Mapping WPI Alumni Career Trajectories Through Data Visualization

An Interactive Qualifying Project Submitted to the Faculty of

WORCESTER POLYTECHNIC INSTITUTE

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Degree of Bachelor of Science

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Abstract

It is a constant challenge for academic institutions to keep up with the transforming economy as workplaces change and new types of careers and opportunities become available. This project aims to create a data visualization tool that enables exploration of WPI's Foisie Business School alumni career trajectories and students' academic pursuits. In this project, we develop a comprehensive anonymized alumni career trajectory database and a WPI alumni career trajectory data visualization tool. This tool will act as a resource for WPI students interested in mapping their potential careers and provide a comprehensive understanding of alumni career paths after college and how undergraduate decisions affect those paths.

Acknowledgements

We want to thank our sponsor, the Foisie Business School (FBS). We especially would like to acknowledge all of the FBS faculty, as well as WPI students, WPI alumni, academic advisors, the Career Development Center, the Alumni Relations office, the Director and Chairs of the Foisie Business School, and the WPI community as a whole, who took time out of their busy schedules to be interviewed for their insights and collaboration throughout this project.

We would also like to thank Professor Elizabeth Long Lingo, our project advisor, for all of the guidance, encouragement, and support she has given us throughout our project.

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1. Introduction

This Interactive Qualifying Project (IQP), Mapping WPI Alumni Career Trajectories Through Data Visualization, is designed to develop a comprehensive and interactive visual representation of alumni career paths. Developing a visualization tool that was useful to an array of institutional stakeholders and that was implementable, sustainable, and could be improved upon over time were driving principles for our project. To accomplish this goal, in this IQP we utilized a user-centered design approach that involved a four-pronged strategy:

1. Conduct initial need-identification interviews with key stakeholders (students, faculty, alumni, admissions, career development center, academic advisors, alumni relations, and outreach);
2. Scrape public data from LinkedIn to create an online database;
3. Develop usable and meaningful data visualization tools and protocols for future refinement and development; and
4. Validate usability with stakeholders.

The outcomes of this IQP can serve as a role model for other universities looking to publicize and promote their alumni's achievements, as well as provide insights into career trajectories.

2. Background

In order to develop this initiative, we first researched the importance of visualizing career trajectory data and how visualizations can be useful to students, faculty, and other higher education stakeholders. We also investigated comparable databases and visualizations at other institutions to draw inspiration and gain insights into current best practices for visualizing data.

2.1 Importance of Mapping Career Trajectories

As workplaces change, new types of careers and opportunities become available (Dhindsa, 2019). The changing nature of career trajectories is particularly acute in STEM fields, where innovations in technology shapes not only how work is done and organized, but also opens up whole new career fields and jobs. COVID-19 also brings changes to the workplace, leading to new types of jobs, careers, and opportunities (Lund et al., 2021). Thus, it has never been more imperative to implement an intelligible visualization of potential career paths. However, WPI currently lacks the capacity to do so. This project aims to address this gap and help WPI keep up with the transforming economy by creating a tool to visualize what types of careers are available.

2.1.1 Usefulness for Students & Alumni

A visualization of career trajectories could have a significant impact on both student and alumni users. WPI students, both current and prospective, will have the ability to see which degree programs lead to which outcomes. Studies show that students' reasoning for choosing majors is heavily based upon the career opportunities they believe will be available to them (Soria & Stebleton, 2013; Wilcoxson & Wynder, 2010). A visualization with such data would aid students greatly in selecting a major that aligns with their goals (Oriol et al., 2015). Similarly, if WPI

alumni wish to change careers or obtain a second degree, this tool will help them understand their options.

2.1.2 Usefulness for Faculty and Staff

From informal conversations with stakeholders, it is clear that WPI faculty and staff frequently advise students on both degree programs and careers. Although faculty often have insights into majors and industries, they may lack fine-grained insights into jobs and companies (Fain, 2020; Hooley, 2017; DeRuy, 2016). Additionally, WPI staff, particularly those who work in the Career Development Center and Admissions, may not always know how to best communicate information about potential careers to students (Fadulu, 2018).

