

Oh, the Places You'll Apply!

CAROLYN CHUN AND DAVID PHILLIPS

To be successful in academia requires mastering a variety of skills. A great deal of planning ahead is required to obtain a permanent job in mathematical academia. In this article, we focus on the academic market in the USA.

Caveat emptor

In this article, we ignore the dire statistics concerning the number of scientists with doctoral degrees that are unable to stay in academia.

Carolyn is a pure mathematician working in matroid theory, and David specializes in operations research¹. As we discuss below, this difference in specialty results in different experiences. However, we note that our viewpoints are only a small sample and anyone applying for jobs is encouraged to talk to individuals in their own specialty. For the record, Carolyn and David combined have applied for over 500 jobs and have been offered fewer than 10 of them.

We focus here on the search for a job in a mathematics department in the United States. Recipients of degrees in the math sciences, e.g., mathematics, statistics, or operations research, should also consider departments outside of mathematics. We stress that our advice and information focuses on the academic situation in the United States.

It's a good thing mathematicians have a strong work ethic

The skill set required to learn graduate-level mathematics, do original research, write and defend a dissertation², and obtain a PhD takes years to cultivate. In the US, depending on specialty, this typically takes between four and seven years, as most PhD candidates do not begin their program with a master's degree level of mathematical training. The skill set required to obtain a job as an academic can seem completely disjoint, but the application process is no less important than obtaining the degree itself. The

work that it takes is often minimized, and applying to academic jobs may seem almost an afterthought, but this work will either launch or sink an academic's career, and it varies from place to place.

In the US, the typical academic ranks are assistant professor, associate professor, and professor. The latter is also called full professor. "Lecturer" in the US refers to a teaching position that is not necessarily permanent or research-active. Another title in US job ads is "visiting professor," which is usually a one- to three-year postdoc position that is either research-intensive or teaching-intensive. Some universities have named professorships. Among Carolyn's collaborators are Boyd Professor James Oxley, and the Herbert Butts Memorial LSU Alumni Association Departmental Professor in Mathematics, Guoli Ding. Roughly speaking, assistant professor in the US corresponds to lecturer in the UK and associate professor corresponds to senior lecturer. It gets a bit harder to directly compare the UK ranks of reader and professor with the US ranks of full professor or named professor, as the details vary between institutions.

In addition to these ranks, there is also the process for obtaining permanence at a US academic job, called tenure. An assistant professor is considered "tenure-track," and the other ranks (excluding lecturer and visiting professor) are considered "tenured." In what follows, we discuss tenure-track assistant professorships. Obtaining tenure is a process that usually takes about six years and is itself a complicated endeavor that depends on the institution. Departments hire assistant professors with the expectation that they will obtain tenure, although tenure is never a given. Describing the associated challenges are beyond the scope of this article and we merely note that the joys of completing applications do not end with obtaining the tenure-track

¹also known as "operational research" in the UK.

²also known as a "doctoral thesis" in the UK. (In the US, the term thesis is typically associated with masters and bachelors degrees.)

assistant professorship. There are also schools³ that do not offer tenure.

Charming nuances to observe in American schools

According to the Washington Post⁴, there are approximately 5,300 schools in the US that offer degrees past the American high school level. There is considerable heterogeneity in these different schools and we limit our attention to describing the schools that would hire tenure-track assistant professors in a mathematics department. Such schools are typically called colleges and universities, although college is a term often used to describe any school of higher learning⁵. For our purposes, the important feature that distinguishes schools are the types of degrees offered. Some schools have as their main focus, or even exclusively offer, undergraduate degrees (associates and bachelors), while others offer graduate degrees (masters and doctorates) as well as undergraduate degrees. The latter tend to be considered universities although all possible permutations of school names and degree offerings exist. For example, The College of William and Mary and Dartmouth College are both universities with mathematics departments that offer graduate degrees and the Naval Postgraduate School exclusively grants graduate degrees. The degree focus of the school determines the proportion of students who are at the undergraduate, masters, or doctoral level. This proportion, in turn, determines many important factors for faculty such as the skill level of student research collaborators, the types of grant funding that may be needed, and the teaching requirements.

