

Dear students and collaborators,

It has been over a decade that I have been seriously doing research with all of you without being clear about my motivations, intentions and so forth. What drives me to do research? Why do I pick particular problems to study and not others? What kind of graduate students and/or collaborators do I like to work with? What's the point of it all? I will try to write down a few of my current thoughts on these matters. Each person will, of course, have their own answers to such questions, and these are mine. I am writing this (as a hypothetical interview) because I hope it can encourage junior colleagues to think about these questions in their own research careers.

Q: You write a lot of papers. Do you like to write papers?

A: Yes, I love to write. But my love for writing is not connected to why I write a lot of papers. I think the volume of papers that anyone writes is an irrelevant metric. I don't care about it. Some people write more than me, some people write less, I couldn't care less either way. Let's make an analogy to journalism. Does it matter how many newspaper or magazine articles a journalist writes? Who cares, right? What matters is whether those stories were interesting, relevant, timely, covered fairly, covered in depth, gave appropriate broader perspective, raised interesting questions, moved readers, and so on. Those are my motivation when I write. If I think that I have an interesting story, then I want to write it down. Not just "another" story. Not just a story for the sake of a story. I don't need more papers to be published, so I am not doing anything out of any professional need. But if I discover an interesting story, I love to tell others about it, so I write. In fact, I think it's more than that. A large part of research is funded from taxpayer money. I feel like I have a *duty* to report things that I think will be interesting. I am not doing mathematical statistics or machine learning only for my own joy. Yes, I love it and it brings me joy. But I am also part of something much larger, like a subfield that is trying to ask and answer interesting questions, or a department that is trying to groom young graduate students to become mature researchers, or even the human endeavor to advance its science and technology through public investment in research. And in that broader context, I genuinely think that, if we have interesting ideas or make novel discoveries, we have a duty to write them down, communicate them with others to the best of our ability, and so on.

Q: Did you have the same attitude when you were a graduate student?

A: No. I published the first paper in my PhD in the middle of my 5yrs. At that point, I did not know if I was any good at research (though I did very well in my classes), so I had other more fundamental concerns (is a PhD the right choice for me, or should I do something else?). I always enjoyed writing and speaking, but that did not mean I was a good researcher.

Q: What makes a good researcher?

A: Are you asking interesting, or, the "right" questions? Are you providing interesting, nontrivial, answers, that are as simple as possible (but not simpler)? Those are the top two factors, in my opinion, but then there's a host of other ones obviously. Do you read the relevant literature thoroughly (both recent and classical) and assign credit appropriately (this will always be arguable, but one must try)? Do you express your ideas clearly, in writing and speaking? Do you

write carefully, taking care of notation, how assumptions/theorems are stated and discussed, etc.? Do you proofread carefully? And so on.

Q: Why not just put papers up on arXiv and be happy with that? Why try to get them published? Doesn't that burden the system?

A: Much of my work is technical and absolutely needs to be peer-reviewed for correctness, for relevance and so on. When done well, peer review improves the quality of papers because reviewers point out related references, ask pointed questions, find bugs/typos, etc. It would be far too presumptuous to assume that everything we put out is perfect and we can just leave it lying on arXiv for everyone to admire. The reality is that all papers are works in progress. I usually see significant changes from a first draft to arXiv-ready to submission-ready to revision to a final published version. Sometimes we even find improvements after the paper is published.

Q: What kinds of questions are you most interested in writing papers about?

A: That has changed over time. Right now, after having written my first book, I have a clear vision of 3 more books that I would like to write over the next decade. I know their topics and even titles. The questions that interest me most are those that will help fill in very particular gaps in my (or the field's) understanding. They correspond to certain minimal questions that I need to answer, without which any book on those topics will be incomplete. When I was younger, there was less of a vision, and I was often just following an interesting lead and seeing where it goes.

Q: Why do you want to write books in the first place?

