Pursuing Research as an Undergraduate

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Disclaimers

- **Please keep survivorship bias in mind when listening to this talk.** Hopefully, I have failed enough to give a rounded view of what it means to pursue research as an undergrad in a college that is disconnected from research, but it is always a good idea to seek out more perspectives.
- Everything I know is a reflection of my 2 years pursuing research. It would be wise to seek out more experienced perspectives.
- This is a general discussion about undergraduate research.
- I will discuss privilege wherever relevant and aim to be as transparent as I can.

Purpose of this talk

- Introduce you to research and help you apply for research internships if you want to pursue it.
- Share my experience. There weren’t any seniors who publicly talked about research to me and I wish there had been.
- Hope that you will carry this forward and help others.

Qualifications to give this talk

- Summer 2019 : Summer Research Intern at IIT Patna
  Domain: Machine Learning, Dimensionality Reduction
  Co-authored three papers which were later published
- Summer 2020 : Summer Research Intern at IIT Bombay
  Domain: Program Analysis, Points-to analysis
- B.Tech. Project : Research Project
  Topic: Formalization of Translation Performed by the SCLP Compiler Phases
  Domain: PL, Compilers

Organization

- What is research?
- How do you ‘do’ a Research Internship
  - Before Applying
  - Applying
  - After Applying
- My experience, briefly

Part I
What is Research?

What is Research

- This is a very hard question and can take hours to answer.
- People who've been at it for much longer than me can answer this question more completely.
  - What is Research by Dr. Uday Khedker
  - You and Your Research by Richard Hamming
- For me, it is innovation and learning at its purest.

Why you should consider Research

- Useful in Campus Placements? Sure.
    - The ability to do research shows an ability to learn new concepts deeply, apply them and present it. This is something that you can talk about in your interview.
- Masters and PhD program admissions committees value research experience.
    - PhD programs value it more than Masters programs.
    - The more competitive the program, the more they value it.
      * Look at profiles of students in Stanford's ML graduate program.

Why you should consider Research

- Personally, it is fun, intellectually stimulating and enriching. You might end up making a career out of it.

Common misconceptions

You need to be smart to do Research.

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You need to be driven, excited, committed.

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You need to be driven, excited, committed.

~~You need to know what field you want to work in from the get-go.~~

A LOT of people change fields (so did I)! A lot of research is also multidisciplinary.

~~You have no business even thinking about doing research as a student in Cummins. You need to be an IITian or a genius or well connected or something that you clearly aren't to even think about doing big-brain things like research.~~

You are what you tell yourself. Don't hold yourself back.

Independent Undergrad Research

A common question I get is “Can I do independent research where I don’t have a professor advising me?”

Most of these students think that the way researchers write papers is, *Choose an algorithm, get some results, cite a few sources, boom it’s a paper and you can get published immediately!!*

- **You might impress your friends, but you aren’t fooling anyone worth fooling.**
- **Predatory journals will publish your paper without peer review because all they want is your money.**
- **Publishing in certain places can be a disqualification.**

Independent Undergrad Research

Good Professors are worth their weight in gold.

As an undergrad, you *need* a Professor with good research experience to help you. They can help evaluate your ideas, validate them and help you develop them. Ultimately, it is a collaboration and the best mentors push you to do the best you can.

Good work takes **time** and **expertise**, **not luck** and research is a marathon, not a race.

Chase opportunities to learn from fantastic people. There is so much that they can teach you! Enter: Research internships! A good way for you to try out research.

Part II
How do you ‘do’ a Research Internship

A. Before applying

How to choose a domain

- Pick a domain that you're interested in and dive right in.
- How to pick a domain?
  - Explore everything and anything that seems interesting to you.
    - I used Coursera to explore. Dan Grossman changed my life.
  - Build up a love of learning above everything else. Learn to think in concepts. Rote learning won't serve you here.
  - Focus on getting your basics right.
- You're still an undergrad. Better to try stuff out now and realise it's not for you. All good research experience is useful experience.

Hot vs. Not-So-Hot

- The disadvantage of ‘Hot’ topics:
  - Oversaturation.
  - You may get a fancy PI with no time for you.
- The disadvantage of ‘Not-so-Hot’ topics:
  - Not flashy. No one is talking about it.
  - Low hanging fruit are all gone.

Hot vs. Not-So-Hot

- So, what do I choose? Hot or Not-so-Hot?
  - Either can be a field that interests you. If your interest is due to how impressive a field sounds, realise that that isn’t sustainable.

Manage your expectations

- As an undergraduate, you can’t contribute until you put a large amount of time into building domain knowledge. The more you want, the more you will have to work for it.
- Levels of expectation from yourself: a certificate of internship, learnt something interesting deeply, a paper, a paper published in a reputable journal/conference, ground-breaking research*.
- Levels of expectation from a professor: resources, guidance, time.
- What you should *not* expect: Spoonfeeding, personal lectures

*Levels are shown in increasing infeasibility

B. Applying

Common advice

- Cold email professors! They’re dying to get students involved in research.
- Keep up a good CGPA and professors will ask you to work for them.
- Getting a research internship is a meritocracy.

