Undergraduate research opportunities

Yes, you can!

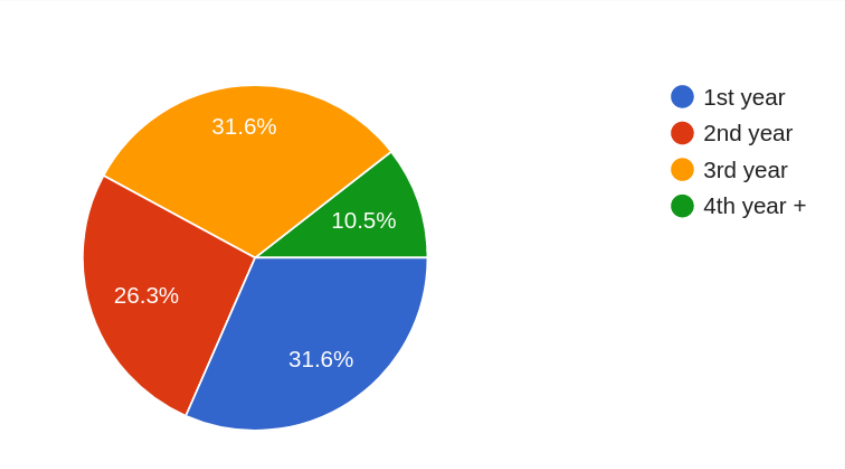
Amar Vutha

Department of Physics

Jan 8, virtual information session

Purpose of this session

- I find that a lot of undergraduates are worried about finding research opportunities, and don't know where to start.



- I would like more undergrads to have rewarding research experiences, so that they can make **informed choices** about going to graduate school.

- We will focus on academic research opportunities, *not* industrial internships or job searches.
  (But some ideas from here may be relevant for those too.)

Plan for this session

- Guidelines & an employer's point of view
  Amar Vutha

- Advice from UofT alums
  - Hiromitsu Sawaoka (Harvard)
  - Hayden Johnson (UC San Diego)
  - Alex Bercik (UT Institute of Aerospace Studies)

- Q & A with the panel

Resources

- See this excellent starting point:
  physics.utoronto.ca/undergraduate/research-employment-and-summer-opportunities/

- Start early & take advantage of UofT resources:
  - Student Life CV and personal statement camp:
    studentlife.utoronto.ca/program/cv-and-personal-statement-camp/

- Talk to your upper-year friends!

- Talk to professors!
  We are mostly harmless, and happy to talk to students

General Principles

- Studying physics is very different from **doing physics**.
  If you want to *do physics*, you should get involved in research.

- **Be bold**.
  If you do not even apply, the answer will *definitely* be 'NO'.

- In resumés & cover letters:
  1. Convey **INFORMATION** clearly.

- **Don't get disheartened!**
  If you are not offered a project, don't blame yourself.
  There are lots of hidden variables outside your control.

What is involved when a professor hires a student

- Creating a research project that fits the student's abilities
  + gives them the best learning opportunity
  + generates new knowledge (= the purpose of research)
  + helps the student with their career +
  + fits with ongoing work in the group + ...

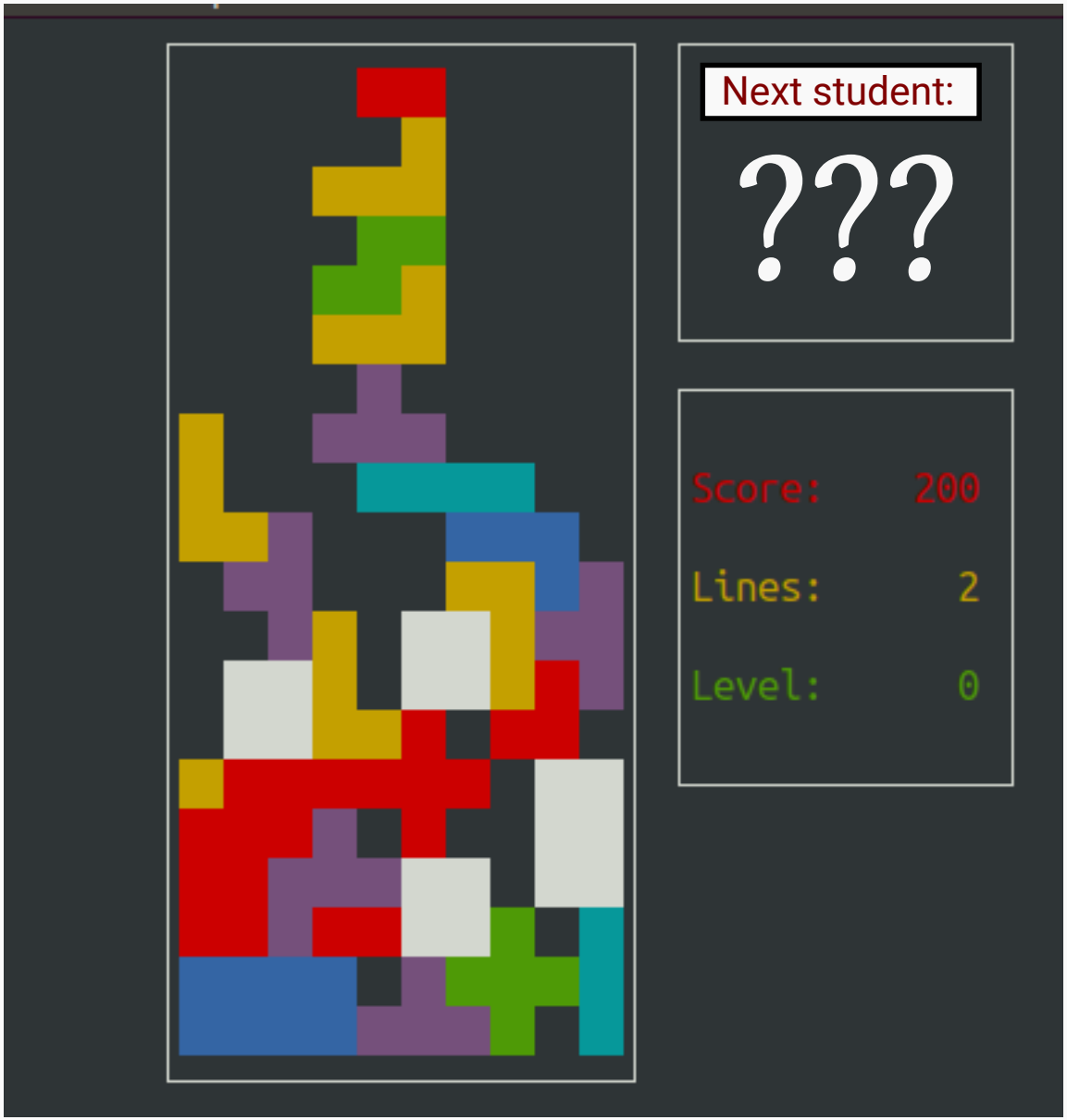
- Accepting responsibility, and committing time [> 6 hrs/week], to teach and mentor the student.

