Career Paths

The careers for statisticians can be grouped into one of three categories:

- Industry
- Government
- Academia

The purpose of this section is to discuss the jobs available in each of these categories. Our guest speakers this semester will also be able to provide further details.

There are a number of hyperlinks in this document. Note that clicking on them does not always take you to the full address. You may need to manually copy-paste these links into a web browser.

Industry

Statisticians who work for a company are generally said to be "working in industry". There are wide variety of positions available, so I will examine the largest one first and then briefly discuss others.

Pharmaceutical

The Food and Drug Administration (FDA) requires that all new pharmaceutical drugs to be proved as safe and effective. Statisticians play a very large role in this process by planning clinical trials and subsequently analyzing the resulting data from them. Due to these FDA mandates, the pharmaceutical industry is likely the largest area and also the highest salary area where statisticians work.

There are two main types of companies that statisticians work for

- Pharmaceutical company - Examples include Pfizer, Novartis, and Merck
- Contract research organization (CRO) - Largest is Quintiles

Both are engaged in the clinical trial process, but the pharmaceutical company is who is in charge of bringing a new drug to market. The CRO is contracted by the pharmaceutical company to run some of their clinical trials and analyze the resulting data.

Job stability can be an issue in the industry due to mergers and acquisitions. For example, in the mid-1990s, I had an internship with a pharmaceutical company named Hoechst Marion Roussel (HMR), which had been recently formed through the merger of Marion Merrell Dow, Hoechst, and Roussel. Since this time, there appears to have been three large mergers associated with HMR and now it is part of a company known as Sanofi.

Statisticians at pharmaceutical companies engage in clinical and non-clinical work, where there is a much larger number engaged in clinical work. The clinical work involves the planning and the analysis of data during the four phases of clinical trials:

- Phase I: Drug is tested on a small number of subjects (people who do not have a particular condition) to evaluate its safety
- Phase II: Drug is tested on a small number of patients (people who have a particular condition) to evaluate its safety and effectiveness
- Phase III: Drug is tested on a large number of patients (people who have a particular condition) to evaluate its safety and effectiveness; if everything goes well through Phase III, the drug is approved for general use by the FDA
- Phase IV: Continued monitoring of safety and effectiveness is done; marketing studies are also performed

Examples of the work for a statistician during this process includes

- Determining appropriate sample sizes of treatment groups before a study is conducted
- Comparing measures of mean effectiveness across treatment groups once data is obtained

In all phases of the clinical trial, the statistician is a member of a team that includes physicians and other scientists.

Non-clinical work can be quite varied. Areas include:

- Drug stability - Every drug needs an expiration date. To determine the "shelf-life" of a drug under development, samples of it are put into storage. Every few months, some of the samples are removed and measurements are taken, such as the drug's potency and how well it has retained its color. Through using regression models, statisticians predict when a drug will be outside of some pre-specified limits.
- Mixture experiments - These types of experiments are focused on determining what percentage of items (factors) to include in a drug so that they add up to 100%. Special types of response surface methods are used to find an optimal combination.
- Pharmacokinetic experiments - The goal is to better understand how the drug reacts within the body. For example, nonlinear regression models can be formed to understand the amount of a drug in the blood stream after it has been ingested.
- Quality control - The manufacturing of a new drug needs to be monitored to make sure it is being produced properly.
- Marketing - Companies need to understand how best to sell a drug.

Both MS and PhD-level statisticians work for these companies.

Other areas

Chapter 2 of Hahn and Doganaksoy (2011) does a decent job of summarizing other areas. The American Statistical Association's (ASA) web page on "Which industries employ statisticians?" at `http://www.amstat.org/careers/whichindustriesemploystatisticians.cfm` does a good job too. A short list of companies where my own colleagues and our alumni have worked (with an emphasis on local) include:

- Acton Marketing (Lincoln)
- Cabelas (Sydney, Lincoln)
- Celerion (Lincoln)
- Con Agra (Omaha, Chicago)
- Deluxe (Twin Cities)
- Experian (Lincoln)
- Facebook
- First National Bank (Omaha)
- Genentech
- Google
- GSK (Lincoln)
- Hallmark (Kansas City)
- Merck
- Monsanto (St. Louis)
- Novartis
- Target (Twin Cities)
- Union Pacific (Omaha)
- West (Omaha)

Government

I have roughly categorized statisticians who work in government into two main areas: official statistics and research. Both MS and PhD-level statisticians work in these areas.