In the US, almost all academic jobs in mathematics departments are not full-year jobs. The faculty is paid for nine to ten months and is responsible for obtaining summer salary during the period of time between the end of the academic year in May and the beginning of the new school year in August. Most US schools use a semester system, where classes are offered during the autumn term and during the spring term, with limited class offerings during the summer term. Other schools use a quarter system,

offering classes during three periods of time in addition to summer classes.

Playing the numbers game

The winning strategy when it comes to the job market is brute force method.

- (1) Apply early.
- (2) Apply often.
- (3) Apply everywhere!

Anyone seeking an academic job in mathematics in the US will need to begin applying to jobs around August of the year before they would like to start the job, assuming that they intend to start at the beginning of the fall semester. To be clear: over one year of lead time may be required to get a job in the US. Lead time for applying to jobs in Europe and the UK market is usually much less. The steps for putting a job application packet together are detailed in the next section.

A mathematician's first job after graduate school is often not in the place she will be long term. She may do several post-docs or visiting assistant professorships, although this is dependent on specialty. Anyone who likes shopping is welcome to think about the job hunt as shopping for a next venue. Whether you intend a brief stay of a year, or you intend to remain indefinitely, we suggest that quality of life is best ensured by assessing the location. Cost of living, public transportation and proximity to an airport, healthcare options, language barriers, cultural factors, and climate conditions are all worth taking into account.

A major factor in these decisions is the availability of jobs that start at a convenient time. The absurd truth of the matter is that the majority of math⁶ professors working in the US did not have a particular dream school in mind to work at, but instead applied to the schools that were hiring the year they graduated or completed a postdoc, accepted the job that they were offered, gained tenure, and intend to stay until retirement.

³In the US, school is used as a generic term to refer to any institution of learning. We understand this usage can be disconcerting for those in the UK. However, in the interest of acclimating the UK reader to our (charming?) US vernacular, we liberally use school, operations research, other American academic slang, and American pop references. In a seeming tangent, we insist that watching *The Godfather I* and *II* is an essential part of any complete mathematical education.

⁴<https://www.washingtonpost.com/news/grade-point/wp/2015/07/20/how-many-colleges-and-universities-do-we-really-need/>

⁵For example, see <https://www.usnews.com/best-colleges>

⁶also known as "maths" in the UK.

Another hard truth that does not receive enough attention when studying for a PhD is that the quality of your research may be secondary to your field of research in the job search. When a school is ready to hire an assistant professor in mathematics, it is often interested in particular fields of study. Since the job search greatly impacts an academic's career, this means that an academic is well advised to understand how her specialty relates to other areas.

Carolyn, the matroid theorist, obtained her PhD in 2009 and worked as a research postdoc from 2009 until 2015, so she sampled the job market every year in between and has this to report: the general category of "pure mathematics" is rarely the direct target of a job ad, whereas statistics and the general category of "applied math" are often direct targets for job ads. Further specifications are popular, too. Mathematical biology, computational mathematics, the fields of analysis, algebra, and geometry are popular fields for assistant professor openings as of the writing of this article. At one job that she applied to, there were about 400 applications for an assistant professorship of unspecified field, whereas an assistant professorship in math education at the same school received about 40 applications. As a pure mathematician, she would not advise anyone who loves studying matroids to give up their passion, but it can be worthwhile to find other sides to your field. For example, matroid theory is related to graph theory and coding theory, which can be considered applied math, and can justify a matroid theorist to consider applied math positions.