2.2 Visualizing Data

Data visualization is often used to capture, present, and analyze complex data in compelling ways. Visualizations focus on representing data in a format that highlights trends and outliers while minimizing noise.

As a part of our research, we examined existing visualizations at other institutions. The visualization that seemed most similar to the one we hoped to create was that of Carleton College (Kubinski, 2021). Their Sankey Diagram matches majors with job industries. When a specific path is clicked upon, it proves a closer view at smaller, individual paths. This color-coded visualization is easy to comprehend. It is clear that most degree programs at Carleton College are not indicative of the industries graduates will work in (Lancaster, 2017). This can clearly be seen

by the lines going from major to career. Students graduating from specific programs do not necessarily work in commonly-associated industries.

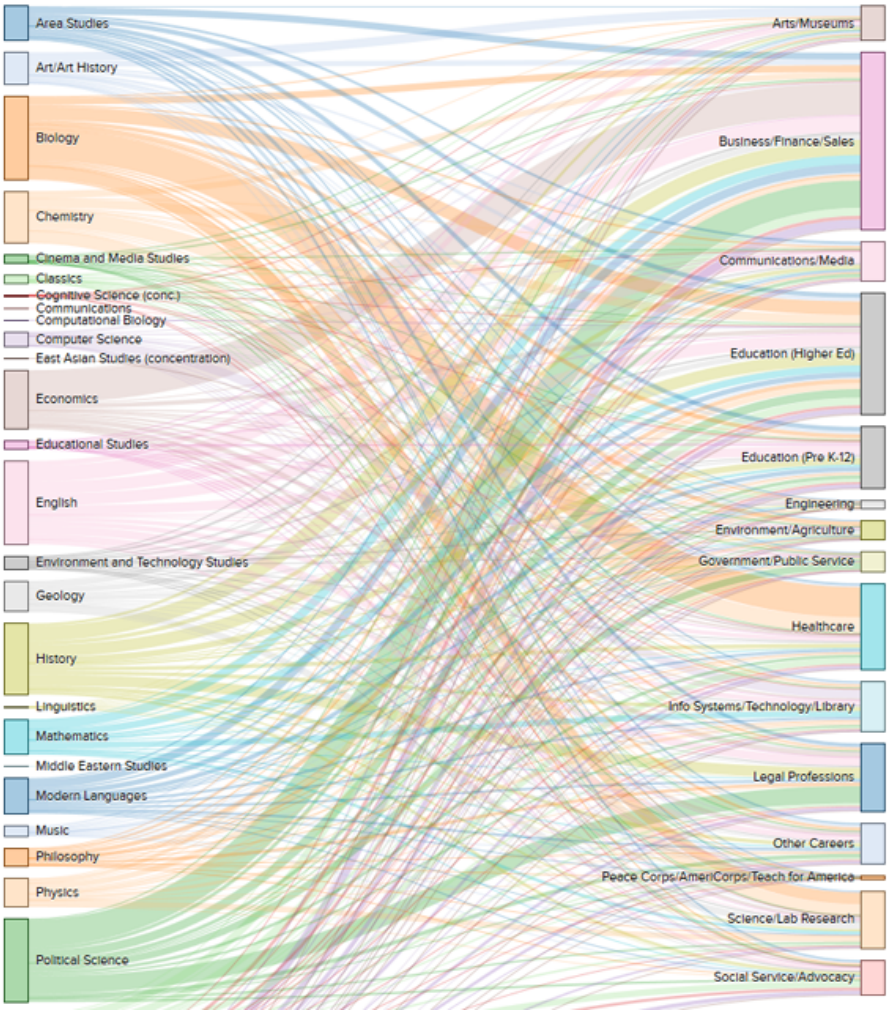


Figure 1. Carleton College's Career Mapping Visualization

Another interactive visualization can be found within The Hamilton Project (THP), an economic policy initiative (THP, 2021). After selecting a major, sex, and age group, users are presented with a colorful graph that shows the most common jobs, annual earnings, and employment rates for those selections. What makes this unique is that when users input their information, they receive a personalized visualization specific to their situation.

