TEACHING STATEMENT

Motivation: I value both aspects of academic life — research and teaching — equally, for four reasons:

1. Most of what I know has come from my teachers, and I am determined to help my students in the same way.
2. While research may not always yield immediately tangible results, teaching offers the opportunity to make regular and meaningful impact.
3. Teaching compels one to examine and refine their own understanding, leading to deeper insight.
4. The process of explaining a subtle idea and witnessing a student's moment of comprehension is profoundly rewarding.

Experience: My views on effective pedagogy have been shaped by experiences as a student, a speaker, and, most importantly, a teacher:

1. I gained experience in teaching advanced material when, as part of the Taught Course Centre, I developed and taught 'Algebraic Methods in Computational Complexity Theory'. I gave 16 hours of lectures (online via Microsoft Teams) to maths PhD students from various universities, building from introductory computational complexity theory to highly technical interactions with algebraic geometry.[1]
2. Conversely, as part of the London Maths Outreach program, I developed and taught 'Effective Methods in Algebra' to motivated Year 10–Year 13 high school students in London. I covered basics like Gaussian elimination up to advanced topics such as Gröbner bases and algebraic complexity theory.
3. I served as a Teaching Assistant for four semesters in the undergraduate course 'Data Structures and Algorithms' at Purdue, leading recitations in addition to regular duties, and serving as head TA for two semesters, in classes of over 100 students.
4. I have given full lectures in PhD courses (e.g., Real Algebraic Geometry) at Purdue, and virtually delivered an invited lecture for over 100 students at the University of Cincinnati.

I have consistently received high evaluations (e.g., Figure 1), and in recognition of my proactive teaching, I was awarded '**Outstanding Service to the Department**' in 2016.

Context of a concept: When teaching, I like to discuss the history and motivation behind each concept, showing how and why it was conceived. I strive to present enough examples and questions so that a definition or theorem feels almost inevitable. For instance, reflecting on the types of sets where continuous functions become uniformly continuous naturally leads one to recognize closed and bounded as desirable conditions, helping students remember the definition of compactness and appreciate why and when compactness matters.

> *"... you have a fantastic way of explaining things in terms that anyone can understand ... starting at a high level and slowly working down into the details ..."* — Algorithms course evaluations, Fall 2013, Purdue

What's wrong: I believe the best way to inculcate rigor is to let students experience what happens when it is absent. I often present incorrect proofs of correct theorems and ask students to identify and fix the gaps. For instance, one might assert that from an exact sequence $0 \to A \to B \to C \to 0$, we automatically have $B \cong A \oplus C$. Seeing the counterexample $0 \hookrightarrow \mathbb{Z} \to \mathbb{Z} \twoheadrightarrow \mathbb{Z}_2 \to 0$ *in context* leaves a far stronger impression than a casual remark while proving the splitting lemma. I include such "what's wrong?" exercises in recitations and exams. While initially disarming, these exercises ultimately help students appreciate why a bit of rigor, previously perceived as superfluous, is essential.

Fight mathematics: I believe the most important thing a teacher can do to foster independence is to encourage students to *fight mathematics* (phrase used by Paul Halmos). When presented with a theorem, students should ask: Why is this not an "if and only if" statement? Where in the proof is this part of the hypothesis used? Can we prove something stronger under more restrictive assumptions? Engaging in this process can exponentially

[1] In the broad sense of including representation theory, commutative algebra, and algebraic topology.

enhance preparedness for subsequent material; for example, such questioning of Markov's inequality can make other concentration-of-measure inequalities immediately intuitive.

Student psychology: I strive to create an inclusive environment where students feel comfortable asking any question, no matter how elementary. Early in my teaching, I noticed that students hesitated to voice fundamental doubts. I realized that it is unrealistic to expect a student to have the candour to say, "I understood only two out of the fifteen words you just uttered" — although this might be true for more than a few. To address this, I set up a method where students could anonymously message me in real time during class as well as after. Having switched fields myself, I empathize with students who feel underprepared - for instance, not distinguishing between a probability density and a probability mass in beginning graduate classes. Armed with insights from anonymous messages, I seamlessly incorporated clarifications into lectures and, when necessary, stayed after class to address foundational gaps. This approach not only supported struggling students but fostered engagement and a sense of belonging, sometimes even drawing students from other sections to my lectures.

Lecturing methods: I primarily use board and chalk, with technology for occasional embellishment. Chalkboard lectures allow students to *walk alongside the teacher*, following the development of ideas in real time. Preparing for chalkboard lectures also forces me to view material from a student's perspective and calibrate my explanations. At the same time, technology can clarify or illustrate concepts in an incomparable way - for example, no amount of chalkboard skill can match an animation in conveying the concept of a deformation retract.

Assessment methods: I choose assessment methods based on the course and learning goals. For most courses, I use traditional grading, though I am also interested in *standards-based grading*, which emphasizes mastery of clearly defined learning outcomes rather than relative performance. In advanced PhD-level courses, I have experimented with alternatives: students submitted brief emails after each lecture highlighting three concepts that stood out and reflecting on their significance in their own words (inspired by Ravi Vakil's note). This method is particularly effective for technical lectures, helping students extract and consolidate meaningful understanding even when the material is challenging.