David obtained his PhD in operations research in 2007, the first year of his first tenure-track job. There are few post-doctoral opportunities in operations research. Most graduates either take a tenure-track job or work in industry after completing their doctorate. For a variety of reasons, including the "two-body problem,"⁷ he was on the market from 2006 until 2011 when he accepted his current job. Echoing Carolyn's advice, at every job he applied for, he found considerably more success when he found connections between optimization and other mathematical specialties such as real analysis, graph theory, and even matroid theory. In addition to finding potential research collaborations, he was able to assess and demonstrate his fit with potential colleagues.

Coffee can be converted into paperwork (as well as theorems)

There are a lot of reasons to become a mathematics professor. The beauty of mathematics, the satisfaction of being an educator, and the joy of paperwork, to name just three. Anyone who could not find joy in paperwork would never want to write a dissertation, a curriculum vitae (CV), a teaching statement, a research statement, and a grant application, right? Maybe it's not fair to categorize these items as "paperwork," but maybe it is fair. History will judge us.

There is no way that we know of to avoid paperwork and become a successful academic. We can suggest many procrastination techniques that have worked well for us in postponing paperwork for a finite amount of time, but the most gratifying way to do paperwork that we have found is to complete it as soon as possible. The pitying condescension with which one who has completed her paperwork approaches her colleagues who have not completed theirs is sufficient reward.

For those of us who do not love paperwork, however, luckily there are lots of ways to get a job. Except in academia. Excelling at plumbing is a good way to get a plumbing job. Excelling at mathematics, excelling at communicating in written and oral forms, excelling at teaching and caring about students, excelling at mentoring students of all abilities and dispositions, and excelling at meeting deadlines and completing committee work are required to get an academic job. It's a lot to take on board. The written communication skills are particularly relevant during the job application process. All of the following documents are usually required to complete a job application:

- (1) a CV,
- (2) a teaching statement,
- (3) a research statement,
- (4) three letters of recommendation, one of which specifically addresses teaching, and
- (5) a cover letter.

There are excellent resources online for putting each of the first three items together. For Item (4), the applicant will need to identify prospective letter writers well in advance of applying to jobs. For Item (5),

⁷In the two-body problem, one has a romantic partner that is also an academic but is at a school distant enough to preclude reasonable co-habitation.

each letter should be specific to the school and position. A cover letter to a research-heavy position will be different from a cover letter to a teaching-heavy position. It is considered good form to know something relevant about the school, gleaned from the website or by word of mouth, and to include the fact that the applicant is a good fit for the position due to that information. The applicant should indicate whether or not she will attend the Joint Mathematical Meetings (JMM) that January in the cover letter, since many US institutions have representatives at the JMM and conduct interviews there. The JMM is the largest mathematical gathering in the US every year, and its location varies. It is worth reviewing the topics of the sessions offered at the JMM. The applicant should endeavor to attend the meetings and to give a talk, either by asking an organizer for an invitation from an appropriate session, or by giving a contributed talk. This advice is also true for operations research and statistics albeit with their main conferences, i.e., the INFORMS Annual Meeting (INFORMS) for operations research and the Joint Statistical Meetings (JSM) for statistics, although the applicant in those fields is still encouraged to attend JMM as well.

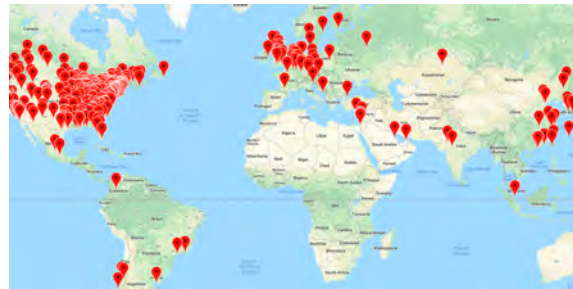


Current job openings listed on www.mathjobs.org for math PhD's. Red dots on the map indicate job openings. Image used with permission from the AMS.