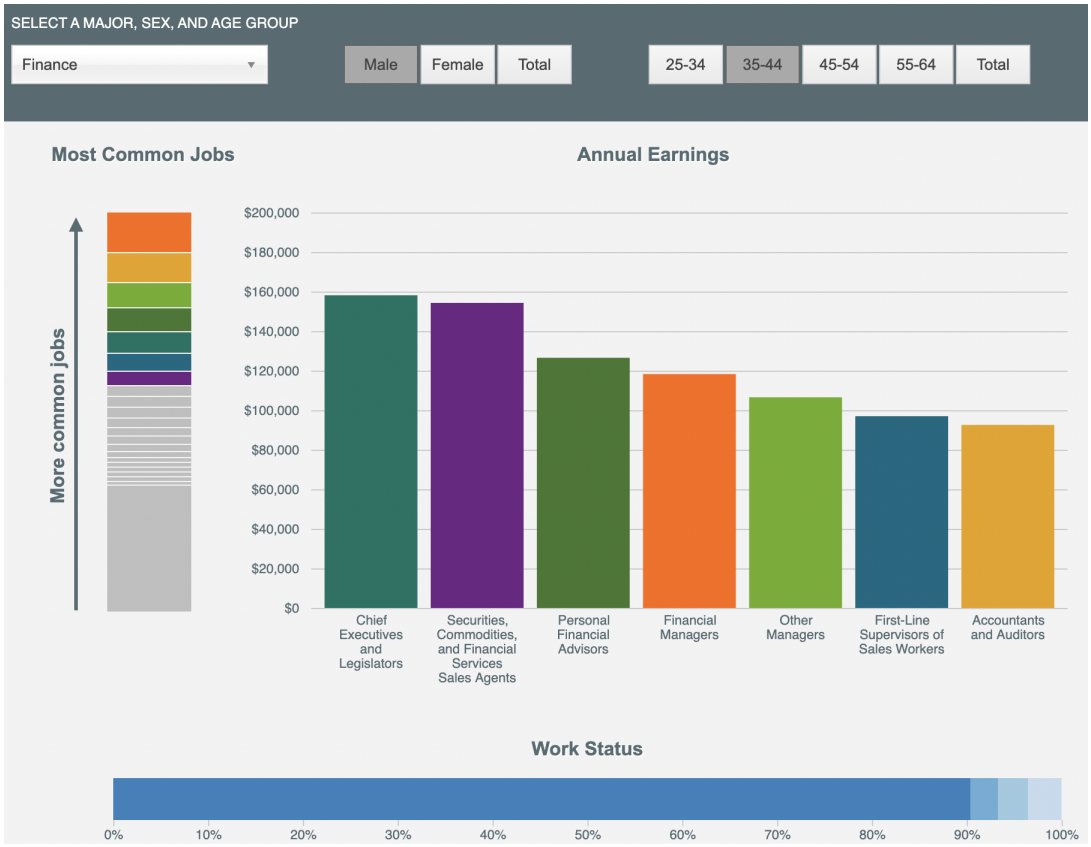


Figure 2. "Putting Your Major To Work: Career Paths after College"

A third visualization tool we investigated was created for the *New York Times* to illustrate paths to congress (Chinoy & Ma, 2019). From left to right, this graphic takes viewers through three sections: education, career, and government. While everyone took a unique path to become a representative, there are many intersections between the individual paths, showing that, for example, most representatives worked in business/management or state legislature at similar times in their careers.

