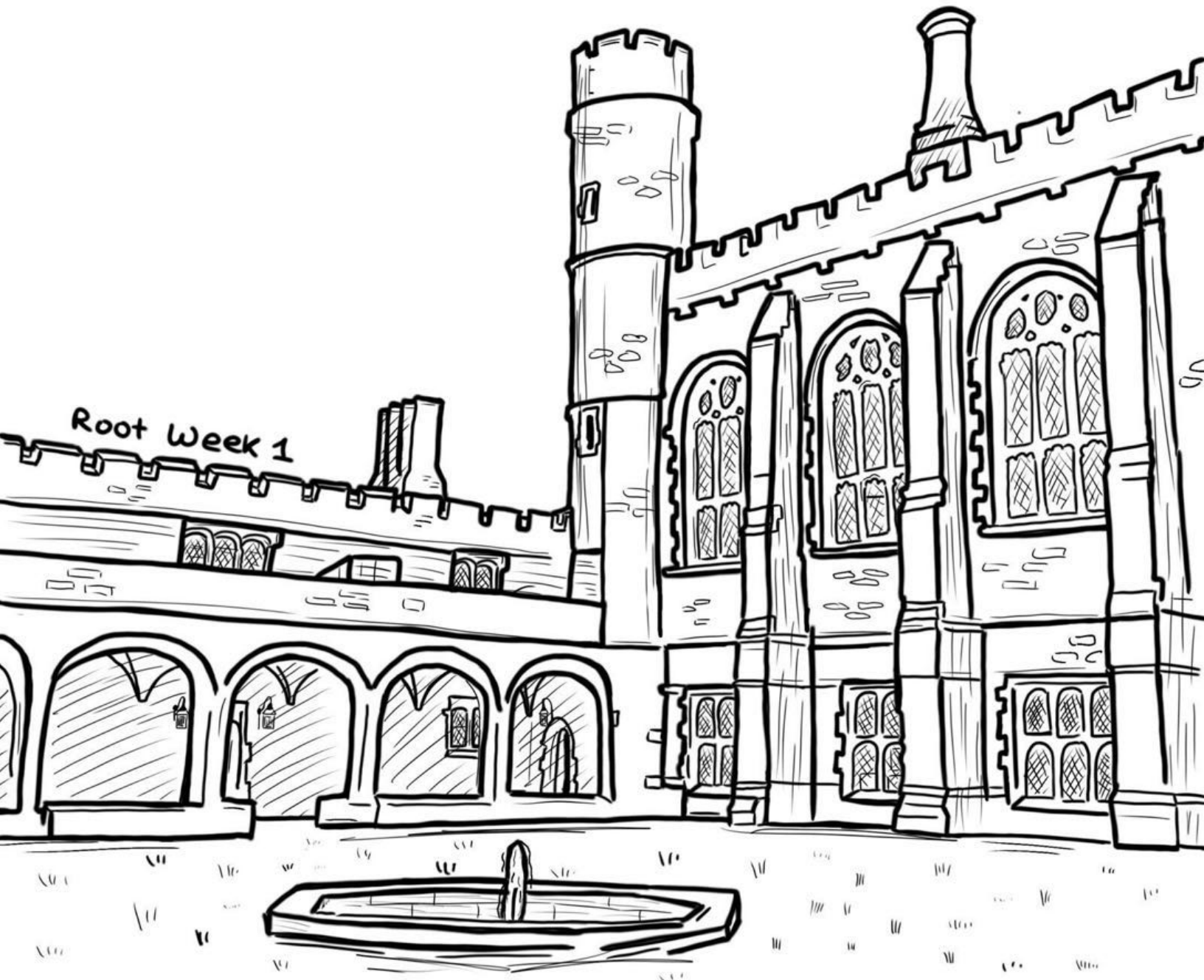


# Mathily

2022

## 1. Record of Mathematics



# the MathILy

## Record of Mathematics (RoM)

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### *Welcome...*

...to the 1st issue of the Record of Mathematics, from MathILy, 2022. This Record contains a summary of all significant mathematics we have seen, including Daily Gathers, Root Classes, proposed problems and more!

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### 3.4 Thursday - Group Testing for Covid-19 BY Shlok

This Daily Gather was given by Katie Haymaker on July 7th, the 4th day of MathILy. Professor Haymaker works at Villanova University and came upon this topic when she was bored with her young 3 year-old during the quarantine.

P-Best, a.k.a. Pooling-Based Efficient Sars Cov-2 Testing, is a method of group testing devised by Israeli mathematicians. In the case of P-Best, 48 pools were devised for 384 people so each person was represented in 6 different testing pools.

Katie presented us with the problem of choosing how to group 7 people between 3 tests if we don't have a positivity rate above 1/7. Many students proposed to put each person into some of the 3 testing groups, in such a way that for each of 7 people, if one tests positive, a unique set of groups will become positive. For example, if Person 6 was positive, then only Group A would be positive and Groups B and C would be negative.

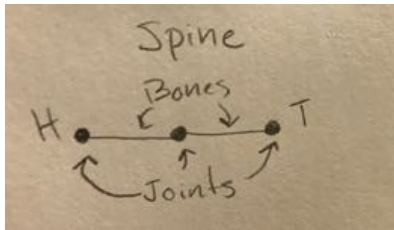
When we have a matrix where the rows represent distinct pools and columns represent a person is in a pool (represented with a 1) or not in a pool (represented with a 0), we can inverse multiply the results of this to find the unique representation of who tested positive. The only problem here is the amount of positive cases so when we have a low contamination rate, this works. Below, for Groups A and B testing positive, if we calculate this, we get the result that Person 5 is positive, assuming our contamination rate is still below 1/7.

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}^{-1}$$

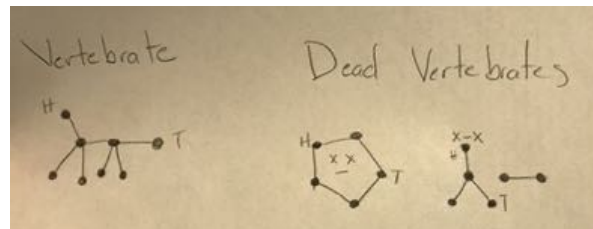
### 3.5 Friday - Shiny, Spine-y Vertebrates BY Hana

**This is Josh Mundinger** He is currently a graduate student at UChicago and previously went to Swarthmore College, but he did not find math competitions important.

**Spines** We all have them, but have we counted them? A spine, for those not inclined to biology, is a structure of alternating joints and bones that extends from a head to a tail. If we number the joints, we find that there are  $n!$  ways to order the  $n$  joints.



**Vertebrates** Vertebrates, for those who are still biologically challenged, are organisms with spines. However, if we make our organism include a closed loop, or break our organism in two, it will die.



Let's not be mean to our vertebrates; let's count them instead! How many vertebrates are there with  $n$  joints?