- Finding funding to pay them during the project [1.5-2 k$/month].

- Accepting responsibility to train the student in safety procedures (laser safety, general lab safety).

- Writing recommendation letters (> 10 in some cases) well after the project ends, even if a student has dropped out of touch.

A bit like Tetris ...



Therefore ...

- In resumés & cover letters:

  1. Convey **INFORMATION** clearly.

Frequently asked questions

- Q: How should I address a prof when writing an email?
  A: *"Dear Prof. [Surname]"*

- Q: Should I attach my CV/resume to an email when contacting someone?
  A: *Why not.*

- Q: What should I do if a prof doesn't respond to my email?
  A: *Wait a reasonable amount of time, then send one more reminder. After that, forget about it.*

- Q: Do profs care about a couple of bad grades, when evaluating whether they can offer me a project?
  A: *Not usually. Unless they are a sign of a deeper problem.*

More questions? Ask the panel during the Q&A !

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My Undergraduate Research Experience

Hiro Sawaoka

Department of Physics, Harvard University

(U of T class of 2018)

Overview of my research experience

- Computational Atmospheric Physics
  - Prof. Dylan Jones' group
  - Summer after 1st year

- Experimental Condensed Matter Physics
  - Prof. Young-June Kim's group
  - Winter semester of 2nd year

- Experimental Atomic, Molecular and Optical (AMO) Physics
  - Prof. Amar Vutha's group
  - From Summer after 2nd year all the way to Summer after 4th year

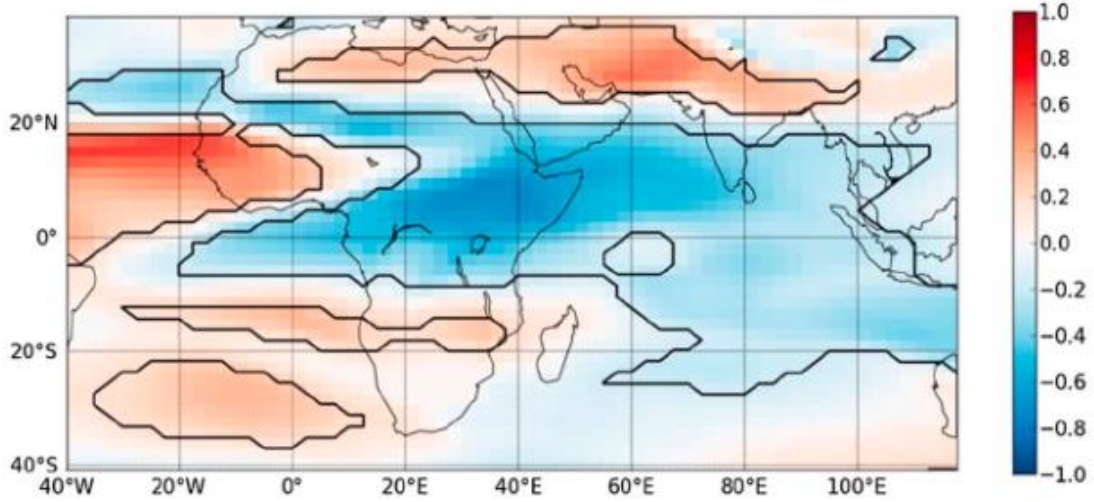
AMO Physics is sometimes referred to as "Quantum Optics" at U of T

Computational Atmospheric Physics (Jones group, Summer 2015)

- Applied through the Centre for Global Change Science (CGCS) Summer Internship programme.
  - I was the only 1st year student who got it! I declined SURF.

- Compared different climate models to understand the atmospheric circulation over Northern Africa

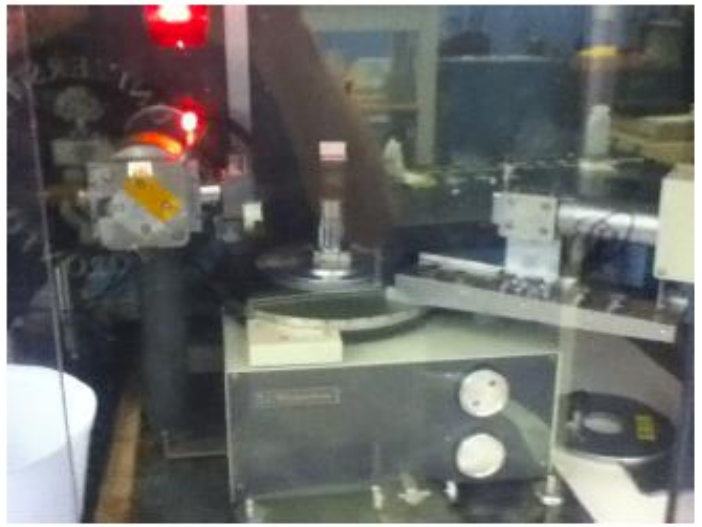
- What I learned:
  - Python is very useful
  - I love physics research!
  - But I don't like computational physics



