One criticism of the modern web is that it creates silos—filter bubbles that prevent people from seeing outside their own worldview. I'm sure that is true in some cases. But in the mathematics community, I see the opposite. It is easy to see why a graduate student might think that mathematics happens only at R1 research universities and that anyone who does not end up at such an institution is not a mathematician. But through social media we see the true diversity of mathematics and of mathematicians. We can be successful in many more ways than by solving a famous open problem or by producing PhD students. I have been inspired by and have learned from middle school teachers, parents who run math circles, mathematical artists, and other people not considered to be "mathematicians." The sense of community is real and powerful. In fact, these social media platforms humanize the superstars. We see that they live ordinary lives, they make mistakes, they have gaps in their knowledge, and they care about students, the profession, and the world.

Social media is a great resource for isolated academics—mathematicians who do not have access to a local research community. Many research collaborations emerge out of social media connections. Social media duplicates some of the benefits of attending conferences, which are becoming increasingly more difficult for many academics to attend, whether it is for financial, personal, or geographical reasons.

Words of warning. The online world can be toxic, and we make ourselves vulnerable by putting ourselves out there. It can be especially bad for women, people of color, members of the LGBTQ community, and individuals in other underrepresented groups. Before writing this article, I reached out to friends who are members of these groups. They reported many more positive experiences in mathematical social media than negative ones. The one exception was MathOverflow, in which the ability to downvote questions and answers, to close conversations, and to comment on responses make it an unwelcome place for some of them.

My personal golden rule for social media is that it should not be a new source of stress. If a Twitter user tries to start an argument, I don't reply or I block the user. There's a familiar internet warning: "Don't read the comments." I would not offer that advice in mathematical social media; some of the best ideas come out of online conversations. However, comments can be hurtful, especially when a blog post goes viral and trolls come out of the woodwork. In such cases, ignore the comments, delete them, block the commenters, or turn off the commenting function for the page altogether.

There is also the possibility that a social media user could damage his or her personal or professional life by posting an inappropriate joke, photo, or comment. We warn our children to be careful about what they post online, but it is important for us to remember this as well. Do not post something on social media—regardless of what you think your privacy settings are—that you would not want to be in the *New York Times*, in the newsfeed of all of your students, or in the hands of your provost.

Who to follow. I have avoided recommending specific blogs to read, people to follow on Twitter, or YouTube channels to watch. There are many good options, and each person should build his or her own circles. But as a start, one might visit `truesciphi.org`, which has lists of mathematicians on Twitter and mathematicians' favorite Twitter feeds. Also, mathematicians may enjoy the Twitter hashtags #mathchat and #mtbos ("math Twitter blogosphere"). For blogs, one might peruse the AMS's "Blog on Mathematical Blogs" (`blogs.ams.org/blogonmathblogs`), which is updated regularly. Or, for a one-stop-shop, the MathFeed app.

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David Richeson

Credits

Author photo is by Mark Richeson.

Using the arXiv

Greg Kuperberg

Although these days virtually everyone in the mathematics profession knows something about the arXiv, a small introduction may still make sense before turning to advice about using it. (First of all, it is officially just "arXiv," but many people like to say "the arXiv." I am in the latter camp

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out of habit, but I consider both usages to be correct.) The arXiv was started in 1991 by the physicist Paul Ginsparg, who was then at Los Alamos. It was initially called "hep-th" because theoretical high-energy physics was its first category; then eventually the name "arXiv" was chosen and became stable. It is the dominant e-print repository across physics, mathematics, and computer science, and carries a few other much smaller sections. As of September 2019, it has nearly 1.6 million submissions, growing at about 150,000 per year. Of these, more than 350,000 have a primary mathematics classification, growing at about 35,000 per year. The mathematics section began in 1992 with the algebraic geometry category (then called "alg-geom"). Math expanded relatively slowly for a few years, and then began in its comprehensive form with thirty categories in 1998. I should take this space to thank David Morrison for asking Paul Ginsparg to create the mathematics section of the arXiv. He was the original moderator for alg-geom, and he convened and chaired the original mathematics advisory committee in 1997.