> *"... sending you emails after every lecture ... seems to be a very good way of engaging with the course ..."* — Student feedback, TCC course on algebraic methods

Selling in basic classes: In advanced courses, students are often intrinsically motivated, and little *selling* is needed. However, in introductory or requirement-driven courses, I like to enliven material with a little gimmickry by connecting mathematical ideas to everyday life - number theory in cryptography, discrete geometry in art, or probability in games. Such examples capture attention and provide an immediate answer to the perennial refrain, "When am I ever going to need this?" Once students engage with the ideas, mathematics largely sells itself.

Balance in advanced classes: Advanced courses, by contrast, inevitably require technical depth, which can risk losing the audience. To maintain balance, I clearly communicate the assumed background in advance and provide resources to fill gaps if needed. During lectures, I do not shy away from intricate material, but I periodically step back to offer a brief "big-picture" perspective so students can regain a foothold. For example, after a dense theorem, a clarification such as "all this is saying is that if your manifold has some favourable structure, a convenient property holds" can illuminate the result and encourage confident engagement with technical material. Experience with mathematical rigor is transformative, equipping students with skills that apply across disciplines. I strive to present mathematics not only as an esoteric pursuit, but also as something relatable and enticing.

> *"... Thank you so much for the course! I've genuinely learned so much, and I feel a lot more comfortable ..."* — Student feedback, TCC course on algebraic methods

Taking feedback: I believe it is essential for a teacher to be receptive to feedback and willing to adjust methods. Early in my teaching, I received comments that my handwriting was difficult to read and that I was not using chalkboard space efficiently. I realized this stemmed from practicing on paper rather than the board. After deliberately practicing on the board, I believe my presentation has improved significantly. This experience reinforced the value of listening to feedback to refine one's teaching style.

Courses: I can teach the following courses:

1. Undergraduate — Discrete Maths, Linear Algebra, Calculus, Abstract Algebra, Algebraic Geometry, Probability
2. Beginning graduate — Algebraic Geometry, Commutative Algebra, Topology, Abstract Linear Algebra
3. Advanced maths — Real Algebra, Real Algebraic Geometry, O-minimal Geometry, Algebraic Methods in Computational Complexity Theory
4. Undergraduate and basic graduate CS — Algorithms, Data Structures, Programming, Theory of Computation, Machine Learning Theory
5. Advanced CS — Algorithms, Complexity Theory, Randomized Algorithms, Algebraic Algorithms

While these are courses I can comfortably teach, I am equally enthusiastic about teaching subjects slightly outside my immediate research area. For instance, I would love the opportunity to teach representation theory. Preparing such a course would be intellectually enriching. At my current career stage, I approach new material with greater maturity and perspective, and I am confident in my ability to internalize fresh concepts and present them in a way that benefits students.

CS standard questions about instructor		Abhiram Natarajan								
		Responses					Individual			
		SA	A	U	D	SD	N	Grp Med	Mode	Std Dev
Q8	My instructor seemed concerned that students learn.	5	3	0	0	0	8	4.7	5	.48
Q9	My instructor showed a clear understanding of the subject.	5	3	0	0	0	8	4.7	5	.48
Q10	My instructor was well-prepared and organized in class.	6	2	0	0	0	8	4.8	5	.43
Q11	My instructor helped me understand the material.	6	2	0	0	0	8	4.8	5	.43
Q12	My instructor graded fairly.	5	3	0	0	0	8	4.7	5	.48
Q13	My instructor was reasonably available to help students outside of class.	6	2	0	0	0	8	4.8	5	.43
Q14	My instructor encouraged in-class participation.	6	2	0	0	0	8	4.8	5	.43
Q15	My instructor shows respect for me and other students in this class.	6	2	0	0	0	8	4.8	5	.43
Q16	My instructor is open to student's questions.	7	1	0	0	0	8	4.9	5	.33
Q17	My instructor encourages an atmosphere where ideas can be exchanged freely and easily.	7	1	0	0	0	8	4.9	5	.33
Q18	This instructor gave quizzes that accurately assessed what I have learned in this course	4	2	2	0	0	8	4.5	5	.83

Responses: [**SA**] Strongly Agree=5 [**A**] Agree=4 [**U**] Undecided=3 [**D**] Disagree=2 [**SD**] Strongly Disagree=1

Figure 1: Teaching Evaluations, Fall 2014, Purdue University.

Advising style: I have observed a wide range of advising styles, both through direct experience and conversations with peers. I am convinced that there is no single best approach. Each student has their own rhythm and temperament: some thrive with high-level guidance, while others benefit from hands-on mentorship. A student's needs may even evolve over time. It is therefore the joint responsibility of advisor and advisee to determine what style works best. I strive to communicate expectations clearly, remain receptive to feedback, and adapt my approach accordingly. I firmly believe that every student has something distinctive and valuable to offer, and that it is the advisor's role to help that potential take shape.

That said, I plan to be closely involved during the initial stages of a student's research. From experience, it can take a newcomer an entire week to unpack even the first line of a paper's introduction. The early stages can feel like a vortex of background reading without a clear sense of progress, and steady guidance can make a decisive difference. For instance, beginning with McCleary or Bott–Tu to learn spectral sequences can be overwhelming, but even a brief contextual remark, such as noting that spectral sequences generalize the way long exact sequences in homology arise from short exact sequences of chain complexes, can provide both clarity and confidence.

It also takes experience to know how much reading is enough. No amount of textbook study can ensure readiness for research; uncertainty is inherent to the process. I am eager to work with any student whose interests intersect with mine, regardless of their background. I look forward to developing these mentoring relationships and am certain they will be deeply fulfilling for me as well.