A: Our field (statistics and ML) has been fantastic at generating new ideas (new theory, methods and applications). While researchers must expand our boundaries, I personally believe it is the responsibility of scholars to also condense that knowledge into more consumable bits. Otherwise, who is going to read the tens of thousands of papers that are written each year in these fields? Each of us can only read a tiny fraction of that. It's possible that most papers written won't be read by very many (even if they are superficially cited). It is also possible that most of these papers will be forgotten by the future generations, who won't bother to read them (or cite them). Later generations will not want to read hundreds of papers in different notations, in different journals/conferences. Much of the new knowledge that is currently being created will later be effectively lost to time. Due to the vagaries of social dynamics in research, some things will become exciting and fizzle out, others will steadily become more popular, and yet others will never take off. I think it is the responsibility of scholars to minimize that loss, or make it harder for things to be completely lost. I believe that we must compress the most important bits of research in our subfield into books, so that everyone outside of our subfield finds it easy to quickly learn the basics if they are interested, and lower the barrier for future generations to find out what we did. In other words, my researcher side wants to write papers (expansion) and my scholar side wants to write books (contraction). Maybe AI will become better at the latter, but until then, it is my intention to contribute my time towards it.

Q: Do you think it is important to promote your research?

A: I think it is important to *communicate* your research honestly. I do not think it is appropriate to *promote* your research if it involves potentially dishonestly hiding known downsides under a rug.

I am not here to promote an agenda. Yes, I may be studying certain classes of methods at the moment (conformal prediction or e-values or betting martingales), but I am not oblivious to their downsides or limitations. I am not a salesperson or marketer for a subfield. Yes, my enthusiasm about some topic can be high, but that's just because I think it is underexplored and has lots of beautiful properties that have not been recognized. It does not mean that I am a blind believer in anything (or anyone). If it eventually becomes evident that there is a better methodology or theory that would be relevant for the problems I am trying to solve, I will change my mind.

Q: Are you usually a very hands-on or hands-off advisor?

A: Usually, very hands-on, especially if it is close to problems that I care deeply about. I usually want to understand deeply both the big picture (why the question was important, why the solution strategy had not been tried before, etc) and the technical details (what step was really key and insightful versus what are just routine calculations). I usually will have opinions on every aspect of a paper: its title, abstract, introduction, notation, references, what results should be in the main paper versus supplement, what results should be theorems versus propositions or lemmata, how those theorems should be stated, what assumptions should be stated inline versus outside of a theorem and discussed, what experiments should be run, whether the story is convincing, whether the structure of each section makes sense, whether the paper is too long or short, where to submit it, what's in the cover letter, how to rebut, and so on.

Q: Do you see much in common amongst the graduate students you have worked with?

A: Not much in common besides being generally smart and eager to learn. I have had the fortune of working with dozens of excellent students, from over a dozen in my own postdoc at Berkeley, to over a dozen during my faculty time at CMU. These students have had incredibly varied backgrounds and skills, and most have gone on to successfully complete a PhD. Some were excellent speakers, and some less so. Some were excellent writers, some less so. Some were excellent at math, some less so. Some were excellent programmers, some less so. Some lead stress-free lives, and some seem stressed all the time. Some like to work during the day, some at night. Some burn out, some don't. Some work extremely hard every day, some don't have a good work ethic. Some come persistently late to meetings, some always come early. Some maintain superb notes on Overleaf, some are quite sloppy. Some have great aspirations and motivation, others don't. Some are physically and mentally healthy, others not. I've seen it all, and probably most faculty have.

Q: What qualities are you looking for in a graduate student?

A: Humility, patience, equanimity, sincerity and coachability. Of course, the admissions committee makes sure that everyone entering usually has excellent technical skills, motivation, aptitude and appetite for research, etc. So the differentiating factors will often be other things.

