Astronomy & Physics to Data Science

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Why I made these slides

- I had a lot of great advice when I transitioned to industry data science. I'm trying to pay it forward.

- I've had conversations with over 100 academics curious about the transition. A lot of the same questions come up.

- My hope is that these slides could serve as a reference and starting point for future conversations.

- All opinions are from my own perspective—biases, privilege and all. Your mileage may vary.

Context: Where am I coming from?
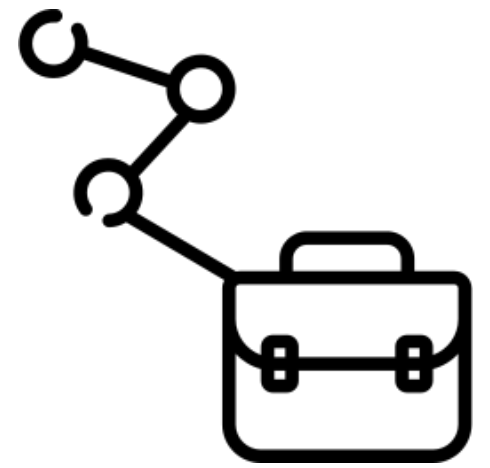
- PhD Astronomy, Columbia U. (2006 - 2011)
  (Side gigs: private high school teacher, translator)

- Postdoctoral fellow outside Munich, Germany (2011 - 2014)
  - A lot of freedom, working with someone universally known in the field.

- Postdoc & Research Faculty, joint appointment at two NY universities (2014-2016)
  - Burned out, micromanaged, sketchy appointment. (One institution wasn't supposed to know about the other side of the joint appointment.)

- Insight Data Science, NYC (2017)
  A bootcamp for PhDs to transition to industry careers.

- Data scientist for consulting firm (2017 - 2019)
  - ~100 employees
  - Promoted to manager in 2018

- Sr. Manager for a health and wellness company (2019 - 2020)
  - Starting and leading a new data team focused on using advanced data methods to guide company strategy.

- Director of Data Science for serial fiction startup (2020)
  - Overseeing entire data practice: data engineering, business intelligence, data science.

About the job

What does a data scientist do?
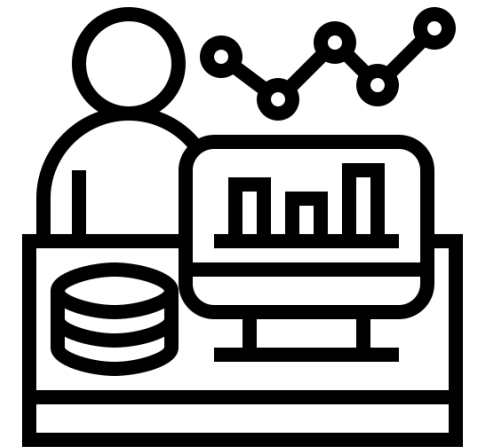
- The "data scientist" title has come to encompass such a wide variety of possible roles and responsibilities, that it's become a bit of a running joke.

- Depending on the job, the role may require a lot of software engineering, or lots of consulting and storytelling. You may spend a lot of your time cleaning your data, pushing code, building models, <u>or</u> preparing presentations. You may be building something totally new, or working with legacy code.

- That being said, the *vast* majority of "data scientist" roles will require machine learning (ML), natural language processing (NLP), or both. Roles that require AI (deep learning / neural nets) are relatively rare and usually distinguished by the job title (e.g. "AI engineer"). You'll be expected to know Python or R.

- Roles that don't require ML/NLP may be called "data analyst" or similar—but not always! Non-ML roles might require SQL, dashboard skills, and some/no Python/R.

- Roles specializing in ML may also be called "machine learning engineer."

What are some example projects?

- Segmentation/clustering—e.g. identify common member profiles

- Predictions (prob. for user to pay/leave; revenue; inventory demand; click on ad)

- Optimization (inventory management; route planning; scheduling)

- Recommenders. "If you liked X, you might like…"

- Experimentation—statistical tests for visual changes, ad delivery, recommendations.

- NLP—parse meaning, automatic text generation, identify topics, flag problematic content.

- Dashboards & automated reports

- Data pipelines (ETL processes) and other infrastructure

- Integrating above into an app, or for internal data augmentation

What skills from PhD/ academia do you use?

- The ability to tackle ambiguous, complex, and/or open-ended problems.

  - The ability to hear about a problem in a meeting for the first time, and immediately start thinking about how you might approach it, anticipating potential time sinks and failure modes.

  - The ability to start hacking together some code and proofs of concept.

- Presentation, teaching, collaboration, project management—especially for roles with a heavy dose of liaising with non-technical stakeholders (clients, non-data teams, execs).

- Being able to field challenging questions from authority figures.