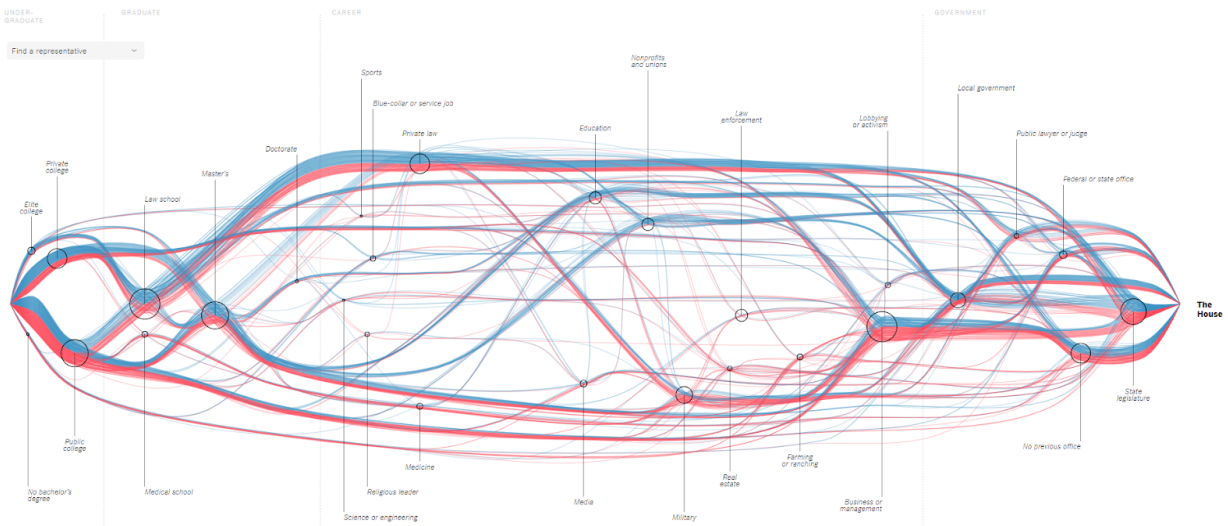


Figure 3. The New York Times' visualization of paths to congress

In summary, there are common themes between the visualizations we examined, such as color and user interaction. Utilizing color is essential to differentiate between vast amounts of data quickly. Similarly, the user interaction found in all three visualizations allows users to isolate specific sets of information. In our visualization, we plan on using colors and creating ways for users to interact with the tool.

3. Methodology

The goal of our project was to create a visualization tool that was useful to an array of institutional stakeholders, such as FBS faculty, WPI students, academic advisors, the Career Development Center, and the Alumni Relations office. We also sought to design the tool, user guides, and materials so that the tool would be implementable, sustainable, and improved upon over time. To accomplish this goal, we utilized a user-centered design approach that involved a four-pronged strategy:

1. Conduct initial need-identification interviews with key stakeholders (students, faculty, alumni, admissions, career development center, academic advisors, alumni relations, and outreach).
2. Scrape public data from LinkedIn to create an online database
3. Develop usable and meaningful data and visualization tools and protocols for future refinement and development.
4. Validate usability with stakeholders.

This tool will act as a reference for WPI students interested in mapping their potential careers and provide a comprehensive understanding of alumni career paths after college and how undergraduate decisions affect those paths.

3.1 User Centered Design Approach

User needs and perspectives are at the heart of this research approach. Innovative design should encompass both "needs and desires" (Van Oudenhove, 2015, para. 8). As shown in the figure

below, user-centered design is used to develop innovations that consider technological, human/ stakeholder, and viability/ implementation issues when developing innovation.

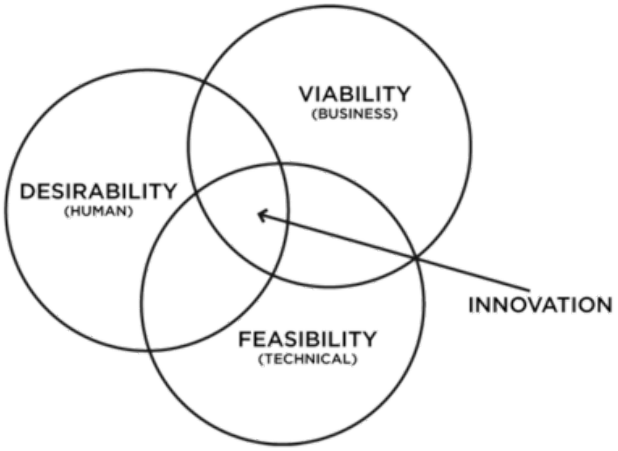


Figure 4. Components of Innovation (Brown, 2009, p. 380)