Official statistics

Governments need to understand its population to better understand their needs. Statisticians who are involved in this process work in an area known as **official statistics**. Examples of where statisticians work for the US government include:

- Census Bureau - Estimate the population undercount in the US Census; conduct large surveys to understand the US population, like the Current Population Survey
- Bureau of Labor Statistics - Estimate the unemployment rate; estimate the consumer price index
- Centers for Disease Control and Prevention (CDC) - Estimate the number of chlamydia cases during a year; understand the trend in influenza cases; conduct large, multi-year surveys like the National Health and Nutrition Examination Survey (NHANES)

The Federal Committee on Statistical Methodology (`https://fcsm.sites.usa.gov`) helps to coordinate the activities of many government agencies engaged in official statistics. See `https://fedstats.sites.usa.gov/agencies` for a listing of various agencies where statistics plays an important role. Some of these agencies may not have "statistics" immediately in their names. For example, the US Department of Agriculture has a National Agriculture Statistics Service (NASS) where some of our students have had internships in the past. A nice, brief description of what

statisticians do at the NASS is available at https://www.nass.usda.gov/About_NASS/Opportunities/index.php.

In all of these cases, statisticians will likely work with subject-matter experts, like economists or physicians. Also, there is a large emphasis on estimation, usually through using complex survey sampling techniques. These techniques are used when a simple random sample may not be feasible or when they would provide less information.

Other government entities have similar statistics frameworks. For example, Statistics Canada performs the role of many separate agencies in the United States. The United Nations Statistics Division also has similar roles for world-based statistics.

Research

Statisticians are involved in research at government agencies. For example, the National Institutes of Health (NIH) has branches that consist of statisticians, including:

- Biostatistics and Bioinformatics Branch (BBB) of the National Institute of Child Health and Human Development (NICHD) - https://www.nichd.nih.gov/about/org/diphr/bbb/Pages/default.aspx
- Biostatistics Branch of the National Cancer Institute (NCI) - http://dceg.cancer.gov/about/organization/programs-ebp/bb
- Office of Biostatistics Research in the National Heart, Lung, and Blood Institute (NHLBI) - http://www.nhlbi.nih.gov/about/org/dpps

Statisticians often are involved in a mix of statistical research and consulting research with subject-matter experts.

Outside of medical applications, there are a number of laboratories where statisticians work with many other types of subject-

matter experts, especially in engineering. For example, the Statistical Engineering Division (http://www.nist.gov/itl/sed) is at the National Institute of Standards and Technology (NIST). This division was the host for a UseR! conference in the recent past that was held on the NIST campus.

The Department of Energy is another government agency with research laboratories. One of these laboratories is the Idaho National Laboratory where I interned at while in graduate school. The Department that I worked in is now called "Human Factors, Controls and Statistics" (https://hfcs.inl.gov/SitePages/Statistics%20and%20Data%20Analysis.aspx). Our small group of statisticians worked primarily with engineers in a consulting role.

Governments like to regulate business and individuals to better society. For example, the FDA employs statisticians to review new drug applications submitted by pharmaceutical companies. While not directly doing research, these statisticians are evaluating the research of others.

There are non-profit organizations that often perform government-like research. For example, Reid Landes, a 2001 graduate of the former UNL Department of Biometry (one of two groups at UNL which formed the Department of Statistics in 2003) worked for the Radiation Effects Research Foundation in Japan; see http://uamshealth.com/news/2015/09/18/cophs-landes-studies-radiation-effects-in-hiroshima and http://www.rerf.jp/programs/outline_e/progstat.html.

Academia

One can further categorize positions in academia as follows:

- Professor at a research university - These are in PhD granting Departments of Statistics or Biostatistics; a PhD degree is needed).