Experimental Condensed Matter Physics (Kim group, Winter 2016)

- Applied through “reading” course PHY372 (as a 2nd -year student)
  - Knew Prof. Y-J Kim well from PHY152 office hours

- Synthesized different Iridium doped materials and tested their magnetizations



- What I learned:
  - Some theory of magnets and experimental techniques
  - I love experimental physics research!
  - I want to try out different fields in experimental physics

Experimental AMO Physics (Vutha group, Summer 2016 – Summer 2018)

- Applied through:
  - NSERC USRA (Summers of 2016, 2017, 2018)
  - Research course PHY479 (during my 3rd year)

- Constructed two different experiments that uses lasers to make use of some special atoms embedded in crystals

This picture is still being used on the U of T Department of Physics homepage

- What I learned:
  - So many things from Prof. Vutha (including but not limited to all undergrad level QM)
  - How to "do" physics
  - I love experimental AMO Physics (that's what I still do in grad school)

Summary

- Be bold when applying to research programs. You never know what opportunities you can get. Apply to as many programs as you can.
- Knowing profs from classes well and joining their group through a reading/research course is a good strategy.
- You learn so many things from research. It is worth the effort applying to them.

Searching for Research

This is hard, man!

First, some street credit

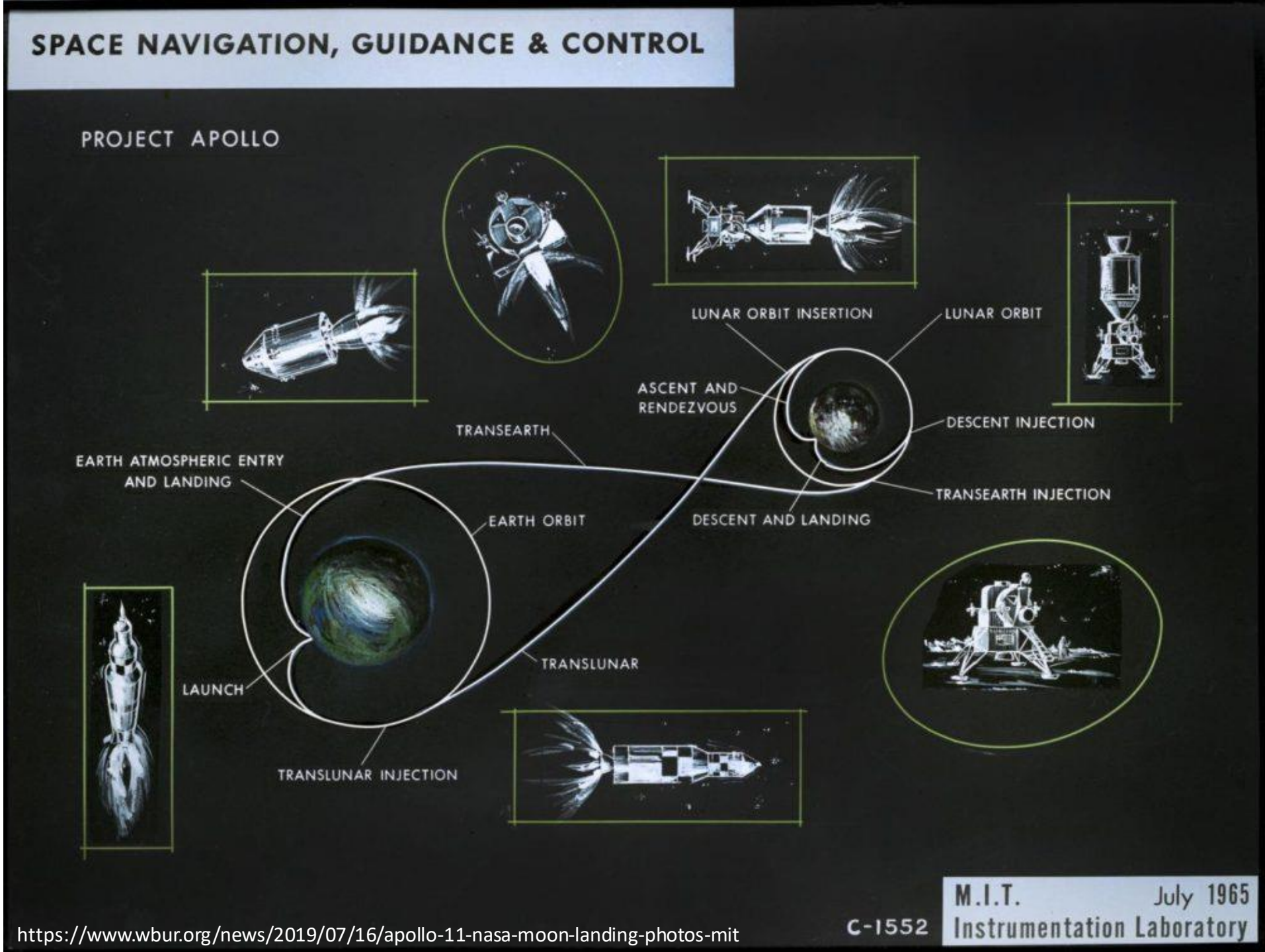
- Atmospheric physics group – Kim Strong
  - Lab assistant during 2nd year
  - CGCS summer internship summer after 2nd year
- Balloon astrophysics group – Barth Netterfield
  - NSERC USRA summer after 3rd year
  - PHY479 during 4th year
- Now: Physical oceanography PhD student at UCSD

Balloon field campaign in Texas, summer 2018.

Why is finding finding research hard?