Optimizing your journey

The American Mathematical Society (AMS) Employment Services for PhD Mathematicians (tinyurl.com/y9dw96mo) provides lots of support for job applicants. It is considered by many to be the canonical website for PhD mathematician job seekers in the US. Here is a quote from their website: "The AMS provides the automated MathJobs.Org job application system plus job ads on the web and on paper, and helps arrange interviews at the January meetings." The January meetings referred to here are

the JMM. This webpage includes links to four services for those seeking jobs, including MathJobs.Org, which is the job listing site that the authors of this article used most heavily.



Current job openings listed on www.mathjobs.org for math PhD's. Red dots indicate job openings. Image used with permission from the AMS.

It is free to create a profile on MathJobs.Org, where you can store all of the documents necessary to apply to jobs, and then apply to those jobs with just a few clicks. Here is some information from the website about the website: "MathJobs.Org was officially launched in August, 2000. In the last 12 months, 1008 employers from 202 states in 44 countries have used the service for 2279 job ads (with 1168 ads-only); 36956 unique users have logged in; 2361 applicants are currently on the 'Job Wanted' list; 8091 applicants have uploaded 197487 new documents; 7785 applicants have submitted 147447 new applications, with an average of 18.94 positions applied per applicant; 21742 reference writers have used the system, with 16205 reference writers uploaded 28718 new letters." This data on the site highlights the amount of traffic it receives. This is good news, aside from the ratio of job seekers in the US to jobs being about nineteen to one: MathJobs.Org can be considered a one-stop shop.

We note that the ease of applying to jobs on MathJobs.Org contributes to the high number of applications for jobs that can be applied to through the site. Some schools list information about open positions on the site but only accept applications through other avenues, and those positions are likely to receive fewer applications since they are slightly more onerous to apply for. You may want to apply to jobs that only list job openings on their websites or where applications are only accepted via snail mail to ensure that the number of co-applicants is relatively low.

Take a deep breath and send it all in

In this beginning stage of the process, you submit your lovely paperwork as described previously, typically via MathJobs.Org. Once these materials are in, faculty at schools begin their decision processes to identify the most promising applicants for further screening. Whether this decision is made by a single individual, a subset of the department, or the whole department is school-dependent. At this stage, given the likely large number of applicants, the department must reduce the number of applicants being considered to a manageable number. It is critical you do not create an easy way for your paperwork to go the way of the dodo. In particular, the you are strongly advised to do the following:

- Make every effort to have materials in on time. For example, a common deadline statement is, “For full consideration, please apply by 8/1/2018.”⁸
- Understand what materials are requested and if any variations on the basic template described above are requested. For example, a current job listing for a teaching focused assistant professorship states, “To apply, please upload a single PDF file which includes a cover letter, a detailed resume and evidence of teaching excellence.”
- Email the contact person to ensure submitted materials have arrived. This both ensures no mishaps with the system have occurred and also signals interest in the job.

Submitting applications is an enormous amount of work — 100 is a normal number of applications to submit when seeking your first job — and applicants really deserve a lot of chocolates, pats on the back, and free drinks for reaching this point in the process. The process is not over, however, so you should keep your game-face on.

What to expect when you're expecting (a response to your applications)

After you have submitted your materials, the next step of the process is the screening interviews. This can be an in-person interview at one of the annual meetings mentioned above (JMM, INFORMS, or JSM)

⁸Note that this means August 1, 2018. In the US, we (how charming!) switch the month and day from the convention used by nearly all of the rest of the world. We also find the metric system *terrifying*.

or a phone interview. The degree of competitiveness varies across both school and type of interview, although typically the phone interview signifies you have made it past one level of screening. At this point, the department is trying to decide which applicants to invite for an on-campus interview. Again, the numbers do not favor you. We therefore advise you to follow these steps:

- Read the job listing again with care and be sure to understand what the department is looking for.
- Find out as much as possible about the faculty at the department including their research specialties and courses taught.
- Be prepared to answer questions about teaching, research, and grant experiences. Think carefully about challenges faced and lessons learned in these areas.
- Prepare a list of questions about the institution. You may want to inquire about typical teaching loads, research collaborations, grant expectations, and student research opportunities. It is also a good opportunity to ask about the culture of the department, the cost of living nearby, and the job satisfaction that the interviewer has experienced in the department.