Empathic design is a research philosophy that aims to "identify the needs that customers themselves may not recognize" (Leonard & Rayport, 1997, para. 1). A key aspect of this philosophy is constant feedback with the stakeholders and our relationship with them (Creswell, 2007, p. 37). To kickstart this relationship, the stakeholders were informally consulted before even beginning this project. From this consultation, we determined the stakeholders' requirements for the project.

In developing this project, stakeholders were initially informally consulted. The purpose of this was to gain insight into what aspects of the tool would benefit them and help scope our project problem space. The user-centered approach utilized in this project requires that research is carried out with participants, not on them (Stoecker, 2005, p. 6). The importance of building relationships over time with stakeholders is fully realized (Creswell, 2007, p. 37).

As described in more detail below, our constant communication with stakeholders enabled us to modify our ideas and processes as we worked. Our successful prototype was tested by our stakeholders and improved based on their feedback. Going forward, our current prototype will be available for the WPI community to use for the next six months before another IQP group will take over this project and start the design process again. This powerful way of designing allowed us to consider who and how this tool would be helping. By looking at a wide range of perspectives, we were able to build a tool that has value to all our stakeholders.

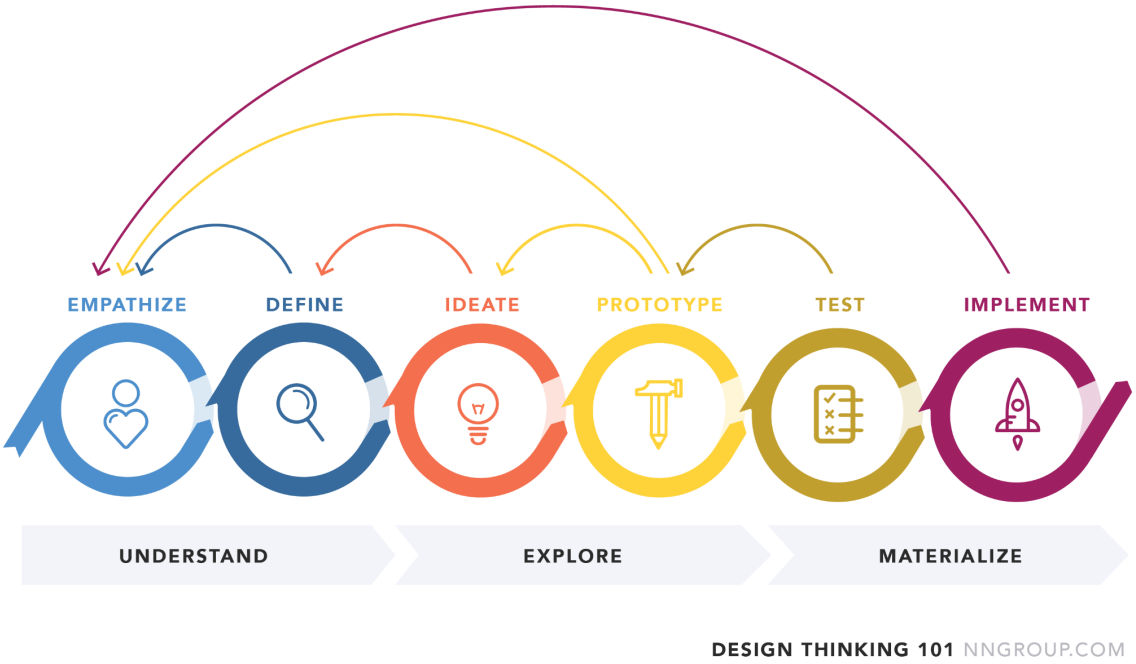


Figure 5. Design Thinking Diagram (Nielsen Norman Group, 2021)

3.2 Data Collection Strategy

As described below, a three-pronged approach to our data collection was taken: 1) conduct interviews with key stakeholders (students, faculty, alumni, admissions, career development center, academic advisors, alumni relations, and outreach); 2) scrape public data from LinkedIn to create an online database and visualizations; and 3) validate usability with stakeholders.