Classes

Can be hard, but they're a solved problem



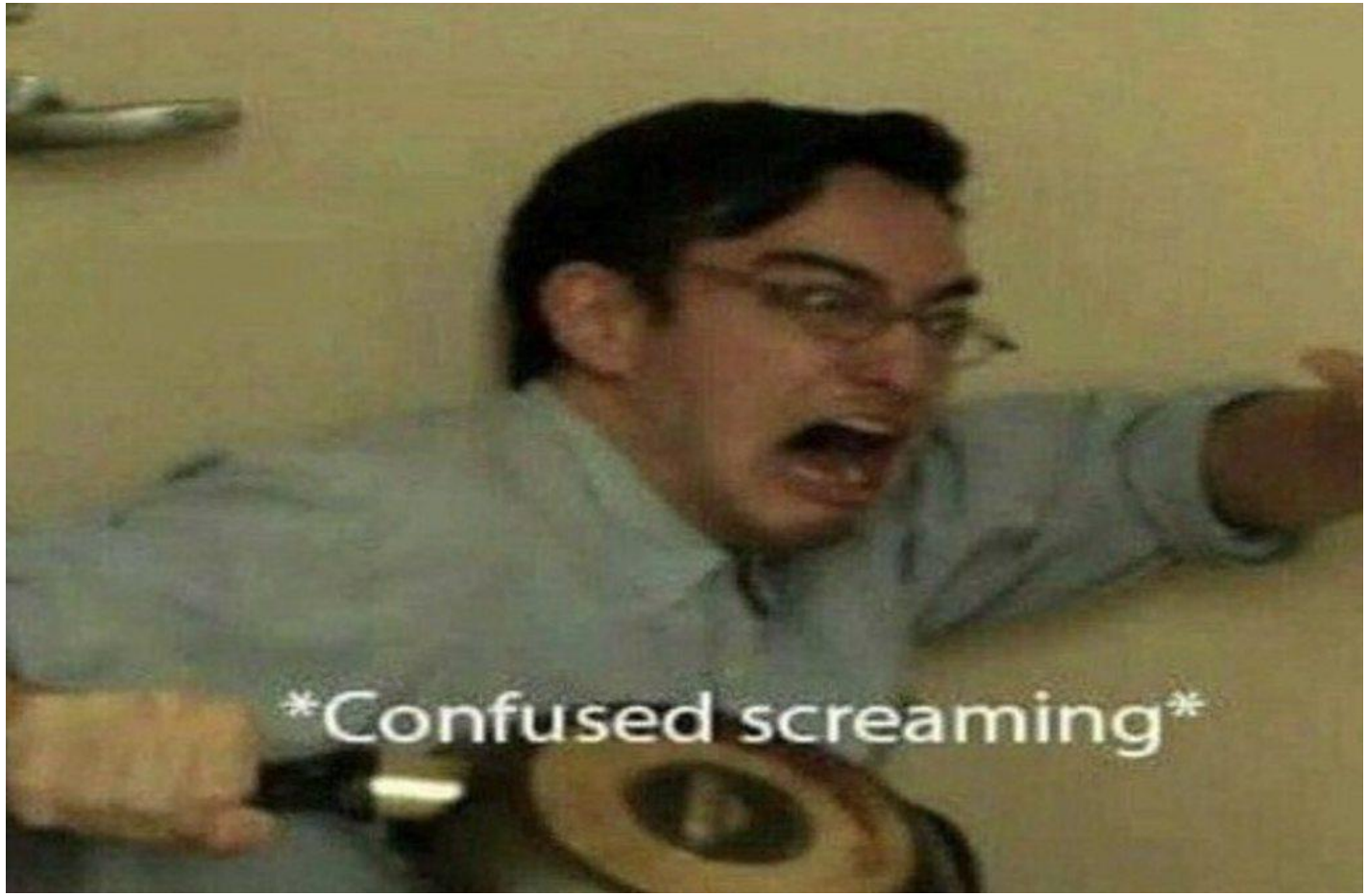
https://www.wbur.org/news/2019/07/16/apollo-11-nasa-moon-landing-photos-mit

