Why You Should Consider an Internship
How to Search for Opportunities
Working as a Mathematician in Industry vs. Academia
My Recent Experiences

Exploring Industry as a Pure Mathematician: My Summer as a Data Scientist

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How I Felt After Qualifying Exams

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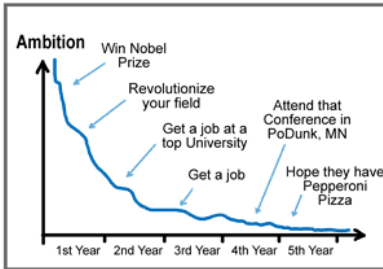
What I Saw My Colleagues Doing

People Who I Knew Planned to Stay in Academia

- independent readings with professors
- conference participation
- teaching practica
- attending workshops
- regular seminar involvement
- organizing student run seminars
- involvement with student government

People Who I Knew Planned to Leave Academia

- on the job market?
- ...

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Why You Should Consider an Internship: PENCO

1. **Perspective**
   We know what academia looks like; this is a way to discover what industry looks like.

2. **Experience**
   This is proof that you're capable of industry work.

3. **Networking**
   It's hard to approach a stranger at a conference; it's easy to follow up with a supervisor from a great internship.

4. **Confidence**
   This gives you a clear direction for your career goals.

5. **Opportunity**
   After qualifying exams, this is an excellent use of the summer; many programs are targeted at current graduate students.

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Preparing and Searching for Opportunities

Preparation:

- get an advisor (you're greatest ally)
- learn a programming language (it doesn't matter what)
- learn something about machine learning (a current hot topic)
- develop a clear idea of your short term career goals

Searching:

- talk to other graduate students who've done this
- talk to advisors of students who've done this
- look out for department emails advertising programs
- talk to industry representatives at career fairs and conferences

Note: I've had very little success with random Googling.

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Should I Do This? When?

I might want to stay in academia, is this still useful for me?
If it helps you choose a direction, then it's time well spent.

I should be doing research, is this the best use of my time?
Yes. Your advisor knows you need a job and will support you.

When should I start looking seriously?
Any time year 3+ (after quals, after finding an advisor).
Summer program application deadlines range November-March.

How difficult is it to find something?
I wasn't accepted to any programs in my first year of applying; I've
seen other colleagues fare better. Give yourself multiple summers.

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What Looks Good when Applying to Industry?

1. **You know how to program** (in any language).
   Whatever you work on will involve computers.

2. **You are excited to learn about what they're working on.**
   A positive attitude, genuine interest, and willingness to learn
   are what stand out, even if your research is unrelated.

3. **You have the necessary independence and patience.**
   If you are capable of working on your dissertation research,
   then you can also handle open-ended problems in industry.

4. **You "have experience with" (anything related to) ML.**
   This is currently a major topic in industry which is readily
   accessible to anyone with a strong mathematics background.

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How is Industry Different from Academia?
(a mathematician's perspective)

1. **No proof writing, all programming.**
   This is what "real world" problem solving actually looks like.

2. **Math (if any) is a means to an end.**
   <u>Engineer:</u> Learn the math I need to solve my problem.
   <u>Mathematician:</u> Learn the problem I need to apply my math.

3. **Somebody intends to benefit from your work.**
   They're investing in your project because they think the results will be useful.

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How is Industry Similar to Academia?
(a mathematician's perspective)

1. **Everything is problem solving.**
   You're working on open-ended problems without known solutions; they need a mathematician's creativity!

2. **You teach yourself most of what you need.**
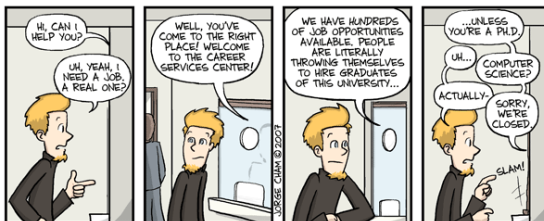   You are constantly learning something new.

3. **Most of what you do doesn't work.**
   Problem solving is about discovering what works and what doesn't; this is true in research and it's true in industry.

4. **You get to work with a lot of smart people.**
   You're likely working on a team with other STEM specialists.

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How Does My Academic Experience Translate to Industry?

Definition

Let $\mathcal{A}$ denote the **category of stuff you do in academia**.

- $\text{Ob}(\mathcal{A})$ consists of theoretical results/theorems
- morphisms consist of writing proofs

Let $\mathcal{I}$ denote the **category of stuff you do in industry**.

- $\text{Ob}(\mathcal{I})$ consists of "real world" problems/solutions
- morphisms consist of writing programs

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The Work-Flow Complex

My academic work usually looks something like this:

$$0 \xrightarrow{p_0} T_{heory} \xrightarrow{p_1} L_{emma} \xrightarrow{p_2} T_{heorem} \xrightarrow{p_3} C_{orollary} \xrightarrow{p_4} \cdots$$

Let W_f denote this workflow complex.

- publication = $\varinjlim W_f$
- collaboration = $W_f \otimes W_f'$
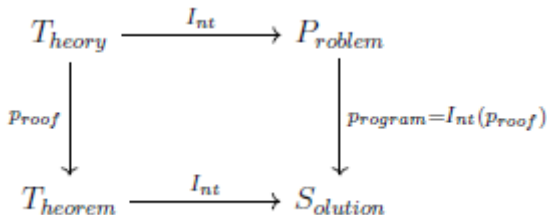- holes in my logic = $\ker(p_{i+1})/\operatorname{im}(p_i)$

My work in industry looks more like this:

$$0 \xrightarrow{p_0} P_{roblem} \xrightarrow{p_1} R_{elated} \oplus P_{roblem} \xrightarrow{p_2} P_{artial} \oplus S_{olution} \xrightarrow{p_3} \cdots$$

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Translating Academic Expertise to Industry

Theorem

Internship is a functor on work-flow complexes!

$$
\begin{array}{ccc}
T_{heory} & \xrightarrow{\;\;I_{nt}\;\;} & P_{roblem} \\
\Big\downarrow{\scriptstyle p_{roof}} & & \Big\downarrow{\scriptstyle program=I_{nt}(p_{roof})} \\
T_{heorem} & \xrightarrow{\;\;I_{nt}\;\;} & S_{olution}
\end{array}
$$

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Some Promising Programs to Consider

- **PI4-IMA Summer Internship Program**
  https://publish.illinois.edu/pi4-ima-2019/

- **IMA Math-to-Industry-Boot-Camp**
  https://www.ima.umn.edu/2018-2019/SW6.24-8.2.19

- **NSF Mathematical Sciences Graduate Internship**
  https://orise.orau.gov/nsf-msgi/

- **NSA (various programs)**
  https://www.intelligencecareers.gov/nsa/
  nsastudents.html
  Graduate Mathematics Program,
  Summer Program in Operations Research,
  Cyber Summer Program

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PI4-IMA Summer Internship Program

- Hosted by UIUC, recently opened to outside students.
- For math graduate students curious about industry.
- 12-day workshop covering data science and ML (using R and Python).
- Includes coding skills and professional development.
- 6-week internship with a company or lab.

Altgeld Hall

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My PI4-IMA Internship with Ameren

I worked as a member of Ameren's interdisciplinary Data Science
Team on several projects involving computer vision, machine
learning, and deep learning.

Ameren Data Science Team

Data Science in Action

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Data Science with UsideU

I also spent a month in Tokyo working with startup tech company UsideU. We conducted exploratory data science and applied machine learning to analyze patterns in fitness exercise data.

Some Colleagues from UsideU

Japanese Data Science in Action