UNDERGRADUATE MATH SEMINAR – Save the Date!

The next math seminar is scheduled for **Thursday, May 6**, during the common lunch hour, 1:20 – 2:15. It will be held via Zoom. More details will be announced in upcoming newsletters, via email, and they will also be posted on the Math Department's website under the Activities tab. Stay tuned!

Senior Writing and Pieces from Thesis

Jason Stack *wrote his senior thesis this past fall and winter terms under the direction of Professor Leila Khatami.*

My thesis was over two terms working with Professor Leila Khatami on the relationship between Hilbert functions and Jordan types in Artinian Algebras. We took Hilbert functions from Artinian Algebras built from quotient rings with a two variable, x and y, polynomial ring and a homogenous ideal of that polynomial ring. In these algebras, the Hilbert function is always of the form H = (1, 2, ..., d-1, d^k, d-1, ..., 2, 1) where the superscript k indicates how many copies of d are in the list. The Hilbert function, in short, gives the dimensions of the basis elements in the algebra. Given these algebras, we could consider linear multiplication maps, all from multiplication by x, which could be represented via matrices. From these matrices, using the Jordan decomposition theorem, we could always find a Jordan type matrix, which is simply a matrix built from Jordan blocks, which are square matrices with 0 entries everywhere except along the diagonal above the main diagonal. So, we took a given Hilbert function and developed an algorithm based on recent literature to find all possible Jordan type partitions that occurred for a given Hilbert function.

The bulk of my work consisted of learning the background material to understand Hilbert functions and Jordan types, along with studying the recent literature, but mostly translating these algorithms into code using SageMath. SageMath is a computer program written in python that has built in methods, functions, and classes very useful for mathematicians in a variety of fields. I used SageMath the summer before my thesis began, so I had some experience, but a lot of the work in my thesis was researching Sage documentation and translated these algorithms into working code. Ultimately, I developed three larger functions that incorporated many smaller methods/functions, that took in a Hilbert function with k=1,2, or >2, and returned all possible Jordan type partitions that occurred. Along with these algorithms, we developed a "dot diagram model" representing the Hilbert function and an accompanying Jordan type partition. Our algorithms were based on this model and in the thesis, I explain more in depth the relationship between the algorithm and the model.

The future of this project lies in translating the model and/or the algorithm into the case of 3 or more variables. We have a few ideas on how to potentially translate the model into 3 variables by essentially including multiple "sheets" of the diagram that would lay on top of each other, but for more than 3 the task is much more difficult. In light of this, we are hoping to be able to translate the algorithm based on this diagram into the case of n variables even if the diagram itself is not able to be translated.

Over the course of my thesis project, the one thing I was not expecting but happened often, was the plan changing. We had a goal starting out in the project, but as we hit different roadblocks, the plan shifted. One aspect of the research would be more fruitful than another, we would realize a certain goal was just too complicated to complete in the amount of time, and that flexibility is necessary in working on a thesis. Going into the project, you simply do not know where certain hang-ups lie and

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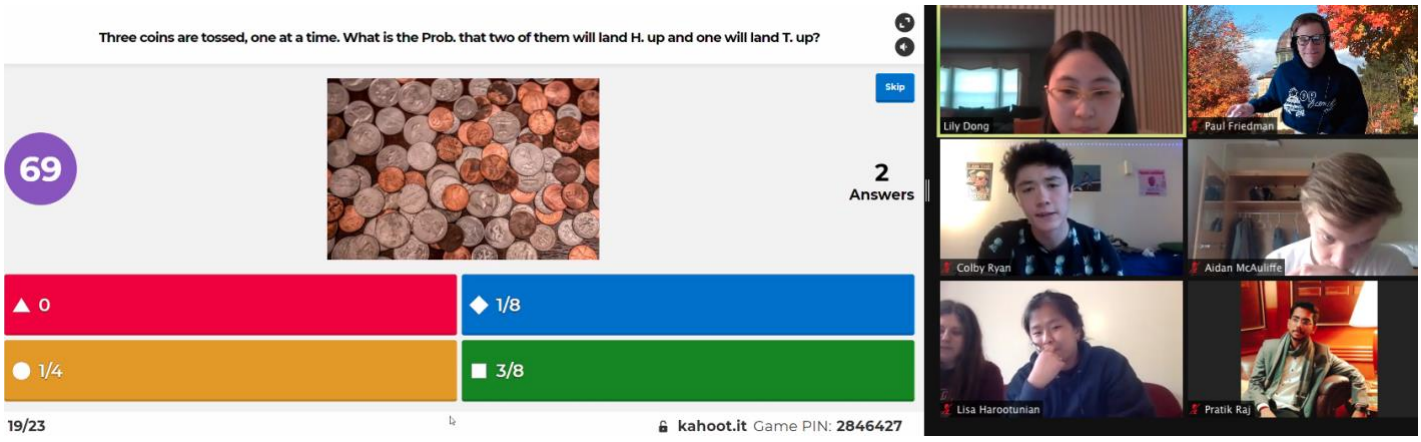
what obstacles there are, so you might be forced to change paths. But I found a lot of freedom in this flexibility, being able to change course rather than ramming my head against a wall for weeks opened up new topics, new ways of approaching a problem, and was an exciting aspect of the research process. The one piece of advice I would give for a student about to embark on their thesis project is to be open to changing directions, especially if in the midst of research, you find something that you just like more. Talk to your advisor about those sparks of interests and be flexible with your goals.

Math Club: Trivia Night – Lots of Fun!

The Math Club hosted a fun trivia night this past Thursday. Participants competed in a 20-question contest designed and delivered by club President **Lily Dong**. The questions required some quick and accurate computations, combined with various levels of knowledge and cleverness.

Sophomore math major, **Aidan McAuliffe**, took home top honors, winning a pair of noise-cancelling headphones for his performance. **Lisa Harootunian**, a senior neuroscience major, placed second in the contest, winning a pack of 16 metal puzzle toys. **Colby Ryan**, a first-year computer science major, rounded out the top three, taking home a book of Sudoku puzzles as his prize.

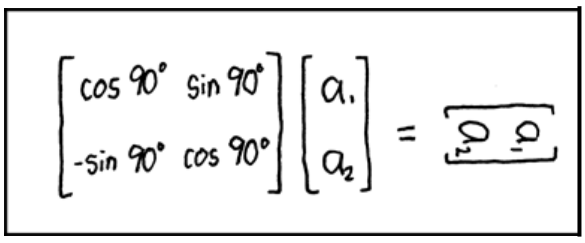


If you are interested in joining the Math Club or in being put on its mailing list to hear about upcoming meetings and events, then email club President **Lily Dong** (dongl@union.edu) to do so.

WeBWorK Woes? Try the Calculus Help Center

The Calculus Help Center (CHC) offers free tutoring in calculus courses through Math 117. The CHC is held over Zoom: the link is **https://union.zoom.us/j/99516768139**. This link is also findable on the Math Department's website under the "For Students" tab.

Need a Chuckle? Fun Math Found Online.



Find the error!

Is there one?!?!

$$
\begin{aligned}
b &= a \\
ab &= a^2 \\
ab - b^2 &= a^2 - b^2 \\
b(a-b) &= (a+b)(a-b) \\
b &= a+b \\
b &= b+b \\
b &= 2b \\
1 &= 2
\end{aligned}
$$