Finding Research Positions

http://moshimonstersrock.blogspot.com/2012/06/asdf-desmond-moon-bear.html

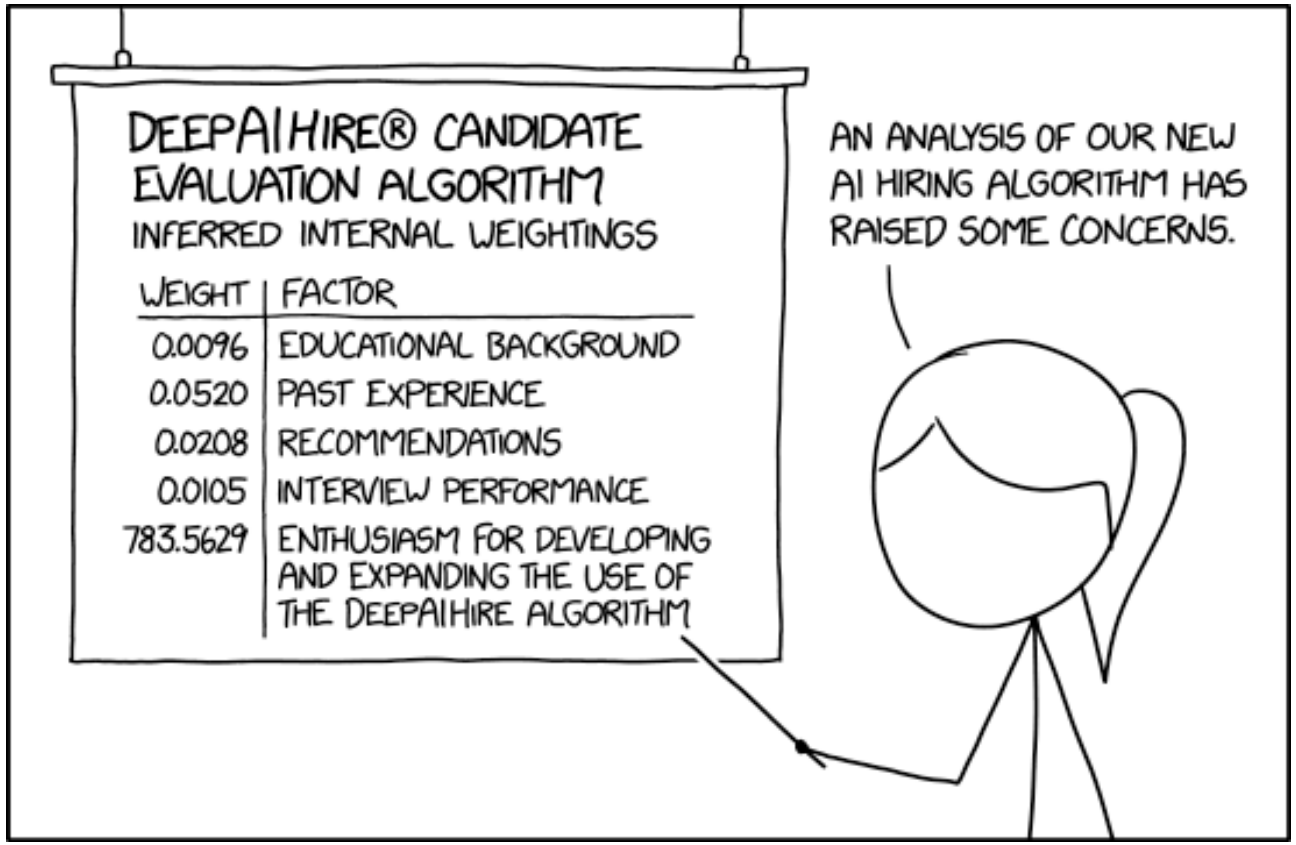
Why? The two great evils of society

- People
- Money



People

- People decide who gets hired to research positions
- People prefer to hire someone they know will do well in the job
- You need to talk to these people so that they know you would do well



How?

- Do well in classes
- Go to office hours
- Go to events like this one
- Be polite and friendly

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Caveat: You have to actually want to do these things. If it’s just a means to an end then it won’t work.

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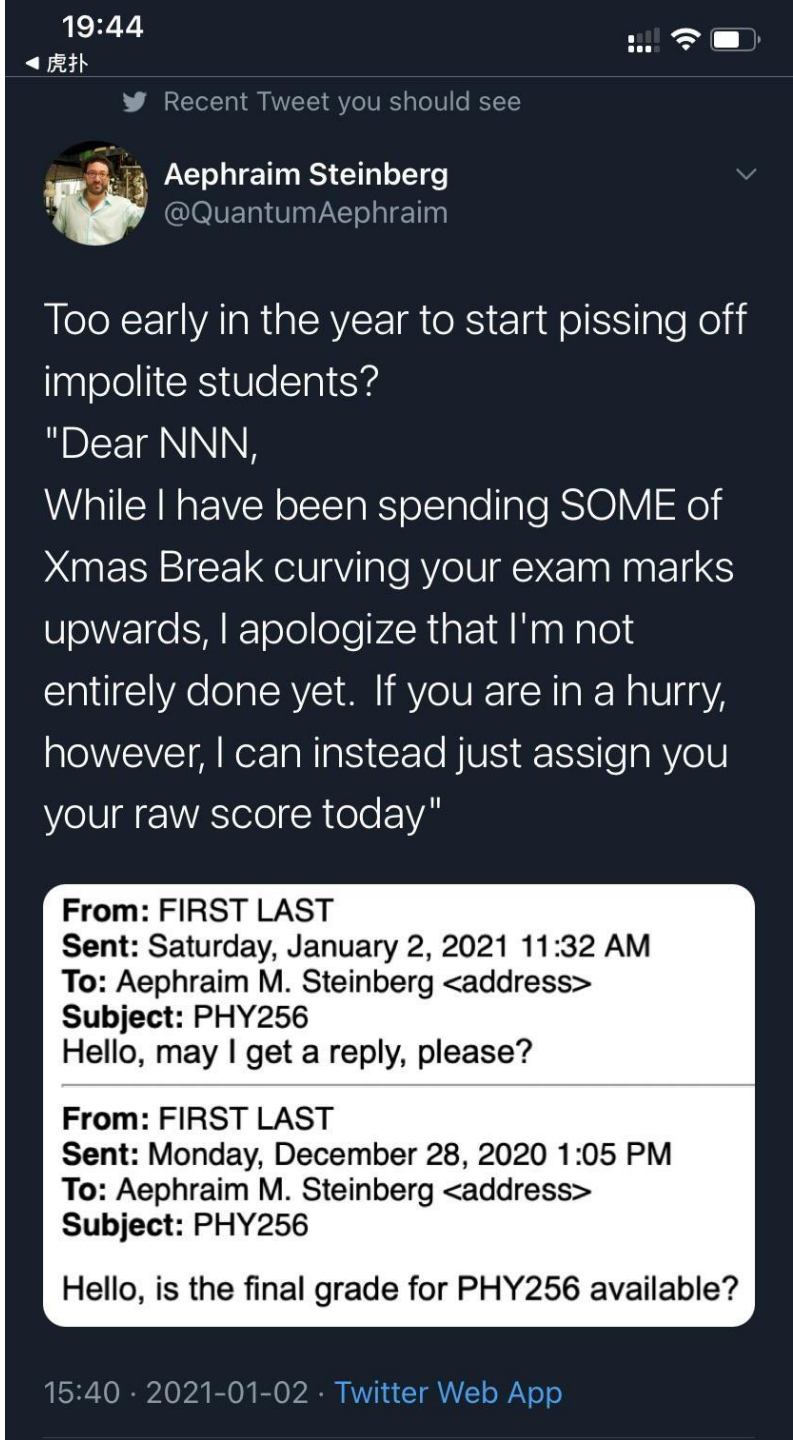
What NOT to do



At other institutions

- Email the people you would like to work with before applying
- Say why you're interested
- Mention relevant skills (i.e. coding)
- Keep it brief
- Attach your CV (maybe even transcript)