The fallacy of common advice

- ~~Cold email professors! They're dying to get students involved in research.~~ *The better the institute, the more students are dying to work with professors. Professors are wary and many don't respond to emails. Especially true with foreign universities.*
- ~~Keep up a good CGPA and professors will ask you to work for them.~~ *Nobody cares about your CGPA. If anything they use it as a qualifier but no one has asked me for my CGPA.*
- ~~Getting a research internship is a meritocracy.~~ *Nothing is a meritocracy. You might be the best person for the job and still not get it. Such is life. Conversely, you might as well apply for every opportunity.*

My advice

Approach professors you know and talk to them about research. Talk about the domain you are interested in doing research.

Ask if they can refer you to a researcher they know.

Why do I say this?

- You are only as good as your PI. If you cold email, you might fall in with a professor who does bad research. No professor will (knowingly) recommend you to anyone who does bad research.
- Higher success rate and they might be more invested in your doing well than a random stranger (hopefully).

Ask your seniors to recommend professors to work with and refer you (if they can).

How do you ‘get to know’ a professor?

Talk to them outside class. Talk about the course. Talk to them about their research. Ask to get involved in a project.

Talk to them about what you want to do. Ask their opinions on those things. They have been in academia and research more than you and most are very helpful.

Be polite. Be kind. Be respectful. Do not talk to them with the solitary aim of getting something out of it. Just build a relationship with the teachers you like.

> P.S. You might need LORs from them in the future and if you speak to them, they can write more about you than a DWIC LOR.

Cold email advice

- **Don’t** send out your CV and CGPA and ask if you can contribute. No one will respond.
- **Do** read their website and their papers. Email them with some questions or a specific (related) problem you’d like to work on.
- Ask about the specifics of the work you would be doing. Establish what you expect very clearly (unless you want to spend 2 months doing nothing) but also be reasonable.
- Be prepared to send out a LOT of emails. 200 is not uncommon a number. Be prepared to be rejected a LOT.

Research programs

- IIT's have research programs that you can apply to. Look online for more program web-pages. Most applications begin in January.
- IISc's SRFP program and INAE's summer program. Some applications end in November.

Good luck!

C. After applying

Yay, you got in!

- If you get in early, ask to start working as soon as possible. Spend time BEFORE the internship to build up domain knowledge so that you can spend the months onsite doing real work.
- Once there, fight for good work if necessary. Believe in yourself and the work you can do and if you are unhappy with a situation, ask for a change. But, again, have this be grounded in reality.
- The quality of research you do is a function of time you put in so if you find a professor and an opportunity where you can really do good, if not great work, realise how rare and lucky that is and give it everything you have.

Publishing

- A question I get asked a lot is, “Do I need to publish papers?”.
  - This can vary from field to field.
  - For Systems, I would say “No”, but for ML, I would say “Yes”.
  - Focus on your work. If the quality of your work is good, you might publish a paper! That’s really all you should concentrate on.

What if I don’t get an internship

- Getting someone to give you a chance is hard and I think I’ve gotten fairly lucky, but I certainly have not gotten a lot more research internships than I have.
- Keep trying and know that everyone goes through this disappointment. You aren’t a stupid loser or anything else you might think just because you didn’t get an internship.

What if I don’t get an internship

- If nothing else, pick whatever topic you want to explore and do an independent project. Build a compiler! Develop your own programming language! Externalize your resilience as an answer to all your horrible luck.
- In the meantime, it would also be worthwhile thinking about what you can improve on in your search process.

Part III
My experience, briefly

Privilege

- Most research internships are not paid. You might need to bear the brunt of travel and living expenses and I am VERY lucky to have parents support me through this.
- Deciding to pursue research beyond a research internship is also a great privilege. I don’t need to provide for anyone and hence can make decisions that will only pay off in later years (hopefully :).
- My parents support and encourage my decisions. That can be rare, quite unfortunately.

Isolation :(

- I’m from an undergrad program that is disconnected from research. I am the only person in my year who is moving forward with research after undergrad. This can be quite isolating.
  - I can’t talk about flow and context sensitive interprocedural analysis with any of my friends because no one else knows about it or thinks it is interesting.
  - If you are in a similar situation, Twitter is a great place to find a research community :)

Why do I do it?

- It is so so so much fun.
- I love learning. It fills me with a lot of joy to learn and think about these research problems, which is why I love it so much and think it’s this much fun.
- If you’re like me, you might just find it to be as fulfilling as I do.

Resources

- Reddit
  - General subreddits: r/gradadmissions, r/LadiesOfScience, etc
  - Domain specific subreddits: r/ProgrammingLanguages
- Build relationships with upperclassmen and talk to them
  - Join a technical club!
  - Student Panel is great for getting over a fear of talking to people.
- **Learn how to judge advice given to you.**
  - Think about bias. Question about specifics: What did you learn, What would you have done differently, etc.
  - *If it seems really easy, you might not be getting the whole story.*

AMA: Ask me Anything!

Connect with me: Twitter, LinkedIn
(I'm not very active on LinkedIn)

Shoot me an email at michelledaviest@gmail.com