Pittsburgh Interdisciplinary Mathematics Review
Volume 2, December 2024, Pages 133–137
https://doi.org/10.5195/pimr.2024.44

Applying to a Math PhD Program

Michael Neilan

(Communicated by Lark Song)

A PhD program in Mathematics can be a challenging and rewarding experience, offering the chance to explore a wide range of mathematical subjects at a depth beyond what you experienced as an undergraduate student. In graduate school, the emphasis shifts away from rote memorization and calculations, placing greater value on understanding the underlying theory. This change in focus encourages a more creative approach to mathematics, which many students find more enjoyable. Graduate school also allows you a chance to hone in on a specific area of specialization, where you develop expertise and potentially become an expert in your field. Beyond intellectual growth, continuing your academic studies also opens doors to career opportunities in a variety of fields in academia, industry, and government.

While this may all sound like a worthwhile experience, getting into the Math PhD program of your choice may be highly competitive, and the application process can be overwhelming. In this brief article, I give my personal recommendations based on what I have learned going through the process myself (some time ago!) and by serving as the Director of Graduate Studies at Pitt Math for the last two years. The advice I provide below is mostly geared towards current undergraduates at a US university applying to a mathematics PhD program, but some aspects may also be applicable to prospective master's students and/or international students.

Before preparing your application

Before starting the admission process, first ask yourself why you are pursuing graduate school in mathematics. It should be a given that you are passionate about mathematics (or at the very least, find the subject very interesting), but you should also consider practical issues and your long-term goals. People generally have many reasons to apply to graduate school, e.g., the intrinsic search for knowledge, long-term career goals, don't want to leave college and enter the 'real-world'. All are valid reasons!

If possible, it is beneficial to talk to several current and former graduate students from different mathematics PhD programs about their experiences. Ask them what they have gained from their time in grad school, the opportunities it afforded them, and how the day-to-day workload and environment compare to their undergraduate experience. These interactions will provide you varied perspectives and allow you to

better understand the realities of a math PhD program. For example, are you ready to spend 5 – 6 years (usually while in your 20s) studying one subject while making a meager living? Are you prepared to undertake challenging yet interesting mathematics? Are you committed to focus on a highly specialized topic for 1 – 2 years that only a handful of people can understand? Is graduate school beneficial for your long-term career goals?

Once you determine that a PhD program is in your best interests, your next step is to determine which graduate schools to apply to. Graduate applications are usually due around January 15th (for a Fall start date), so an ideal time to start researching graduate programs would be the summer before your last year as an undergrad. Find programs that fit your needs and aspirations. This can include areas of research, program size and status, professors in the departments, funding opportunities, and location. Typically, students apply to 6 – 12 (or sometimes more) programs and this should be done strategically. If you have a very strong record, then it is reasonable to apply to 3+ elite schools. However, your selection of graduate schools should always include a few "back-up schools," where you have a decent chance of getting in. These should be solid schools with a large graduate program, e.g., a medium- or large-sized public university.

Overview

There is no one silver bullet guaranteeing you an offer letter from your dream school. Rather the reviewing committee looks at a variety of factors, each contributing to the overall strength of your application. Building a competitive application isn't something that can be accomplished in just a semester or two; it generally takes years to build up a competitive graduate application. This may include earning a high GPA and taking advanced and varied courses, gaining some research experience, and forming relationships with your professors and mentors to obtain strong letters of recommendation.

Grades and Coursework

If you're pursuing graduate school, then it is likely that you did very well in your math courses and have a relatively strong GPA. Many graduate programs set minimum GPA requirements, both overall and subject. For example, the University of Pittsburgh Math PhD program requires a minimum overall GPA of 3.00 and a 3.25 GPA in math courses. It's important to determine whether the programs you're applying to have similar requirements and whether you meet them.

While GPA by itself provides some measure of competency of an applicant, the level and type of courses is just as important. Admissions committees pay close attention to math courses on a transcript, particularly those taken in the final years of

study. Did you take a variety of mathematical courses throughout your undergraduate education? Were you last years filled with advanced-level math courses? Or did you merely meet the minimum degree requirements?