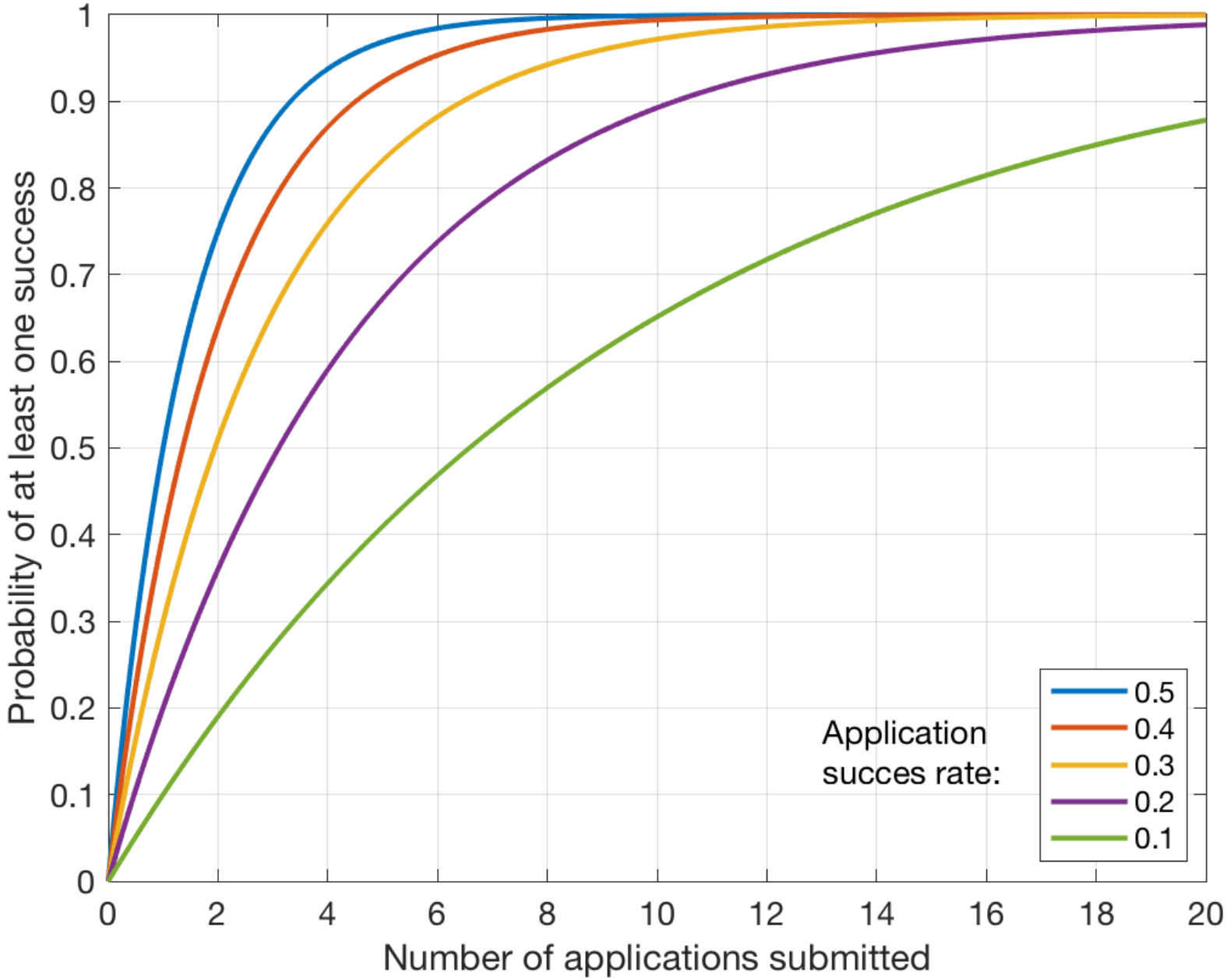
Money

- Is often the limiting factor for undergrad research positions
- You need to find it

Some programs:

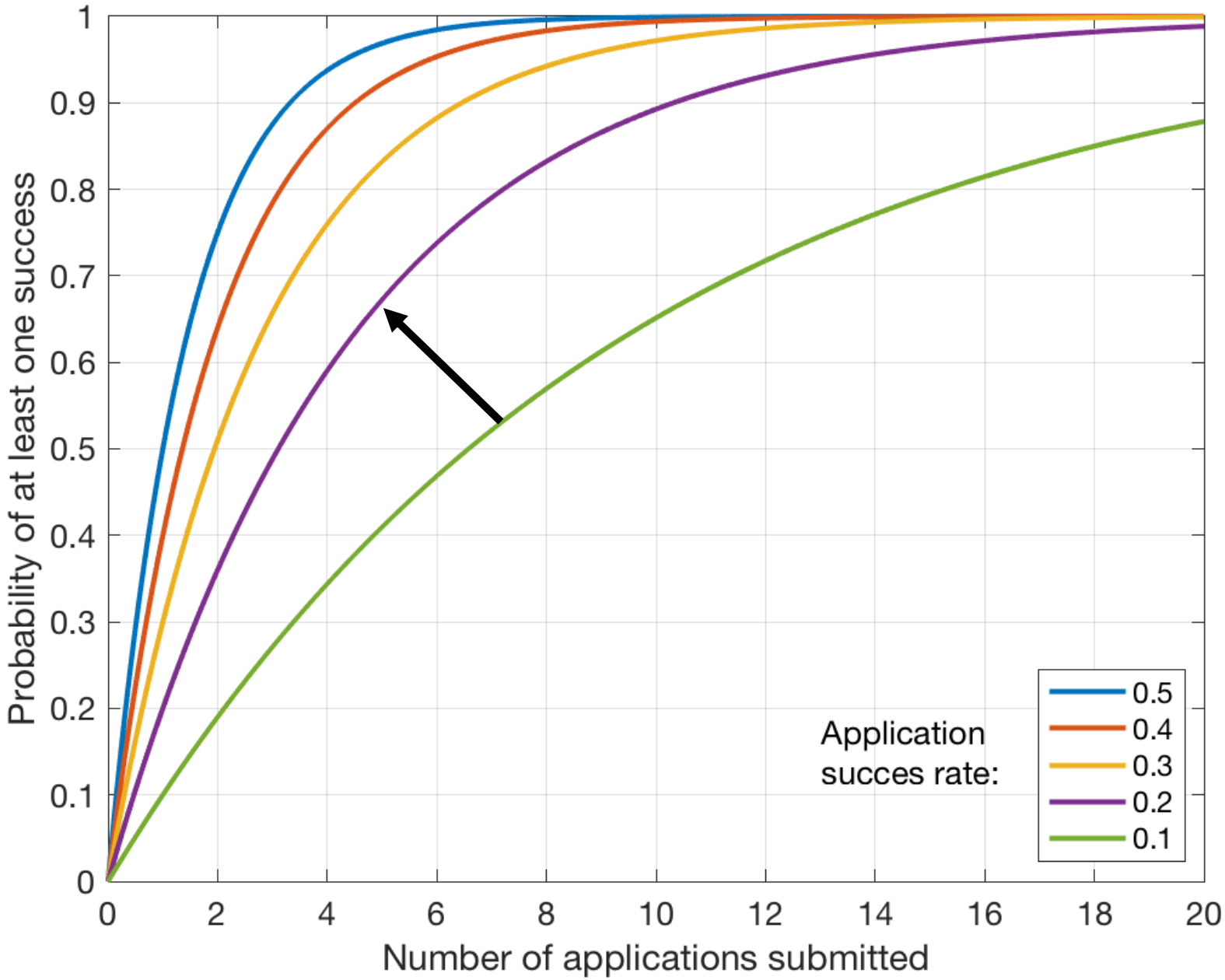
- At U of T:
  - NSERC USRA
  - SURP (astronomy and astrophysics)
  - Center for Global Change Science summer internships (atmospheric physics)
  - Probably others
- Elsewhere:
  - NSERC USRA
  - Definitely others