- Professor at a teaching university - These are in non-PhD granting Departments of Statistics or Biostatistics; a PhD degree most likely is needed unless it is a 2-year college or a small liberal arts college.
- Statistician supporting the work of others - This includes consultants or programmers that help support PhD statisticians or researchers in other fields (MS or PhD degree is needed); these types of positions are similar to those in industry, but may also include some teaching of non-statistics majors

These are not necessarily perfect categorizations, but this will help to understand the duties of individuals in academia.

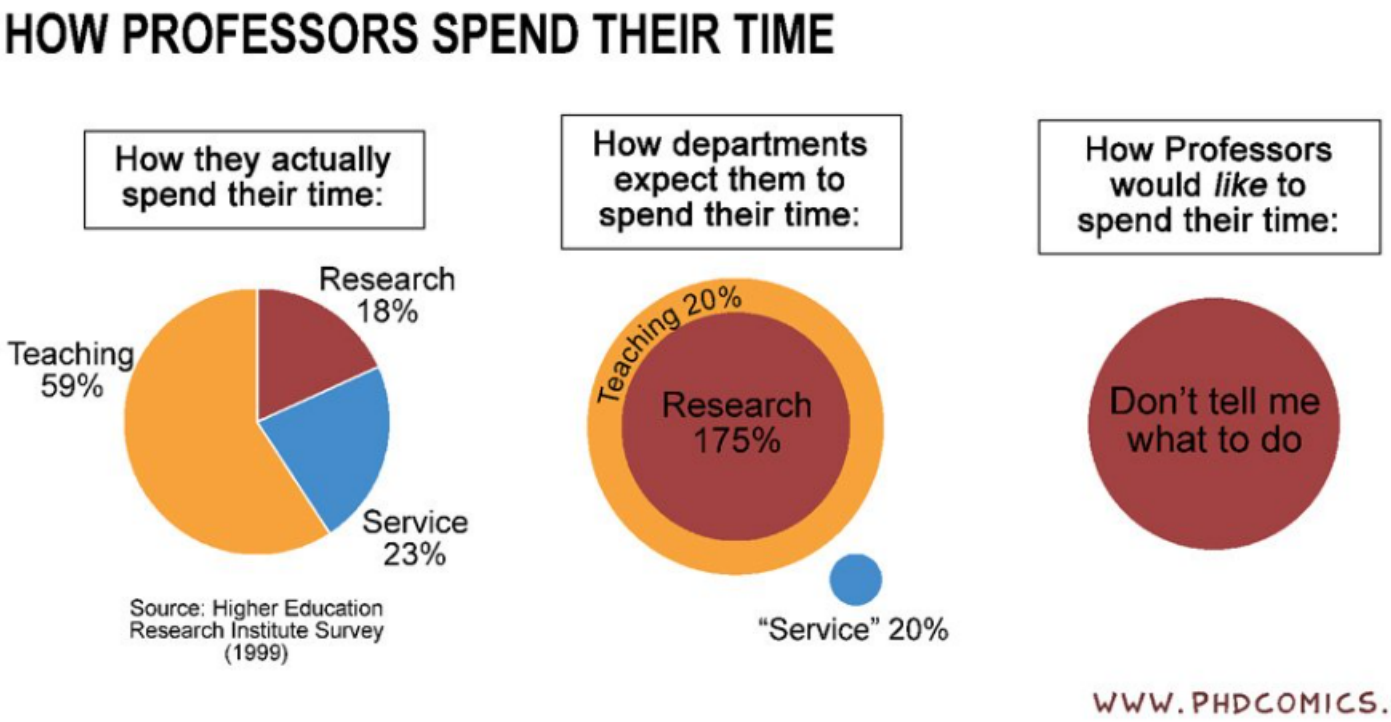
For the first two categorizations above, there are three levels of being a professor (in rank order):

- Assistant - This is the level that individuals begin at, and it usually lasts for 6 years. Individuals will have fixed-term contracts. For example, UNL has 2-year contracts that are renewable with satisfactory work performance. During their 6th year, individuals are evaluated for promotion to the Associate level and also for tenure.
- Associate - Unlike the Assistant level, there is no fixed duration to being at the Associate level. Typically, one needs to be at this level for at least 7 years before promoted to the Full level. Some individuals may stay at the Associate level for the rest of their careers.
- Full - At most universities, there are no further levels of promotion beyond Full unless an individual goes into administrative work.

