

## UNDERGRADUATE MATH SEMINAR

The next, and last, math seminar of the winter term will be

**DATE:** **THURSDAY, October 1, 2026**

**Time &** **12:30 – Refreshments in Bailey 204**

**Location:** **12:50 – 1:45 Seminar in Bailey 207**



In this seminar, **Professor Emeritus Bill Zwicker** of the Union College math department, whose current research lies in applications of mathematics to the social sciences, in particular, voting and social choice, fair division, and cooperative game theory, will present the following talk, reflecting joint research with Dominik Peters and Alan Taylor.



Professor Bill Zwicker

### Title: What Is Proportional Representation

**Abstract:** Suppose a democracy wishes to elect a legislature that is a microcosm of the society it represents. Such a legislature embodies *proportional representation* – with the mix of opinions among elected legislators reflecting that among the voters. How should they proceed? Electoral methods currently in use include those based on geographic districts, and others in which voters cast ballots directly for political parties. These approaches have notable flaws, leading researchers in social choice theory to seek methods that are more flexible, allowing voters to weigh in on a wider range of positions.

This added flexibility raises a question, however: what does *proportional representation* even mean for these new voting methods? That's the sort of puzzle mathematicians love; we get to invent our own definitions as a way to make precise some idea that is important but still vague. As it turns out, researchers have invented a great variety of definitions for proportional representation. Our focus will be on two of these – the *core* (proposed 11 years ago) and the *uniform core* (proposed by us quite recently) – that have their roots in cooperative game theory.

### My Summer Research, by Avi Paudel '28

This summer, I conducted research as a SURF (Summer Undergraduate Research Fellowship) Fellow at Caltech's Math-AI group, advised by Dr. Sergei Gukov. In this 10-week program, I worked on using reinforcement learning to solve difficult instances of a group theory conjecture known as the Andrews-Curtis Conjecture.

My work involved creating algorithms that can solve these instances by identifying patterns from an initial state. Besides my research, we had weekly seminars with distinguished professors, grad school prep, and weekend tours around Southern California.

If you're interested in applying next summer, here are a few suggestions. The Caltech summer research application process is similar to Union's.



Avi in front of Fleming's House at Caltech.

First, you need a faculty advisor willing to mentor you; then you write a research proposal and a short application. I started by making a list of professors I'd like to work with, and emailed them about my interest and background. It's also a good idea to skim the lab's latest papers and mention that in your email. One final tip I heard from friends: contact postdocs and research scientists instead of professors, since they may be more likely to respond. I'm happy to share more guidance. You can email me at [paudela@union.edu](mailto:paudela@union.edu).