What are some common tools for the job?
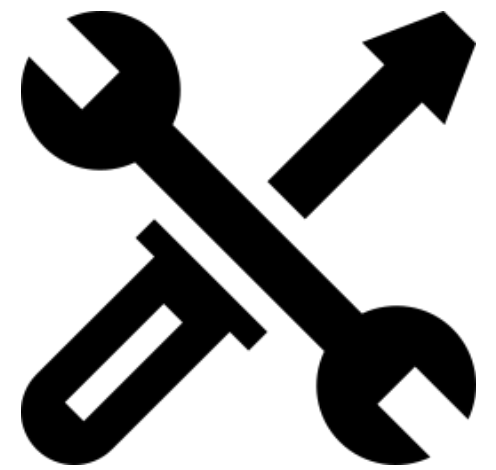
- Cloud computing tools:
  AWS (S3, Redshift, Data Pipelines, EC2, ECS…)
  GCP (GCS, BigQuery, Colab…)

- Containers:
  Docker, Kubernetes

- Version control (git)

- Dashboarding/BI (Looker, Tableau)

What's the pay?

- It can really depend on the location and industry!

- As of spring 2017, the median base salary (before bonuses) offered to Insight Data Science fellows in NYC was 120k. (Source: Insight program manager.)
  Note that these are candidates with PhDs, coming through a well known bootcamp.

- As of fall 2019, the typical salary for senior/manager data science roles at tech companies in NYC was in the ballpark of 140-160k.

- Bonuses are typically around 10-20% of salary. A part of your bonus may be tied to company or team performance. (Bonuses are typically taxed at a higher rate, around 40%.)

- GlassDoor is a decent resource to get ballpark ideas for salaries. It's also a good place to gather anonymous feedback about specific companies from current and past employees.

- Talking to someone is also a good way to gauge whether you're being fairly compensated.

How is the DS job market?
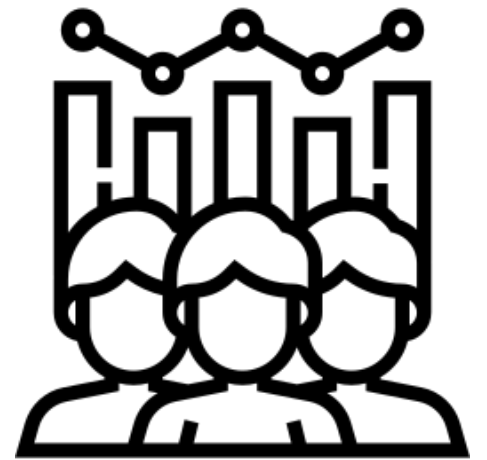
- My perception is that it's getting slightly harder to break in than it was 5 years ago. I think this is because of:

  - More people with a few years of experience.

  - Standardization of "the right skill set" for junior roles. Many recruiters and hiring managers like to see certain algorithms and programming tools listed in your resume.

  - The above goes hand-in-hand with the maturation of DS teams in industry. If a team works with specific tools, candidates who know (about) them have an advantage. (This is something you can prepare for, ahead of interviews.)

  - The proliferation of boot camps and BS/MS programs that specialize in ML and NLP.

Getting hired

What's the hiring process like?

- Plan on the search taking months, not weeks. It's definitely not as easy as "PhD here, job please!"

- Typically, 4-6 weeks from application to last interview. Junior roles may be filled on this timescale; roles that are more senior or that require specific qualifications may take months for the company to fill.

  - Phone screen with a recruiter, typically to check for basic communication skills; understanding of the position; salary and other expectations.

  - A phone interview with a data scientist to screen for experience, basic ML knowledge, simple coding questions.

  - Data challenge or take-home test. They'll send a data set and some instructions, and you'll be expected to build a ML/NLP model then explain your approach and findings. For some roles, you'll be asked to present to a non-technical audience.

  - On-site interview. Common to have 3-5 interviews over several hours to gauge technical skills, communication skills, cultural/company fit.

  - Offer and negotiation.

- Read up on the company, industry and role ahead of time, so that you can ask meaningful questions at each stage.

What's the hiring process like? (cont'd.)

- It's my belief that with preparation and practice, you can get to a state where (i) you're getting asked for a phone call on a decent fraction of your applications, and (ii) if you get that first phone call, you're consistently making it to the on-site interview stage.

  - If you're not getting to the phone screen, consider revising your resume. (This is the most common barrier I see for academics transitioning into industry.)

  - If you're not making it past the phone screen or the initial technical conversation, consider talking about it with people in industry to understand why not.

  - If you're not making it past the data challenge, again it's a great idea to walk through your submission with an industry data scientist.

  - For interviews, it's practice, practice, practice. The goal should be to get to the same standard as a good talk: presenting yourself professionally and speaking knowledgeably, while exhibiting enthusiasm and interest.

- But beyond that point, there's a lot of luck involved. Another candidate might be (or feel like) a better fit for them. They might decide that they want someone with more experience in their specific industry. I think of getting through the on-site interviews thinking "That went pretty well" as a "shot on goal," and that the way to get a job is to repeat that feeling until you get an offer.

How can I prepare?

- Polish your resume. Have people you know in industry look it over. Do NOT write it like a CV. Most people won't know the words "redshift" or "boson"—or even care. **Prominently** list the coding/ML tools you've used.
  - Example of what not to do: Moving-mesh GMHD simulations of accretion onto high-redshift AGNi, Johnson et al., 2019, *MNRAS*
  - Example of how to present the above: Project lead for a computational study (C++, bash, git; cloud GPUs) that led to the most detailed understanding of supermassive black holes in the early Universe.