Note that professors working in a College of Public Health or some other medical environment may not be considered for tenure until their promotion to Full.

Time allocation

Below is a nice graphic from PhD Comics which does a good job describing the time commitments for professors.



Interestingly, I think the first pie chart is rather close to how I currently spend my time. Of course, there is semester-to-semester variability. Officially, professors are given a percentage time commitment for their duties. My job appointment has a common split for a research university:

- 45% Research
- 45% Teaching (3 courses per academic year)
- 10% service

Depending on the stature of the research university, a "45% teaching" appointment could actually mean 4 courses. Professors at teaching universities will have a much different split. Teaching will by far be the largest percentage and lead to teaching 8 or more courses per academic year!

Examples of the service portion correspond to

- Departmental committee work; e.g., Graduate Committee, Technology Committee, Curriculum Committee, where committee chairs will have a larger work load
- College or university-level committee work; e.g., Arts & Sciences Assessment Committee, Faculty Senate's Information Technologies and Services Committee, and IANR Faculty Task Force for Defining Standard of Excellence Principles in Faculty Evaluations
- Professional society committee work; e.g., Current Index to Statistics Management Committee, ASA Section on Statistics in Sports Secretary/Treasurer, IBS ENAR Regional Advisory Board

There are lots of committee opportunities for professors!

The research component is the most difficult component to describe. One can divide research into three different categories:

- Statistical research: The purpose here is to forward the statistical science. This type of research is usually published in statistical research journals, like the *Journal of the American Statistical Association*. A statistician is the first author of these papers.
- Collaborative research: Subject-matter experts and statisticians work together to forward science. If there is a significant amount of statistical innovation, a paper may be published in a statistical research journal. More frequently, a paper will be published in a non-statistical research journal. Sometimes, papers can be published in both types of journals.
- Consulting research: A statistician's role here is the smallest for each of these categories. For example, a statistician may write the "statistical methods" section of a paper that details the application of known statistical methods. Papers resulting from this work will not appear in statistical research journals.

Note that some individuals may use only two research categories, where the middle category above is appropriately divided into the first and last categories.

Depending on the type of professor position, the research component could be only one of the above categories or all three. For example, a professor in a Department of Biostatistics will typically have a much larger consulting and collaborative research component than a professor in a Department of Statistics. Also, the sources of funding for a position often plays a larger role in what type of research is most important. For example, Colleges of Agriculture often provide partial funding for statistics professors provided they engage in consulting for their agricultural research needs.

If you choose to go into academia, it is important to understand what particular percentages exactly mean. Of course, one can ask during an interview. Another great resource is to look at the online CVs (like a résumé) for tenured professors in the department that you are interviewing with.

What is tenure?

Tenure allows a professor to keep a job essentially as long as they would like it, provided they maintain the minimum standards of a position. The main purpose of tenure is to give professors the academic freedom to express their views without fear of losing their job. This reduction of fear though can lead to behavior which one may not normally see in industry.

Until a professor receives tenure, they may be working on fixed-term contracts with a university. For example, as described before, Assistant Professors at UNL have 2-year contracts that are renewable provided satisfactory work performance. Thus, the Assistant professor time period essentially gives the university a 6-year trial period to determine if an individual is a "good invest-

ment".

The effort that one needs to put toward getting tenure is somewhat similar to the effort that one puts into obtaining their PhDs. The biggest difference is that the pay is much better for professors! Also, I like to equate getting tenure to a residency program required to be a medical doctor.