3.3 Need Identification Interviews

Our decision to engage in empathic interviews with stakeholders to begin our project helped us define the problem we were trying to solve. We conducted semi-structured interviews that included a core set of questions and allowed for follow-up questions that differed depending on participants' answers. This form of interviewing provided enough flexibility for each participant to expand upon their unique points of view. Interviews create an environment in which researchers can probe interviewees for their "deeper thoughts and behaviors that governed their responses" as well as their specific stories and emotions (Cresswell, 2007, p. 40). The core set of questions we used can be found in *Appendix A*.

After conducting interviews, we sorted the data into categories. This raw data can be seen in *Appendix B*. From our initial gathering of data, we condensed and visualized our findings into a Need Identification Mapping, as shown in Figure 4. Through our mapping, we identified our stakeholder's requests and the high-level themes they correspond to.

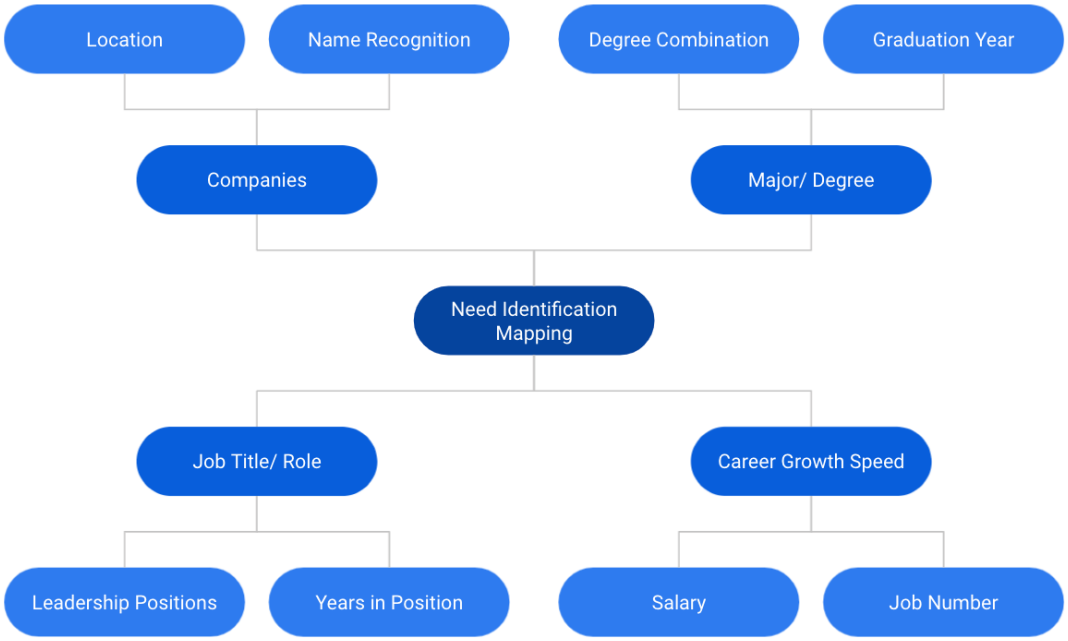


Figure 6. Need Identification Mapping

3.4 Data Scraping LinkedIn Profile Data

One of the primary concerns of the project stakeholders was the quality of the collected longitudinal career data. Simply put, if the data is not accurate, the tool's users cannot feel confident in any insights that they may discover. Existing databases of alumni career trajectory on campus were not sufficient, thus requiring the team to build a process for developing a comprehensive, accurate, up-to-date and sufficiently detailed database of alumni career trajectory data.