Despite its enormous influence, the arXiv has a fairly small paid staff at Cornell University, about ten people in total, whose duties include user help, software development, fundraising, and management. It also has about two hundred volunteer moderators and advisory committee members.

I serve as the chair of the advisory committee for the mathematics section of the arXiv, and as the appellate mathematics moderator. (I also run a front end for browsing and searching the arXiv called "Front for the arXiv.") In that capacity, I was invited to contribute this Early Career piece. Since the arXiv has an extensive online help system, I will focus on advice rather than instructions for using it. I'll start with the most general point that comes to mind.

Practicalities should come before opinions. In its twenty-eight years of existence, the arXiv has always attracted many opinions. People have ideas about endorsing the arXiv, or extending it, or criticizing it. Or more radically, some people boycott the arXiv, while others dream about supplanting it with something better. All of this is perfectly valid for discussion, but I recommend first considering how the arXiv can be useful to you as a mathematician. Particularly in the early days, the arXiv's user interface was on the forbidding side. Although that has improved, the arXiv has grown relentlessly because people need it, not because they like it. (Although many people like it a lot.)

Reading the arXiv

With that general point out of the way, here are a few thoughts about reading the arXiv.

Subscribing to the arXiv can be excellent for your development… Whether by email subscription or by browsing the daily announcements, recent arXiv listings are a great way to experience the drama of new research in mathematics. This advice might only be fresh for graduate students. If you are a graduate student, you might want to try it. Although it's not really all the research in the world in any category, it's a comprehensive portion, and it is more likely to have the best new results. It is impossible to understand everything posted, but it's still very exciting.

…but don't overdose on announcements. Although there are roughly thirty arXiv categories in mathematics, the average math category still gets more than 1,000 submissions per year. Again, each category is especially likely to carry the best results in the field. If you have subscribed for a while, and especially if you are on the job market, it's best to calm down and not feel that you have to keep up with everything. Of course you don't.

Egogoogling has its benefits. If you already have a publication record, then I see nothing wrong with looking for your own name in the arXiv from time to time. I think that getting cited or mentioned is a reasonable form of encouragement, and people who cite you are often doing research that is relevant to yours. The arXiv has a full-text search facility; or you can look in Google Scholar; or you can do a Google search of the form "`bourbaki inurl:pdf/1901 site:arxiv.org`."

Submitting e-prints

Here are rather more pointers about submitting e-prints to the arXiv.

There are many good reasons to submit to the arXiv… The main criteria for suitability of an arXiv submission are fairly simple: Does the submission have the basic format of a research document, and is it plausibly interesting for a research audience in its category? This criterion is similar to publishability in a journal, although it is not exactly the same; for instance, it includes PhD theses. It also doesn't have to be a final draft (although good drafts are generally preferable). The main consequence of submitting an e-print is also straightforward: People will see it and read it! It is not uncommon to get unsolicited email expressing interest in your work after you submit to the arXiv. It is also particularly convenient to submit an e-print before giving a talk, since interested listeners will retrieve it afterwards (or even during your talk in some cases).

Even if submitting to the arXiv isn't traditional for your advisor, or your coauthor, or your department (all of which still sometimes happen), it is still a valuable method of scholarly communication.

…but don't be cavalier. Although the submission standards for the arXiv are more flexible than for journals, the arXiv is not a free-for-all for stunts, would-be blog posts, and wild experiments. Moreover, although revising an arXiv submission is a perfectly normal practice, all public versions are permanent. The best principle is simply to respect the audience, as you would when giving an invited seminar.

Limited pre-arXiv circulation can be sensible. Okay, you think that you proved an important theorem; but is it possibly too good to be true? Instead of rushing to post it

before your excitement fades, you can consider limited circulation among close colleagues. I don't think that anyone should be outright scared of submitting to the arXiv; everyone accepts that to err is human, and arXiv submissions can be revised. Moreover, papers with mistakes are often partially correct or otherwise still valuable. Rather, you should remember that you don't need to wait for the formal referee process to get some useful independent review.