First, humility. There were excellent ones before you, and excellent ones will come after you. Most likely, you are not the best student that I have seen on any axis. Even if you're the best student I have seen at one on one axis, you're probably not the best on most other axes. (To be clear, the same held for me too when I was a PhD student. That's just life. Nobody is excellent at everything that matters. That's why we all need each other, need to learn from each other,

collaborate and cooperate with each other, etc.) Don't walk around patting yourself on the back all the time about how amazing you are at everything that you do; apart from annoying the heck out of everyone around you (especially your mentors who have always seen better). (Don't beat yourself up either, someone in the admissions committee probably saw something special in you to let you in, so you do have some special juice, but so do all of your cohort-mates, juniors, seniors, faculty, etc.) To be clear, most of the time, the students I have met have this quality. But oddly, sometimes they don't. Humility, I think, is absolutely natural in academia. At best, we are experts on some (relatively speaking) narrow slice of the literature, and won't have anything smart to say about the vast majority of research going on in our fields. It is just natural to admire the good qualities in everyone around you.

Next, patience. The PhD is more like a marathon than like a sprint. There will be ups (periods of fast progress, accepted papers, etc.) and downs (repeated roadblocks in solving some problem, rejected papers, etc.). It will take time to get a PhD. You need to be patient.

Next, equanimity. Google defines equanimity as a state of mental calmness, composure, and emotional stability that remains steady even under stress. Students will face many deadlines, and need to deal with them with a clear mind. Rejections are utterly common (even for the most successful researchers), and one must just take them in stride. The acceptances and rejections must be taken in the same stride. Students must learn, make amends, and move on. You cannot get swayed by the successes of those around you either; you're surrounded by brilliant people who will achieve amazing things — that's fine, and in fact you should be happy to know them, not feel pressured to do the same (or have the same level of success or fame or whatever). A famous phrase from the Bhagavad Gita comes to mind "Karm karo, phal ki ichha mat karo", meaning "Focus on the work, don't dream of the fruits of your labor".

Next, sincerity. Students will have to do many things that we may not want to do along the way (improving various skills that we are not so good at, certain PhD deliverables that may not make sense to us personally, formatting requirements of journals, reviewing papers, etc.). You cannot put those things off indefinitely. You have to just put your head down and do them. We all did.

Last, coachability. Google defines coachability as the willingness and ability to actively seek, receive, and act on constructive feedback to drive personal or professional development. It requires a growth mindset, humility, and the determination to implement changes rather than getting defensive. Every graduate student will improve during the course of their PhD. But how much? Will they plateau sooner or later? Will they maximize their potential? Sports coaches call this "coachability" and it is a huge determiner of future success. I've seen the best of students come in, and they simply don't care for getting feedback, and when they do, they don't care for it; they still do well because they're smart, but they're a headache for the advisor because they make the same errors (in writing or speaking or conduct or whatever) over and over again. And I've seen others who are seeking feedback at every single stage of their PhD, even before their defense, and sincerely incorporate feedback. Clearly, the latter are the ones that grow the most, and honestly give us the most pleasure to mentor. I personally would happily mentor a less

brilliant but more coachable student (of course, that's because admission processes usually guarantee a lower bound on each students' academic ability).

Q: What should students focus on in the age of AI?

A: The best AI models are already excellent at mathematics, and only going to get better over the next few years. They have “read” more books and papers than any of us will ever read in our lifetimes. They are faster at coming up with proofs or short lemmata, or counterexamples, than we will ever be, and making fewer mistakes and hallucinations with every model release. Currently, they are gearing up to be fantastic research assistants — smarter, faster, cheaper than human research assistants, and they actually listen to your questions, suggestions, instructions (they are patient, coachable, sincere, etc.). So outside of our duty — to the department, science, etc. — to groom the next generation of world class researchers, the incentives around hiring of graduate students has completely changed in the last year. It's clearly going to get harder for graduate students: the qualities that were mentioned earlier (outside of mathematical excellence) that I am looking for are no longer optional. The population of graduate students will need to grow up or mature very quickly, having a very high standard on all those character issues. Even then, students will have to think carefully about the value of a PhD (and how that value will change in a few years), what kinds of skills they want to develop (and whether those skills will be relevant in a few years), what they want to do after the PhD (and whether those jobs will exist in a few years).