In conversation with stakeholders, it was agreed upon that LinkedIn, the most popular professional social networking site, was the most reliable source of information readily available (Davis et al., 2020). One concern is that the alumni are not necessarily "consenting" to having their data scraped on LinkedIn. This exact issue was brought up in a 2019 court case, *hiQ Labs v.*

LinkedIn, after which it was decided that all data that is accessible from a non-authenticated browser is intended to be public and can therefore be scraped.

We developed a pipeline, or an automated process, to automatically scrape LinkedIn profiles while respecting the privacy of our alumni as much as possible. As LinkedIn data is deemed to be in the public domain, we designed our pipeline to imitate an "external" observer. Because LinkedIn does not offer an Application Programming Interface (API) to query their users, we had to split our data collection into two discrete steps: getting the LinkedIn URL for a given alum and scraping the LinkedIn URLs.

3.4.1 Querying LinkedIn

One of the most difficult parts of the dataset generation process was identifying the LinkedIn profile for a given alumnus/a. Because LinkedIn does not offer a search API, we had to figure out a way to query Linkedin externally.

Our team created a custom Google Search Engine to query all LinkedIn profiles. Custom Search Engines (CSEs) is a service by Google that allows developers to use Google's search technology on a limited subset of the internet. Our team built a search engine that only considers URLs prefixed with either `www.linkedin.com/in/` or `www.linkedin.com/pub/`. By only considering these URLs, our CSE effectively only searched LinkedIn profiles.

Even though our CSE's search scope is heavily limited, there is still much uncertainty when using the CSE to find a particular user profile. Google considers many factors when ranking a

search result (text matches, page popularity, etc.), so additional care had to be taken to ensure that the best match was returned. On top of limiting the scope of the CSE, we had to design a custom search query template to only consider exact matches based on static content:

```
-intitle:profiles {name} “Worcester Polytechnic Institute”
```

where *name* is the alum’s name. Using this query template alongside our CSE, we can achieve an 80-90% accuracy when trying to find LinkedIn users.

3.4.2 Scraping LinkedIn

By using CSEs, we were able to get the LinkedIn profile for a given WPI alum. However, we still needed a list of all WPI alumni and a way to scrape the Linkedin Profiles themselves.

Fortunately, the office of Lifetime Engagement at WPI maintains an internal database of all students (about 80,000) and their registrar data. After taking the necessary privacy precautions as determined by our IRB process, we were able to acquire this list of names to guide our scraping efforts.

We then built an automated scraper for LinkedIn profiles. LinkedIn implements a battery of anti-scraping defenses, so our script had to imitate a human as much as possible to gather data. Our scraper uses an incognito Chrome 89 agent controlled via Selenium to browse Linkedin. The team is confident that imitating a logged-out user on the most popular web browser ensures that all data collected is within the public domain (Liu, 2021). To prevent getting blocked from LinkedIn, our script opens a user profile, expands all profile sections, and scrolls throughout the page with occasional pauses--as if a human was looking for a specific piece of information. With

these measures put into place, we can scrape about 150 profiles consecutively. After we reach about 150 profiles, LinkedIn automatically hides the profiles. To secure another set of profile data, we then restarted the agent (clearing all cookies and caches). However, this soft limit was consistently imposed and had to be addressed.

Using these techniques, we are able to scrape a LinkedIn profile in approximately 5.25 seconds on average. Running this on the entire dataset of 80,000 alumni would take 120 hours of *active scraping time* to complete the entire WPI alumni dataset. Given that our project was sponsored by the Foisie Business School, we limited our scope to focus on Foisie students who received their undergraduate degree from WPI. By introducing this filter, we were able to reduce our number to 5000 alumni, whose data was then scraped.

3.5 Iteratively Eliciting User Feedback

The team's primary goal for this project was to make this tool as useful as possible for the array of interested stakeholders, including WPI students, WPI alumni, academic advisors, the Career Development Center, the Alumni Relations office, the Director and Chairs of the Foisie Business School and the WPI community as a whole. However, since nothing similar to this tool currently existed at WPI, the team embraced an iterative user-centered, empathic design approach that also included eliciting user feedback throughout the tool development process.

