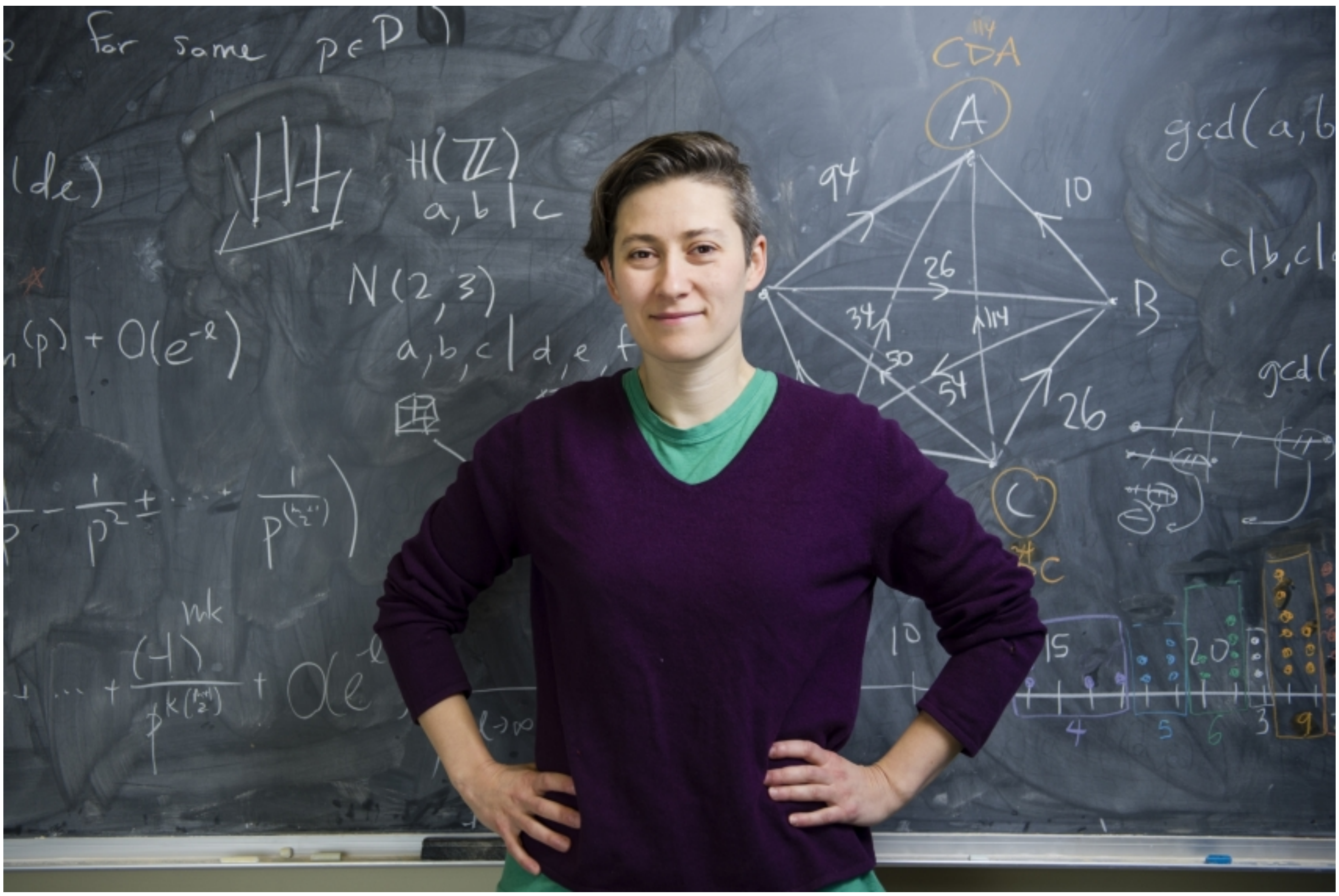
Meet the Math Professor Who's Fighting Gerrymandering With Geometry

By Shannon Najmabadi February 22, 2017



Tufts U.

Moon Duchin, of Tufts U., has helped create a program to train mathematicians to serve as expert witnesses in court cases over redrawn electoral districts.

A Tufts University professor has a proposal to combat gerrymandering: give more geometry experts a day in court.

Moon Duchin is an associate professor of math and director of the Science, Technology and Society program at Tufts. She realized last year that some of her research about metric geometry could be applied to gerrymandering — the practice of manipulating the shape of electoral districts to benefit a specific party, which is widely seen as a major contributor to government dysfunction.

At first, she says, her plans were straightforward and research-oriented — "to put together a team to do some modeling and then maybe consult with state redistricting commissions." But then she got more creative. "I became convinced that it's probably more effective to try to help train a big new generation of expert witnesses who know the math side pretty well," she says.

> *"It's clear that this is the right moment to do this kind of work. We want to harness all that energy."*

In part, she says, that's because court cases over voting districts have risen since a 2013 Supreme Court decision, *Shelby County v. Holder*, struck down a key part of the Voting Rights Act of 1965.

Former President Barack Obama is said to be making redistricting a focus after his presidency, and the former attorney general Eric H. Holder Jr. is leading a new Democratic group targeting gerrymandering ahead of 2021, the next time district lines will be drawn.

Before the *Shelby* decision, some states and localities with a history of racial discrimination were required to get federal clearance before redrawing electoral districts or making other changes in their election laws.

"Changes to voting rules that used to be considered by courts before they could be implemented," Ms. Duchin says, "are now implemented first and the courts consider them after the fact." Because of the increase in cases challenging new electoral maps, she says, there's a need for expert witnesses who understand the mathematical concepts applicable to gerrymandering.