Overall, time management is a very important issue when working toward tenure. I recently was invited to give a presentation on this and similar topics at a New Investigators' Luncheon held at the WNAR meetings.[1] A recording of my presentation "Yes! Yes, but... NO!" and the corresponding slides are available at `www.chrisbilder.com/wnar`.[2] There are a number of great external references that I make in this presentation. In particular, I urge all individuals who are interested in a academic job at a research university to read

> Nagpal, R. (2013). "The Awesomest 7-year Postdoc or: How I learned to Stop Worrying and Love the Tenure-Track Faculty Life," *Scientific American* guest blog, July 21 (`http://blogs.scientificamerican.com/guest-blog/2013/07/21/the-awesomest-7-year-postdo`

[1] This conference is described later in the course.

[2] My introduction did not go as well as I had hoped due to some initial technical difficulties. :(

This blog post provides some good advice about how to handle the pressure associated with the tenure process and also offers time management ideas.

Tenure-track (those who are Assistant Professors trying to earn tenure) and tenured positions are the most costly for universities. Many universities are now increasing the number of non-tenured track positions to lower-cost positions, especially when research is not involved. These positions are often referred to as "lecturer" or "instructor" and do not provide opportunities for promotion. Fortunately, some universities, including UNL, are making changes to recognize non-tenure track positions as a desired career path. At UNL, we now have "Professors of Practice" which also follow Assistant, Associate, and Full levels. Still, the disadvantages of these positions are

- Lower pay
- No tenure
- Fixed-duration contracts

In PhD-granting Departments of Statistics especially, these types of positions are often used to teach undergraduate service courses (like STAT 218).

Qualifications

Assistant Professor positions at research universities are typically more difficult to obtain than those at teaching universities. For research universities, common qualifications include:

- Mostly A's in courses, including the PhD theory
- At least one paper published in a top-tier journal
- At least one course taught
- Good English communication skills

Also, many Assistant Professor job advertisements will have particular areas of expertise listed that they are looking for. Common areas now include: big data, statistical (machine) learning, and genetics-based experience.

There are typically 40 or more applicants per position. However, most applicants will not have all four of the above qualifications. The earliest that interviews begin is early December. Most interviews occur toward the end of January and into February. If an individual does not have a position by mid-March, chances are low that a job offer will come. However, there are some other options which may make an individual more likely to obtain a job offer in 1-2 years:

- Visiting Assistant Professor positions - These often result from faculty resigning during the spring semester, which does not leave enough time for a full Assistant Professor search. Sometimes, a visiting position can eventually turn into a permanent position.
- Post-doc - Historically for Statistics, there have not been many of these. However, they are becoming more common now.
- Don't graduate! - One can sometimes spend another year as a student, if funding is available. This can be a reasonable choice as long as a student has not already spent too much time in graduate school (PhDs should be obtainable within 6 years of being in a Statistics program).

A good paper on how to get a job in academics is

> Stasny, E. (2001). How to get a job in Academics. *American Statistician* 55, 35-40.

I submitted a follow-up to this paper entitled "More on How to Get a Job in Academics: Strategic Advice from New Assistant Professors," but unfortunately it was not accepted by *American Statistician.* I would still be happy to share it with you!

9 vs. 12-month appointments

The majority of professors in Departments of Statistics have 9-month appointments. Similar to a K-12 grade teacher, a professor only gets paid for work during the 9-month academic year (mid-August to mid-May) and they are free to do what they choose during the summer. "If" a professor wants to do *paid* work by their university during the summer months (mid-May to mid-August), they can teach a course (usually at a much lower salary than during the academic year) or attempt to obtain a grant. This grant funding can be for their own statistical research or through consulting.

A minority, but still a large number, of professors in Departments of Statistics have 12-month appointments. While "12" is used here, these can mean 11 months with a month of unpaid vacation. These longer-term positions often occur due to consulting duties; e.g., a professor with a partial appointment in a College of Agriculture. Professors in Departments of Biostatistics have 12-month appointments.