Even senior researchers will have to re-examine research in the face of such insane progress in AI for math. I always thought that my own advantage was never the mathematical ability (there's tons of amazing mathematical statisticians all around), but having an inkling as to what is the right next question to ask and what its answer may look like, and collaborating with excellent people (usually who I like a lot, often friends) to help answer those questions. But can I be sure that this is something that AI cannot one day do better than me, or at least faster? Will AI replace us, asking good questions and providing interesting correct answers all in one endless loop, so that one day, I will wake up to find all my dearest open problems solved, the papers already written and submitted to arXiv, the talks created and uploaded on YouTube, with the book written in the following week? It's entirely possible, and then I'll have to find some other way to contribute to society. Sure, I can still teach (and I love to), but will AI be better at that?

Q: Do you think of research as being competitive?

A: Yes, it is competitive. But it does not have to be *ruthless*. Grants are hard to obtain, papers are hard to publish in the best venues, hard to get into the best PhD programs, hard to get faculty positions at the best universities, and so on, so of course it is competitive and silly to assert otherwise. Any selective process is competitive. We also take some joy in being the first ones to present some solution to interesting questions.

But all of this competition has to be taken in the spirit of true sportsmanship, i.e. taking inspiration from how good sportsmen deal with competition in (individual or team) sports. Sports is (perhaps even more) competitive, and people want to win, but when they are beaten, the right

attitude is to say “well played mate, fair game”, learn from it and move on. Fierce competitors on the field can often be good friends off the field.

Despite the competition, we should always behave with the highest integrity during grant and paper reviewing (merit must trump any other considerations), and be gracious in acknowledging others’ contributions. In the end, we are building communities, making lifelong friends and collaborators, and the competition has to be light and friendly, taken somewhat lightly in the grander scheme of science and life.

Q: Is there any point to all this research, mentorship, teaching, etc.?

A: In everything in life, there is only as much meaning to something as you give to it. For something as simple as spending 30mins slowly doing some art with your 3 year old, one person can see it as a waste of time, and another can see it as one of the most beautiful quiet moments of the day. The same goes for teaching, mentorship, research, service, etc. If you think that these are worthy endeavors, then they can provide great satisfaction in doing them well. If you don’t, then they can seem like a “waste of time”. So the difference is just attitude and perspective. In some sense, everything in life is somewhat meaningless. We do some things because we have to. As researchers, we are very lucky that we can spend most of our time doing things that we *want* to — pursuing questions that interest us, and things that we choose to give meaning to (for now). One can just as easily lose interest in some direction, and take meaning away from some pursuits. When that happens, it is ok (in fact advisable) to change course. You just have to hope that it does not happen too often, otherwise you will never have momentum and never go deep into anything. If you constantly second-guess yourself (or the field), you will never learn the joy of deep work, the feeling of flow, etc. So if you decide to give it a shot, go all in and dive headlong for some time and see what magic happens (if at all). You can always change course later on if you don’t like the way things are panning out.

Q: What about life outside research?

A: Despite all this talk about research, nothing is more important than the life outside of it. You will realize sooner or later that the most valuable things in your life are outside of work. The most important example is your relationships (with partners, parents, children, friends, colleagues, and so on). But there’s also things that may matter to you personally, i.e. hobbies, books, sports, travel, spiritual growth, personal goals, etc. Staying physically and mentally healthy is absolutely critical, nothing in research is worth giving up your health and long-term well being for. Sleep well, live hygienically, build good habits, live your life with vitality and bring joy to those around you on a daily basis. This is the only life you have, live it excellently.