To meet that need, she's spearheaded the creation of a five-day summer program at Tufts that aims to train mathematicians to do just that. The first three days of the program will be open to the public and available online, with lessons that put redistricting in legal, historical, civil-rights, and mathematical contexts. Attendees of the program's final two days will participate in one of three specialized tracks on giving expert testimony, teaching, and working with geographic-information systems.

The summer program, created in partnership with the Lawyers' Committee for Civil Rights Under Law, was announced late in January. Already, Ms. Duchin says, over 900 people have indicated their interest by signing up for a mailing list. "What was really remarkable," she says, "is that the mailing list didn't say, Sign up if you care about gerrymandering. It said, We want to train mathematicians as expert witnesses. That's very specific."

Overwhelmed by the interest, Ms. Duchin and the Metric Geometry and Gerrymandering Group, or MGGG — a five-person group founded by Ms. Duchin that is organizing the summer school — decided to hold additional trainings in California, North Carolina, Texas, and Wisconsin later this year.

"It's clear that this is the right moment to do this kind of work," Ms. Duchin says. "We want to harness all that energy."

Ms. Duchin spoke with *The Chronicle* about the summer school and the group's broader goals. This interview has been condensed and edited.

Q. What is the Metric Geometry and Gerrymandering Group's aim?

A. In redistricting, one of the principles that's taken seriously by courts is that districts should be compact. The U.S. Constitution does not say that, but many state constitutions do, and it's taken as a kind of general principle of how districts ought to look.

But nobody knows exactly what compactness means. People just have the idea that it means the shape shouldn't be too weird, shouldn't be too eccentric; it should be a kind of reasonable shape. Lots of people have taken a swing at that over the years. Which definition you choose actually has stakes. It changes what maps are acceptable and what maps aren't. If you look at the Supreme Court history, what you'll see is that a lot of times, especially in the '90s, the court would say, Look, some shapes are obviously too bizarre but we don't know how to describe the cutoff. How bizarre is too bizarre? We don't know; that sounds hard.

Q. It's like how they define obscenity.

A. Exactly. When I started thinking about this, I was surprised to see that even though there were different mathematical attempts at a definition, you don't ever see mathematicians testifying in court about it. So our first aim was to think like mathematicians about compactness and look at all the definitions that already exist, and compare them and try to prove theorems about the relationships between the definitions.

What courts have been looking for is one definition of compactness that they can understand, that we can compute, and that they can use as a kind of go-to standard. I don't have any illusions that we're going to settle that debate forever, but I think we can make a contribution to the debate.

Q. How was the group formed?

A. I founded it through realizing that this landscape of compactness had a hole in it. It's not that mathematicians hadn't been working on it; it's that [geometry experts] hadn't entered the legal conversation.

> *"What courts have been looking for is one definition of compactness that they can understand, that we can compute, and that they can use as a kind of go-to standard."*

I'm always a little bit wary of coming off sounding like I'm the very first person to work on this idea; I just want to be clear that's not the claim. But I do think we're taking a new approach. There are scores — one of them is called the Polsby-Popper score; that's the area of a district compared to the area of a circle of the same perimeter, given as a percentage. Certainly courts have heard about Polsby-Popper scores. It's just that no court has ever found that that alone is a persuasive way to rule out a bad district.

In geometric group theory, I work on what's called metric geometry and within that, I already had a series of papers that were about essentially the average distances between points in various kinds of shapes. That's actually directly applicable to compactness. It turns out that if you take a district and you look at the average distances between all of its points, then the bigger that is, the less compact, once you normalize by the diameter. That meant that I already had published theorems that, I think, cast some light on the districting problem.

Q. One of the group's projects is the summer course. Are there other avenues you're pursuing?

A. Absolutely. Our aim is to do some publication between now and then. We want to write papers where we prove theorems about different compactness metrics.

But the summer school — boy, you wouldn't believe the incredible, incredible response we've gotten, including from leaders in all the various fields that touch on this problem. The point of the summer school isn't just to bring people together so we can convince them of our ideas. We also want to pool ideas and see, putting all those brilliant people in one place, can we make some progress on what's been a pretty intractable problem?

Q. Judges and jurors are often not mathematicians. How do you train a technical expert to explain these concepts to a lay audience in a courtroom setting?

A. That's been on my mind a lot. Since I started working on this project, one thing that I've been doing is giving a lot of talks to different kinds of audiences about this work. It began with my "Mathematics of Social Choice" class. I was trying to explain to them some of these compactness statistics and to my surprise, some of the things that seemed very intuitive to me didn't at all seem intuitive to my students. Then I started giving lectures to mixed audiences. I gave a talk at Parents Weekend at Tufts; I spoke to a public audience in Washington, D.C.; I went to a high school to talk about it.

Bouncing things off of diverse audiences has taught me things I didn't already know about how rhetorically accessible different ideas are. This is well-known to educators: Once you achieve a certain level of expertise, it can be hard to find the difficult spots and the reasoning anymore because they're so familiar to you.

A beautiful fact about high-stakes court cases is that they produce a lot of written documentation, so you can read transcripts of questions, you can read the decisions of particular Supreme Court cases, you can read these long detailed decisions, and you can look through those to understand what they accepted and what they didn't accept in terms of the evidence.

Recently there was a big media sensation in Wisconsin around something called the "efficiency gap." It was a new metric of partisan gerrymandering that, for the first time, a court said they liked. The way it was devised was that the people who created it, they went back and they read all of Justice Anthony Kennedy's written decisions about measuring gerrymandering. By reading his words and by reading what he said he found convincing and less convincing, they designed a statistic to appeal to him. He's that vaunted median justice. If you can come up with something that will be convincing to Anthony Kennedy, then you've probably just changed the outcome.

Shannon Najmabadi writes about teaching, learning, the curriculum, and educational quality.