- Build significant depth in SQL, and either Python or R. Build broad familiarity with common ML and NLP algorithms, (e.g. when you might use a random forest; what word2vec is) and focused experience with a few specific algorithms.
  If you don't use these in your academic work, then do a self-contained side project that sits in a Jupyter notebook, a blog post, or a public GitHub repo. Pick something interesting to you (so that you have the domain knowledge and that you can follow through). You can also use coding drills (HackerRank, Cracking the Coding Interview book).

- Do mock/practice interviews.

- Make a LinkedIn profile. Fill out the various sections, add a professional photograph, keep it up-to-date. See top bullet about resumes.

- Make connections. **Referrals are probably the most powerful way to get an interview.** Ask people to have coffee with you, pick their brains (over video chat is okay!).

- Study! Read up on ML, NLP principles (e.g. go through Andrew Ng's lectures at 1.5x speed), relevant business fields (e.g. digital marketing, tech blogs like Netflix, AirBnB).

I'm nervous that I can't code well enough

- As mentioned in an earlier slide, DS roles can vary in how much they focus on software engineering and coding.

- Most roles don't require you to write perfect code. Even if you have to google a bunch of stuff, if you code in a way that's collaborative and sensible (e.g. descriptive variable names, comments, knowing when to write a function or class), that's usually sufficient.

- You'll also find yourself getting more efficient with company data challenges over time, because many of the tasks are similar (explore data, build a quick model, validate).

Should I reach out to people to ask about specific opportunities?

- YES. Find someone on LinkedIn that's at that company, with any relevant connection whatsoever (a common acquaintance, same alma mater or former workplace, is a data scientist, etc.).

- This is because most companies offer referral bonuses (typically 5-10k) for candidates they end up hiring.

Is there a right time to apply?

- There's no set "hiring season," but this may vary from industry to industry. Jobs come and go quickly. So apply to a bunch as they come up.

- Starting near the end of the bonus cycle may impact bonus eligibility. (Bonuses may be paid at end of calendar year, end of fiscal year, or on 1-year anniversary of hire.)

Should I do a bootcamp?

- All things being equal, yes. Especially if you want help with current DS tools and business thinking. It's also a great way to build your professional network. You will also get structured support around things like resume polishing, interview prep, and studying.

- It will constrain timing of job applications. (You're probably not going to be applying much during the bootcamp.)

- Bootcamps differ in what they offer and how they fit to individual needs. I was happy with Insight; I know others who weren't.

- My personal advice: don't pay upfront for a bootcamp or certification; make sure that it's free to you, or that the fees are contingent on finding a high-paying job.

Data science as a career

Some questions to consider about specific opportunities

- Are you motivated by the company's business? Are you morally comfortable helping the business?

- Is data science central to their business? (Or are they doing it because they feel like they have to?)

- What's the company culture like? How do they share and act on their values on topics like diversity & inclusion? Do they engage their community, and how?

- How good is the technical infrastructure? What does the rest of the tech org look like?
  e.g.: Do they have a clean data lake maintained by a data engineering team, or will you be hacking it together as you go? Are code base and ML models well documented?

- What will your career trajectory look like at this company? How will they support your growth?

- Are you comfortable with the people who'd be your teammates and manager?

- What will your first project be? Who do you go to for help when you don't know how to do something?

- What are their work hours actually like? How often will people expect you to respond to emails or Slack outside work hours? What's their PTO policy? Do people actually use their vacation days and unplug?

- Are company social functions important to you? How does the team/company socialize? Do people socialize outside work hours? How much alcohol is involved?

- What are the perks you like? How important are they to you?

How often and why do people change jobs in industry?

- Typical data science tenures are 2-3 years. Also not unusual for people to stay at a job for 5+ years, or move on after ~1 year.

- People tend to change jobs because they choose to.

  - Career/pay progression.

  - Looking for something new (different industry, different responsibilities, alignment with career goals, culture, work-life balance).

  - A job change may be planned, or you may be approached. (You will receive more and more communication from recruiters as you gain experience and seniority.)

Can I stay connected to my academic community?

- I think so. Some things I've done since moving to industry:

  - Was on a review paper with N>>1 authors.

  - Corresponded on scientific ideas.

  - Attended the AAS conference twice in three years, attended talks and posters. **There is a recurring "ATDS" splinter session** specifically meant to foster connections between academic and industry (ex-)astronomers.

  - I try to be a resource for academics who want to learn more about making the transition.

Some learning resources

- Andrew Ng's machine learning lectures

- towardsdatascience.com

- Chris Albon's machine learning flashcards
  (He has a standing offer for a 100% off coupon if you cannot afford the $12 price.)

- Books:

  - Cracking the Coding Interview

  - Statistical Learning (James, Witten, Hastie)

  - The Hundred-page Machine Learning Book

Feedback?

- Was this helpful?

- What would you change?

- I would love to hear from you!

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