Hedge your bets



Hedge your bets

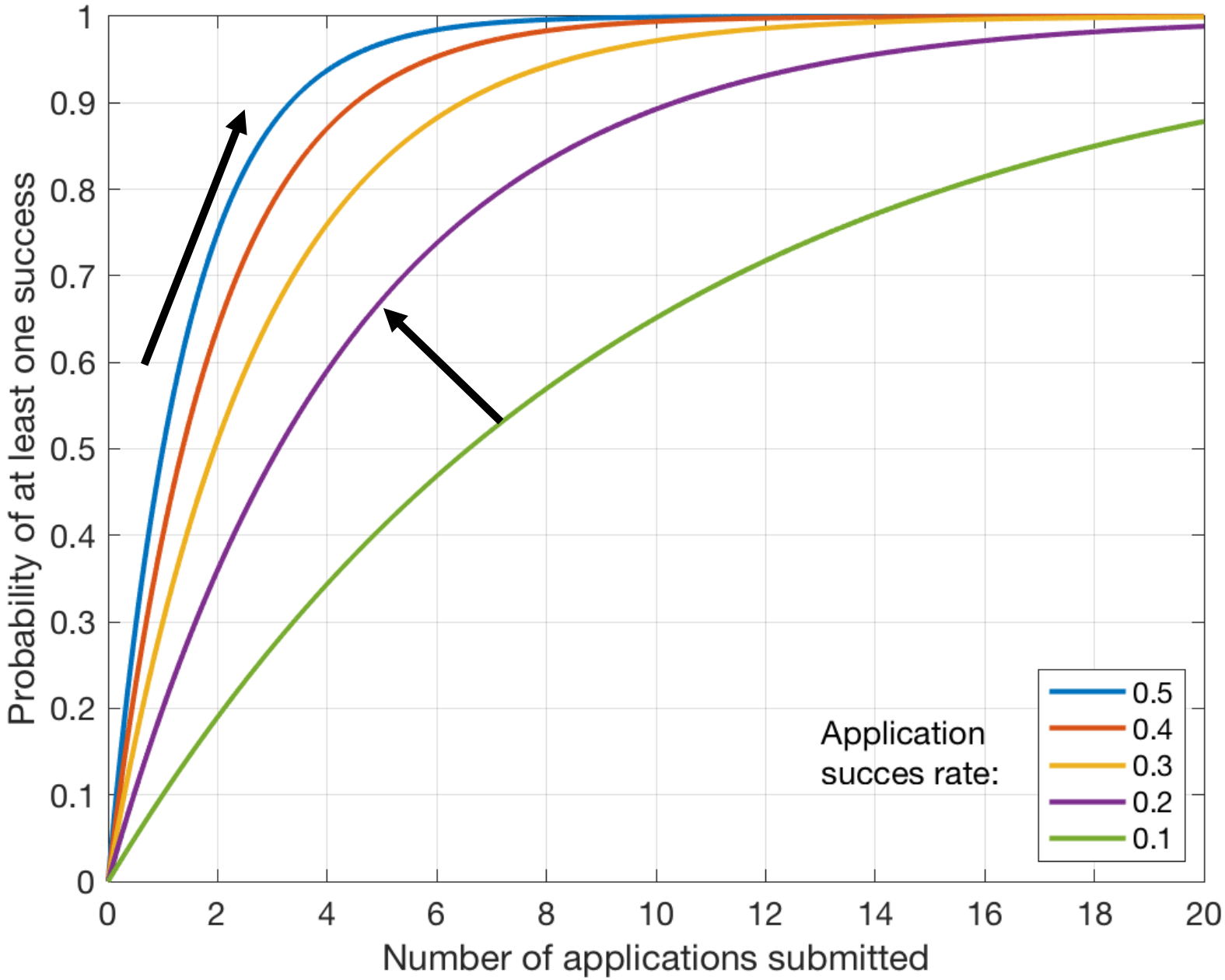
Green and purple: More efficient to move between curves