Use arXiv identifiers for both published and unpublished references. Many people see it as traditional to give the arXiv number only for references that are not yet published in journals and thus only the journal citation for published papers. For various reasons, it's better to include the arXiv number for every bibliography entry that has one. It makes your bibliography more useful. You should also follow the standard format of an arXiv identifier, "arXiv:1234.56789," or variations of that for older e-prints.

Use the daily deadline as a breather, not a race. As the arXiv instructions explain, the submission deadline for the immediate next announcement is always 2pm, Eastern time, excluding weekends and holidays. Although you may feel eager to rush the submission before this deadline, this is usually a mistake. It's usually wiser to finalize a submission after the cutoff rather than immediately before it to give yourself about a day to check for mistakes.

Take your time with the metadata and the preview. In the old days, the arXiv had a nerve-racking interface with no preview page, but now fortunately it has one. The submission system lets you double-check everything, and you really should. It is easier than you think to rush forward with a missing bibliography, with a spelling mistake in your title, etc.

Choose categories according to readership, not taxonomy. The arXiv is not just an automated digital library, but also a living social network. You should choose the classification for submission based on who would be interested in your e-print (with some restraint), rather than which concepts it mentions. For instance, just because you use groups in your paper, that does not necessarily make it a group theory paper.

Keep your paper titles in sync. For all of the work that has gone into document identifiers and bibliographic records, a stable title for an e-print or a paper matters more than ever. It matters for both people and software to decide when two documents are meant to be two versions of the same document. So you should choose the title of your e-print carefully before you submit it to the arXiv, and you shouldn't change it for small reasons.

Notate any major reuse of text in the comments. Of course, it is usually poor scholarship to reuse a lot of text from another paper by you or anyone else. This is one reason that the arXiv has text overlap labels. But there are exceptions; for instance, you may have a journal article with pages in common with your PhD thesis. In any such circumstance, the best step is to document the shared material yourself in the comment field. If you put a standard arXiv identifier here, it will get hyperlinked to the other e-print.

The TeX source is public. It is good practice to clean up your LaTeX and remove vestiges that you don't want other people to see. You are also always free to download the source of any arXiv e-print, if you want to work from examples to better understand LaTeX document classes, style files, TikZ, commutative diagrams, etc.

You can include code and data as extra files. If your work is computer-assisted and you have supporting code or data, then it can be a good idea to include it with the TeX source of the submission. (Within reason—don't do this if it runs into gigabytes.) In fact, attached files are better than appendices with huge, unusable data tables. You can include a special file, "00README.XXX," to get the autocompiler to ignore these files.

Seek solutions before blaming the system. Although it has gotten much better, submitting to the arXiv is still a bit forbidding, above all because it has a tiny staff in relation to its enormous user base. If you feel stymied while trying to submit something reasonable, then there is probably a workaround. Studying the help system and asking other arXiv users is a good idea. If that's not sufficient, you can send help email to the Cornell staff; the only problem is that the staff is small.

Share the password with coauthors, and add publication information. It may seem that your e-print no longer needs your attention after you submit it and it has appeared, but there are some side errands to keep in mind. For one thing, you may want to revise it later, but a couple of other steps are also good practice. You should share the password with your coauthors so that every interested coauthor can share ownership. Also, if you later publish the e-print in a journal, it is good practice to add a journal reference in the journal-ref field. (These extras might one day be more automated; for now, they are usually but not quite always on you.)

Revise your arXiv e-prints, but sparingly. The ability to revise an arXiv e-print is an important part of the system. It is silly to imagine that the first arXiv version needs to be perfect. At the other extreme, it's equally spurious to interpret the arXiv version as just a draft and the journal version as "official." You help the readership when you revise your arXiv e-prints. In fact, if you find a mistake after your paper has been published, you can make the arXiv version more accurate than the journal version. You should just be careful to plan ahead and collect corrections before revising an arXiv e-print. Only the first five versions are listed in the daily announcements, although the most recent version is always the default one on the web. Also, the first version usually gets the most attention in the short term.