Resources to find job announcements

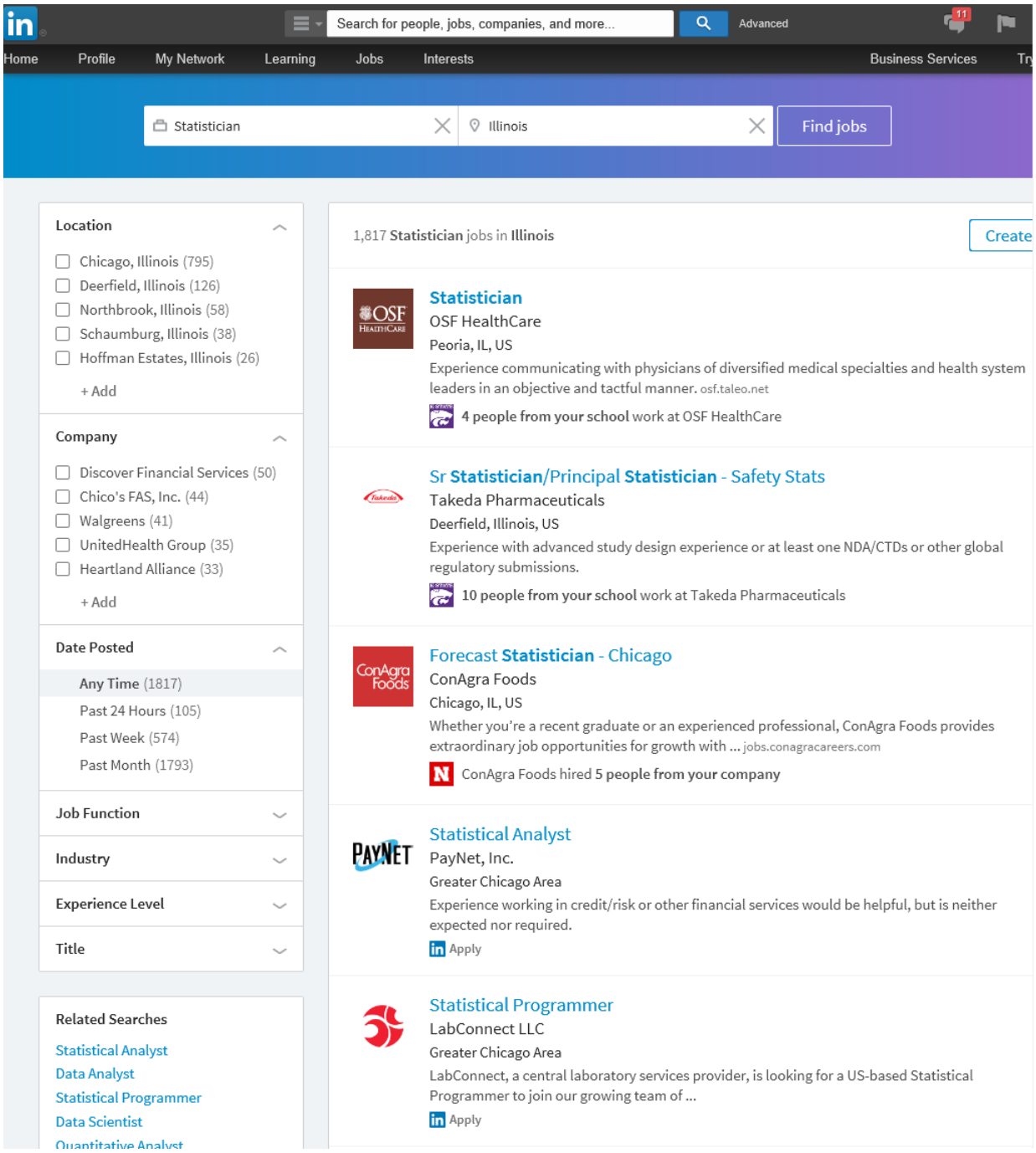
Below are some resources to use for finding job announcements with a MS or PhD degree.

- AMSTAT News (monthly membership magazine of the ASA; job postings are toward the end of an issue) and the ASA JobWeb at `https://www.amstat.org/jobweb/index.cfm`
- University of Florida Department of Statistics website at `http://www.stat.ufl.edu/vlib/Index.html`
- University of Purdue Department of Statistics website at `http://www.stat.purdue.edu/jobs`
- On-site interviewing at JSM and ENAR meetings

- LinkedIn
  - Below is a comment from David Johnson (UNL MS '06) about using LinkedIn and finding job postings there

    > For me, a lot of the legwork is on LinkedIn. I get hit up constantly there by recruiters. A lot of companies post jobs there and it has an easy function to search. My job searches usually involve a recruiter who I was introduced to or who reached out to me via Linkedin. A great resource there is the ability to join groups and discussions like "R Users Group". Recruiters will join those groups to see who is in it and connect.