Hedge your bets

Green and purple: More efficient to move between curves

Yellow, red, and blue: More efficient to move along curves

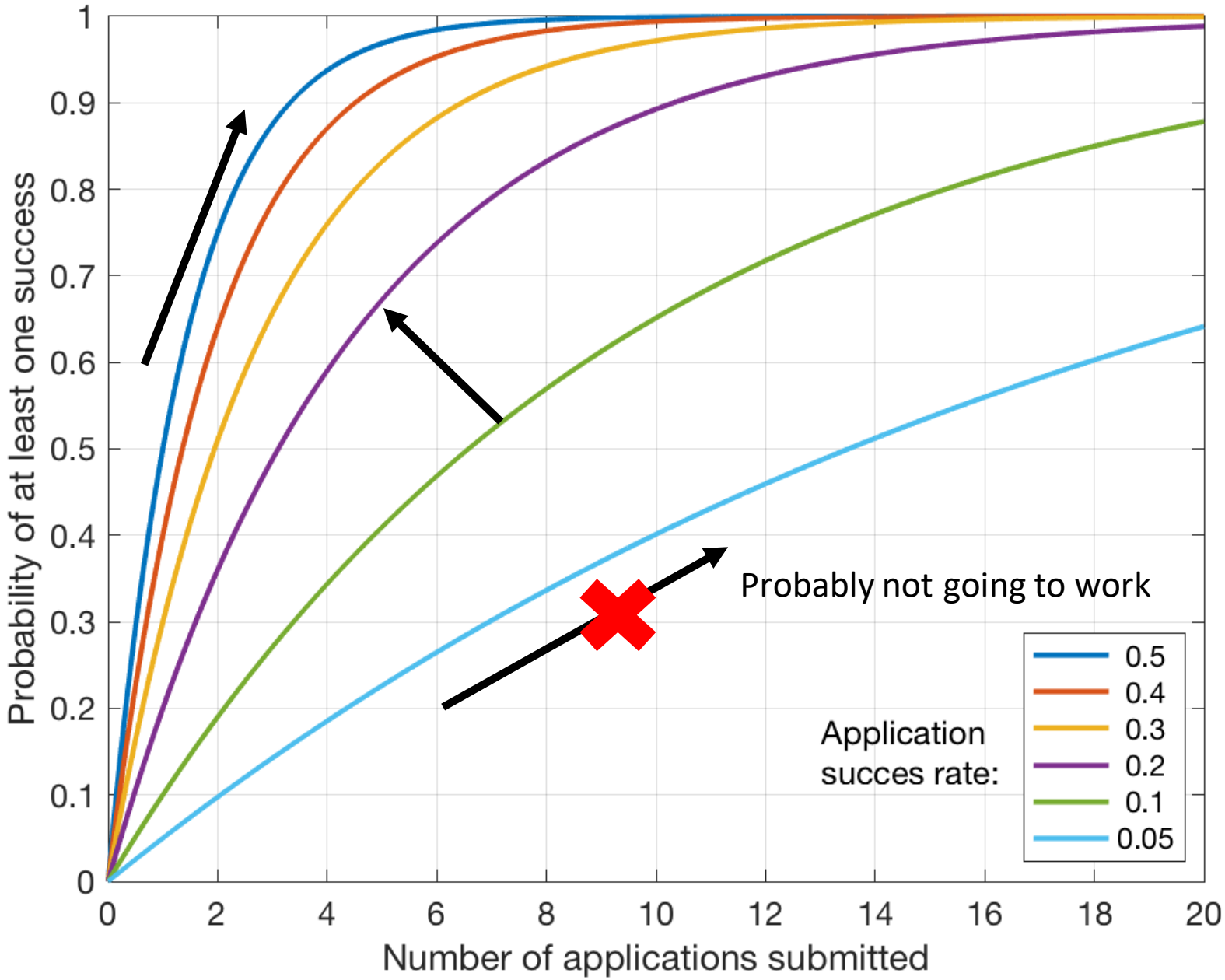


Hedge your bets

Green and purple: More efficient to move between curves

Yellow, red, and blue: More efficient to move along curves

Caveat: Assumption that results are uncorrelated breaks down at low success rates



Good luck!

Getting Undergrad Research Opportunities

A collection of random tips

Alex Bercik

Computational Aerodynamics Lab

University of Toronto Institute for Aerospace Studies

My Research experiences

1. 1st year: Volunteered in Biology lab (connection I made through a family friend)
2. 2nd year: Atmospheric Physics with Prof. Kaley Walker (SURF)
   - Worked on a suntracking machine for balloon measurements
   - First real exposure to coding - was ROUGH
3. 3rd year: Computational Astrophysics with Dr. Terrence Tricco (SURP)
   - Worked on simulating White Dwarf mergers with magnetohydrodynamics
   - At the time I thought I was interested in condensed matter physics (even applied to two other labs - HEATER, DAAD RISE)
   - Showed me where my interests lie - numerical physics and CFD
4. 4th year: Did nothing and loved it

Random Tips

1. Contact more professors than you think you need to
   - Chances are relatively low, especially for 1st and 2nd years
   - You can always turn something down if you get more than one
   - Persistency is almost always rewarded

2. Look at department websites for research you find interesting
   - Look outside of your department or university
   - Often experimental labs are better for undergraduate research

Random Tips

3. Personalize the emails to the Prof
   - Introduce yourself
   - Show interest in their research, not necessarily understanding
   - Keep it short!
   - Attach Resume and CV

4. Look into research funds, competitions, or course credit
   - More incentive for Prof if you have funding (NSERC) or are getting credits
   - Competitions (SURF, SURP) can pair you with a supervisor

Random Tips

Q: Do grades matter?
A: Kind of? Less than you think.

- Motivation, interest, and personality matter much more

Q: Should I expect to be paid?
A: It depends...

- Some Profs prefer to pay, some don't have the funds
- Volunteering is a great way to get your 'foot in the door'
  - You get a reference and build your CV for next time
  - You may get invited back, this time with pay