Planning ahead to apply to the US academic market

- The overwhelming majority of positions begin in the autumn.
- Application deadlines may be as early as the autumn of the year before the autumn that the position is for.
- If the applicant would like to begin working in January, then she should apply for autumn, and ask to delay by one semester after receiving a job offer.
- The applicant should plan to attend the Joint Mathematical Meetings in January.⁹

⁹For those in operations research, the applicant should additionally plan to attend INFORMS in late October or early November, and for statisticians, the applicant should plan to attend the JSM in August.

The big show

After you have gone through the screening interview process, the next step is the on-campus interview. This typically consists of one to two days of interviews with individual or groups of faculty, meeting students, and giving one or two job talks. Depending on the school, one job talk will focus on your research and the second on teaching. In the latter case, applicants usually give a talk to students with one or more faculty present. The importance of the job talks cannot be overestimated: this is often a major part of the decision process for most schools. We offer the following advice.

- Suss out the knowledge level of the audience in their particular research area and be sensitive to ensure enough introductory material is present. Depth at the end of a talk is encouraged but be sure to start from a point which any member of the audience can understand.
- If there is a teaching talk, be sure to be organized and understand fully what material should be covered. Extra material such as slides and handouts can be helpful and demonstrate preparation as long as they are used effectively.
- Be aware of your rights under the law: For example, it is illegal to use gender, race, romantic partners, parenting, or disabilities to make employment decisions.
- At this stage, you are also interviewing the school: ask questions about the school that indicate a sincere vision of you being a faculty member at the school. Where would the faculty advise you to live? What opportunities for collaborations and summer funding exist? What courses would you be expected to teach? What, if any, travel funds are available to faculty?

They make you an offer that you can't refuse

Finally, you have received a job offer! Congratulations are in order from being converted from an applicant to a prospective employee. Typically, the chair of the department makes the offer and conducts subsequent discussions. At this stage in the process, you have to negotiate such things as salary, start date, and any additional remuneration, e.g., moving costs or start-up funds. We advise you as follows:

- Ask for time to consider the offer.
- Consult with others, e.g., your advisor.
- Consider the relative merits of other offers including non-academic offers.
- Consider your constraints, e.g., is there a two-body problem or some current job-related start date?

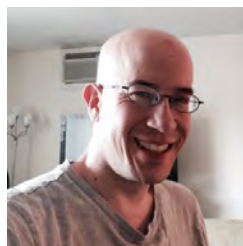
After these questions are answered, always negotiate. Respectfully ask for higher salary, more start-up money, a computer, a lighter initial teaching load, and travel funds. Patience is the best strategy here within the time constraints the department indicates. The chair will indicate what flexibility the department and school has, if any.

And then make a decision. Notify your letter writers of the outcome and thank them for their help. Whether or not you are successful, you are entitled to consume your weight in chocolate! Those are the rules! Also, keep in mind that any applicant who undergoes all of this bother and ends up leaving academia is likely to become exceedingly wealthy and happy. Her work ethic and big strong brains are a credit to her training, her family, and her country.



Carolyn Chun

Carolyn Chun is an assistant professor in mathematics at the United States Naval Academy. Her main research interests are graphs, matroids, and delta-matroids, but she procrastinates by writing experimental fiction and making comics of herself, her husband, her twin sister, and her tiny, hilarious daughter.



David Phillips

David Phillips is an associate professor in mathematics at the United States Naval Academy. His research interests are in convex and combinatorial optimization and their applications in data sciences. He never procrastinates under the logic system where “never” means “always”.