Other Thoughts

Although one of my points is that practicalities should come before opinions, in the end there is also time for

opinions, activism, and thoughts about the future. I certainly think that the arXiv in general and the math section in particular are as important as ever. If you want to actively support the arXiv, then one valuable form of participation right now is to serve as a math category moderator. (If you have early career concerns such as getting a job or getting tenure, those would ordinarily take precedence over serving as an arXiv moderator.) Looking to the future, I see the math arXiv as an unfinished effort, no longer mainly because participation is less than 100 percent, but above all because the journal publication system is still roughly the same as it was in the twentieth century. (Journal articles are now submitted and published online, but other basics such as journal titles and paid subscriptions are still traditional.) I think that the peer-reviewed layer of mathematical communication will be modernized in an effort parallel to the arXiv, although not necessarily directly as part of the arXiv. However, this will be a major reform and it remains to be seen how it will happen.

Greg Kuperberg

Credits

Author photo is courtesy of the author.

Where to Submit Your Paper

Chuck Weibel

If you are early in your career, and have just finished writing a paper, you will want to get it published. However, you probably don't have a handle on where to submit your masterpiece. This is a very important decision, since your nascent career probably depends heavily on accepted publications to get jobs and get promoted.

Here is a list of dos and don'ts, based upon the assumption that you don't have tenure and are within five years of your PhD.

Do ask for advice! The best advice I can give you is to talk with a senior faculty member about which journal to submit your article to, and take advantage of their experience. Your advisor is not the only person you should ask; it helps (but isn't crucial) if that person knows your field.

When I was a graduate student, I had a woefully bad understanding of where to publish my first paper. Thankfully, after hearing some of my ideas about this, a sympathetic faculty member (Paul Sally) sat me down and helped me decide where to submit it. He knew nothing about the subject area, but he had experience with submitting papers.

Do tell what you've done on page one! One of the worst mistakes I see authors make is to postpone telling the reader what the punchline is until page 3 of their paper. Don't begin with a long history of the context of your main result—tell the reader what you've proven, and only then explain why the reader cares. It is even better if you announce this in the first fifteen lines. If your result uses special terminology, explain the terminology immediately after stating your result. You can put your result into context after the reader knows what it is.

Editors choose referees, and make accept/reject decisions, based on how well the paper sells itself. Since they frequently only read the introduction, and often only the first page, that has to be where they see what is great about your paper. (My apologies to any diligent editors reading this. I'm speaking in general terms about human behavior.)

Follow the crowd. Do think about which journals have published similar papers in the same subject. The "Citations" link for reviews of these papers (and other papers by their authors) in MathSciNet is a very useful tool for getting a list of journals that may be appropriate for your paper. In many cases, you may want to submit to a "niche" journal like the *Journal of X*. (X can be Algebra, Combinatorics, Topology, Functional Analysis, Linear Algebra, Differential Equations, etc.)

Don't go for broke! Do not submit your paper to a top journal unless you have solved a really famous outstanding problem. Although you might get lucky with a quick decision, which is always a rejection, the more common result is a rejection after eight months or more. At that point you will have to revisit the "where?" problem.

Delaying the time before you get credit for your work can have real-world negative consequences for you. In boxing terminology, when you submit above the weight class of your paper, you hurt your career.

How to relocate. Suppose that your paper is rejected. Now you have to go through the process all over again. But don't be discouraged! If you are lucky, the referee will propose a more appropriate journal for your rejected paper, and the editor may pass along this recommendation with a promise to share the referee report (and sometimes the referee's identity) with editors of the new journal. This is great for you, because you don't have to wait very long for a referee report, and it is great for the community of referees, because it avoids duplication of effort. This referral process

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