  - Below is an example job search that I did for a Statistician in Illinois (Just an example! I am not looking for a new job!)



- Job announcements circulated through our department (employers will contact us to post a job opening)

Of course, the classified advertisements in local newspapers can provide job announcements as well, but these are less likely to be geared toward the PhD level.

Some statisticians and companies use search firms (a.k.a., recruiters and headhunters) to find employment/employees.These search firms receive a fee (maybe 20% of a base salary paid for by

the company) for making a match. An example search firm is Analytic Recruiting (`http://www.analyticrecruiting.com`), which was once recommended by a graduate.

Salary

Each bullet below provides a general hierarchy that is ordered by size of salary:

- Industry > Government
- Industry > Academics
- Research university > Teaching university
- Biostatistics professor > Statistics professor (adjusting for 9 vs. 12-month appointments)

It is important to note that *starting* academic salaries are often comparable to industry to entice new graduates to go into academics. Yearly raises in academics do not match those in industry leaving later on a much more significant salary gap between academics and industry.

I like to think of differences between academics and industry as being like the differences between safe and risky investments:

- Safe investment - Expect a low, positive rate of return with little variability over time (Academics: Great job security with decent pay and small raises)
- Risky investment - Want a high rate of return to compensate for higher variability over time (Industry: Less job security, but with higher pay potential)

The ASA publishes yearly salary surveys in AMSTAT News. Salary surveys are available at `https://www.amstat.org/careers/salaryinformation.cfm`; unfortunately, it does not appear that the most recent have been included here. The most

recent are available in spring issues of AMSTAT News. Academic salary surveys are conducted each year. Industry and government surveys appear every few years.

Salaries are negotiable. Whenever you obtain a job offer, do not accept the first salary offer! Of course, if you ask for a higher salary, it is good to have reasoning. These ASA salary surveys can provides some reasoning. Also, if you are negotiating a salary for an academic position at a public university, salaries for all professors are open for public review. You can usually find these online or at least at the university's library in a "budget book". For example, here are some locations where salaries can be obtained:

- U. of Nebraska: `http://www.nebraska.edu/administration/business-and-finance/budget-information.html`
- U. of South Carolina: `http://www.thestate.com/news/databases/article14573084.html`
- U. of Iowa: `http://www.thestate.com/news/databases/article14573084.html`

By examining the salary for other new Assistant Professors in a department, one can find an "upper bound" for a salary to request. This is because there will generally be a salary hierarchy for Assistant Professors based on the number of years at the university.

Additional information

- ASA's web page on "Which industries employ statisticians?" at `http://www.amstat.org/careers/whichindustriesemploys.cfm`
- There is a large demand for statisticians. This has led to a significant amount of moving by statisticians from one job to another in order to find a better fit and salary.

- It is much easier to move from a academic to industry/government job than vice versa, especially if the academic job is at a research university. The main reason is because an individual's research program cannot continue while in industry/government (in most cases).
- Dress for success when interviewing for a job.
- How do you prepare yourself for a government or industry job while in graduate school?
  - Often, no experience is needed and a MS/PhD degree is enough.
  - Of course, specific course work may give an individual the edge over others. For example, survey statistics course will help for an official statistics position. A clinical trials or pharmaceutical statistics course will help for a pharmaceutical position. A consulting course will help for most positions!
  - Good grades!
  - Try to obtain a variety of work experiences. For example, a nice blend of RA (with a consulting emphasis) and TA experiences will be helpful. If RA experience is not possible, internships will serve the same role. Overall, a 6-year TA work experience looks good, but a 4-year TA and a 2-year RA (or internships) will likely look better. My CV at the time of graduating with a PhD is available on the course website. While this CV helped me get a job in academia, I also focused on work experiences that would help me obtain a job in industry - see the professional experience section.