evaluated my career choice and realized I would be happier doing something else.

I reached out to a few friends from grad school who went into government and industry, as well as a couple former academics who transferred to tech and finance jobs. I did a little research to see what was out there, and found "data science" to be a broad enough field to entertain my intellectual curiosities (e.g. machine learning algorithms) while providing plenty of opportunities. My first post-academic role was data scientist at a non-profit doing R&D for various federal agencies. In my first year there, I worked on research projects involving machine learning and agent-based models to drive policy analysis, and I prototyped a web-based simulation tool to explore workforce strategies for the VA. Since then I have pivoted towards software engineering. Currently I lead a team of software developers at Indeed.com, where we are building data analytics and pipeline tools used within the company. There are many industry roles that are good fits for mathematicians, and it is possible to change roles.

While in the transition to industry, I realized that much of my academic training and some of my hobbies positioned me to be an attractive candidate. As a math major/PhD candidate/professor, I had accrued a ton of experience teaching myself complex, abstract concepts. Employers seek out job candidates who can demonstrate the ability to pick up new things quickly. Working in help centers/recitations/lectures, I had accrued a ton of experience explaining deep, technical material to non-technical audiences. Employers like to hire teachers because they can put you in front of customers or use you to mentor young staff. As a mathematician, you have surely gained similar experience. Find a way to brag about your superpowers!

You're going to need programming skills. In my journey, I was lucky to have learned to code. In college, I learned a bit of Java in CS 101. In grad school, the math department hired me by the hour to maintain their website. I chose to write up my homework in LaTeX. Frequently, I would need to do some computations in Mathematica, Maple, Matlab, or Sage. As a postdoc, I got bored one summer and wrote a couple of card games in Objective-C. For a research paper, I needed to diagonalize some matrices over a non-commutative base ring, and I wrote the code to do this from scratch in Python. Before I had even heard of data science, I had ten programming/markup languages under my belt, and I put all of them on my resumé to show employers that I am comfortable writing code. If you don't have experience programming, I recommend you pick up Python. It's a good general purpose language. Pick a project and use Python to attack it (e.g., implement matrix multiplication from scratch).

The last piece of advice I have is to acquire domain knowledge and to network. The biggest hurdle I had in my journey was learning to communicate with potential employers. I decided to take online courses in data analytics and machine learning, and these courses taught me what people in industry care about, how they talk, and what tools they use. I also participated in some coding and data science competitions online. Since I had a noticeable lack of business experience, these competitions were something I could point to as proof that I could do data science. I would also recommend attending meetups in your area. In my experience, meetup people are very friendly and helpful.

Transitioning out of academia was scary, but it has been one of my best decisions. At first I was worried I wouldn't be what employers were looking for, but I learned that many employers want to build companies with people from diverse backgrounds. Don't worry about trying to fit the mold. Reach out to friends, former classmates, and friends of friends, and you will find all the support you need.

Peter D. Horn

Credits

Author photo is courtesy of Peter D. Horn.

Threefold Advice: Making the Jump from Geometric Group Theorist to Computer Vision Specialist

Lucas Sabalka

I began my mathematical career as a research mathematician, but now I work in industry even though my degree is not in an applied area. With so few academic jobs available recently, transitioning to industry is becoming more common for mathematics PhDs. So to help any mathematicians thinking about that transition, let me tell you how I got where I am.

I had always planned on being a professor as I pursued my PhD. That's what I became: after two postdocs and a

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decent rate of publication, I got a tenure-track position at a research university. A career in academia has significant pluses, including the promise of tenure and thinking about interesting problems all day. However, through the course of these positions, I gradually realized the impact of two important minuses of a career in academia. One is that, with academic jobs so few and far between, you typically do not get to choose where you live. My wife and I are from Nebraska, and wanted to end up close to family and friends. The second is that research is driven by self-motivation. That's good for someone like me who is highly self-motivated, but it can also add undue stress: I was easily on-track for tenure, but found myself pushing hard to make a name for myself with little recognition.

The experience that changed my career path from academia to industry was a consultantship. A co-author and good friend of mine, Dr. Josh Brown-Kramer, was working as an applied mathematician at a start-up tech company called Ocuvera in my home town. I have undergraduate degrees in math, computer science, and history, and together with Josh, I had competed in and won a few programming contests back in the day. I had done very little programming in the intervening years, but I had enough knowledge to pick up coding quickly. Josh put in a good word for me, and got me a full-time consulting position one summer. That position turned out to be a good opportunity for the company to see that I was a good fit culturally and could contribute positively to their products, as well as a good opportunity for me to see what working in industry was like. A few months after my consultantship ended, the company extended me a full-time offer. It was a difficult decision to make, but the draw of moving back home and (what was for me) the lower stress of working in industry led my decision. I took the plunge and switched careers: from "mathematician" to "applied mathematician."

That transition was anxiety-inducing. I had prepared for many years to be in academia. It had the promise of tenure, and it was familiar. Industry was scary: what if my company folded? How would I handle the different stresses? In retrospect, I should have had more confidence in myself. I now trust that I will be able to find another job if my current job were to disappear. The stressors are different, but overall my stress levels have decreased. I have more time for hobbies, including advocacy and volunteerism (I speak with elected officials and thought leaders about climate change and the transition to a clean energy economy).

My job is Computer Vision Specialist. I develop algorithms for computers, equipped with 3-dimensional cameras, to automatically monitor patients in hospital settings. If the algorithms detect risky behavior from the patient that could increase their risk of falling, they automatically alert hospital personnel to determine an appropriate course of action. Falls cost hospitals and patients billions of dollars per year and can result in death. Helping reduce fall risk and introducing automated monitoring should reduce health care costs as well as improve patient outcomes and save lives. It is rewarding to feel like this project could help improve people's lives.

My dissertation was in geometric group theory, a topic at the intersection of algebra and topology. While my job does not call for geometric group theory or really any graduate-level mathematics, I do use undergraduate-level mathematics concepts extensively, including statistics, probability, calculus, Euclidean geometry, various computer science algorithms, and linear algebra. We use machine-learned algorithms and we also write computer vision algorithms by hand. Consider, for example, taking an array of points in 3-space representing a single camera frame from a video stream of a hospital room, and trying to identify exactly those points that represent a bed. What properties of a bed are important, and how do you quantify that in a way a computer could evaluate? Once you know where the bed is, which points in 3-space represent the patient, and which the nurse? How will you deal with noisy or missing data? I may not be using the tools of my specialization, but I am using the problem-solving skills that I developed while pursuing my degree. My degree is not applied, but having a PhD in mathematics in any subject shows that you're good at problem solving.

My advice to mathematics PhD students considering industry for work is threefold. First, remember that your degree will mean you are a very good problem solver, and have confidence that there are companies that value your skills. Second, it's a good idea to get some classes under your belt that could help you in your desired fields: computer programming, statistics, probability, finance, or any classes that could apply in industry. These classes aren't necessary, but can distinguish you from other candidates and help prepare you for the transition. Third, if possible, I recommend finding an internship in the field you're looking at. This will give you valuable experience, help you know what to expect, show you whether you'd like that industry job, and will help you on the job market. Even if you don't take other classes or have an internship, companies provide new employees training for their new roles.

If you are faced with a career change and decide to leave academia, remember: a PhD shows you are a good learner and you have the problem-solving skills necessary to succeed in industry!

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Author photo is courtesy of Lucas Sabalka.