If available at your university, taking graduate-level courses is an asset in a graduate school application, as it indicates to the committee that the student possesses the drive and perseverance to succeed in rigorous and fast-paced courses. This is especially true for traditional/core sequences such as analysis, abstract algebra, and topology. Taking such courses indicates to the committee that the student has the necessary prerequisites to jump into graduate-level mathematics and research.

Undergraduate Research

Participating in undergraduate research is highly beneficial, both intrinsically and practically. It offers students a glimpse into what mathematical research entails and provides a preview of the second half of graduate school. It also allows students to explore specialized topics in mathematics beyond what is typically taught in undergraduate courses. Additionally, undergraduate research encourages closer relationships with professors, offering students valuable mentorship and insight into the academic world.

If you participated in undergraduate research, make sure to highlight this experience in your personal statement as well as your CV. Describe the specific problems you addressed and the type of mathematics you learned. Report on any research talks you have given, such as those at undergraduate research seminars or conferences. Finally, if you have any documentation of your experience (e.g., publications in peer-review journals or reports in public repositories), make sure to include this information as well.

Letters of Recommendation

Letters of recommendation are a critical component of the application, as they provide an honest assessment of the applicant and their potential capabilities from experts in the field. It's your responsibility to select 3–5 letter writers to support your application. These letters typically come from math professors at your university, but they may also include professors from other departments or universities or supervisors from jobs or internships. However, to emphasize that you can succeed in a Math PhD program, I recommend that more than half of your letter writers are math professors. If you've done undergraduate research, make sure your research advisor is a letter writer, as its absence can raise concerns with the admissions committee.

Building relationships with your professors during your years as an undergrad is important to secure meaningful letters of recommendation. It's important to find letter writers who genuinely know you and speak to your strengths and achievements.

I've read (and written) countless letters of recommendation simply describing adequate course performance. In such scenarios, it's unclear whether the letter writer actually knows the applicant or if they are simply using a boilerplate template. Additionally, while unfortunate, status and pedigree matter in academia. If you can, and if it satisfies the previous criteria, obtain letter writers who are well known in their field. For example, this may include those with prestigious prizes (e.g., SIAM and/or AMS Fellows), named professors, or many publications in leading journals.

Personal statement

The personal statement is usually 2–3 pages long and offers applicants the chance to share their academic background and future ambitions. In it, you should explain why you are pursuing graduate school and convey your passion for the field of mathematics. You should also discuss your academic journey, including any undergraduate research experiences, and any struggles or hurdles you've had to overcome along the way. Additionally, you should briefly touch on your research and subject interests. This part doesn't have to be too detailed, and shouldn't be a commitment to a specific area, but it should provide a sense where your academic focus lies.

In addition to these general components, it's essential that you tailor your personal statement to each university you're applying to. Clearly explain why you are applying to program X, whether it's the resources, academic program culture, or reputation of the department that attracts you. Highlight any research groups or professors you are interested in working with. Feel free to mention faculty by name – it shows you've done your homework (and academics like to read about themselves). Finally, discuss how you plan to contribute to the program's academic community, showing that your statement closely aligns with the department's environment.

GRE

The merit of incorporating GRE scores in the ranking of a graduate application seems to be mired in some controversy as of late. They are not required in many graduate programs (including Pitt), but may still add some value of the application as a whole. I will not dwell on the merits or flaws of the GRE scores, but only provide my own (brief) two-cents: (i) The Math General GRE score typically works against applicants. For example, scoring below the 80th percentile can be a red-flag, yet scoring above this threshold – on a test consisting of high-school level math – is not too impressive for a striving PhD student. (ii) The Math Subject GRE can potentially help an application other areas are lacking. For example, a strong Subject GRE may offset a lower GPA caused by a few poor grades.

Conclusion

Applying to a PhD program in mathematics is a multifaceted process that requires preparation throughout your undergraduate experience. It involves building a strong GPA, forming relationships with professors, and engaging in undergraduate research. While these components provide a foundation, equally important is the ability to work them into a personal statement that highlights your passion for mathematics and your long–term academic goals. A strong application does more than simply check off a list of requirements. It tells a compelling story about your academic journey, your commitment to the field, and your potential to contribute to the academic community.

Department of Mathematics, University of Pittsburgh, Pittsburgh, PA 15260
E-mail address: neilan@pitt.edu

Pittsburgh Interdiscip. Math. Rev. is published by the University Library System of the University of Pittsburgh.