Once a presentable version of the tool was ready, the stakeholders were invited to beta-test it. *See Appendix C: Email Invitation to Participate in Focus Group*. Where possible, we used focus groups to elicit feedback. A major benefit of focus groups is that participants can bounce ideas

off each other, creating a more collaborative environment. This will also allow for more discussion, potentially leading to more new ideas. Another benefit of user testing over zoom is that participants will likely be located in their home or office, somewhere they may realistically use this tool (Creswell, 2007, p. 37).

After participants read through our verbal consent form (*See Appendix D*), focus groups were recorded and feedback was captured to feed into the next iteration of the visualization tool. As this project aims to develop a tool for multiple stakeholders, the data collected in stakeholder focus groups were fed back into the visualization design. This is to help validate the team's design decisions and identify any future areas for improvement.

3.6 Alumni Interviews

We had initially planned to invite select alumni through LinkedIn or by email to share their unique career path during a Zoom interview. *See Appendix E: Email Invitation to Participate in Interviews*. Before the interview, participants would have been asked to give their written consent to be interviewed and to have the contents of their interview published on the database. We went through IRB approval to interview alumni; however, the data collection and visualization took more time than we had anticipated, and we did not have time to reach out to alumni.

We still feel as though alumni interviews would provide invaluable nuance and context to the data visualization. Adding individual stories to the database is what differentiates significance from meaning. Background information and context are an essential part of research (McKenzie,

2004). Good qualitative research "includes the voices of participants" as well as the context in which they are sharing (Creswell, 2007, pp. 37-40). We plan for future IQP groups to look into the benefits of including alumni interviews as part of the career trajectory visualization tool.

3.7 Protecting Human Subjects

Throughout our project, we took several measures to ensure the protection of our subjects. The data visualization only accesses data that alumni have already voluntarily made public via LinkedIn. This tool aims to understand the long-term experiences of WPI alumni, and only relevant data was used. Publicly shown data includes information on professional (company, position, years) and academic (university, degree, years) careers. Any information that is not relevant to the visualization, such as names, will be excluded out of respect for the users' privacy. Furthermore, this tool will be primarily used with aggregated filters (i.e., graduation year by decade), adding another layer of anonymity.

The biggest concern is that WPI alumni on LinkedIn are not necessarily "consenting" to having their data scraped for this visualization. However, the users published their information knowing that their profiles are public. This controversy was addressed in court (*hiQ Labs v. LinkedIn*, 2019), where the judge ruled that all data that can be accessed from a non-authenticated web browser is intended to be public. Our protocol abides by those rules to ensure that data is scraped ethically.

All human subjects in our study (in the form of interviews and focus groups) are fully consenting and aware of our data storage practices. Interviews and focus groups were audio and/or video

recorded. Before starting any discussion, we asked for consent for the interview/ focus group as well as permission to record the conversation. If a participant did not want to be recorded, we did not record them. We also explained that recordings will be destroyed after they are transcribed. Participants can ask to stop being recorded at any time. Transcripts are carefully stored so only the researchers had access to them and were deleted upon project completion. Individual details on data storage can be found in *Appendices D & G*.

3.8 Data Visualization

A key challenge in our work was to develop visualizations that were both useful and implementable within WPI. Key considerations for our visualization development included decisions on how to host our dashboard, the performance of the filtering and interactivity, and ensuring that our visualizations are actually meaningful.

The data collected from LinkedIn was used to create a digital visualization tool. This tool offers a series of interactive visualizations to help gain insight into alumni career trajectories. Users can filter and pivot the data based on professional (position, company, etc.) and academic (degrees earned, majors, etc.) to help answer their unique career questions.

To generate possible visualizations that would best meet the needs of our users, we searched for further visualizations across the web, and for other datasets. For example, in the visualization below, users can see job locations over time, which could be invaluable to users with geographic requirements. This inspired us to look into creating a geographic map of where WPI alumni work after graduation.

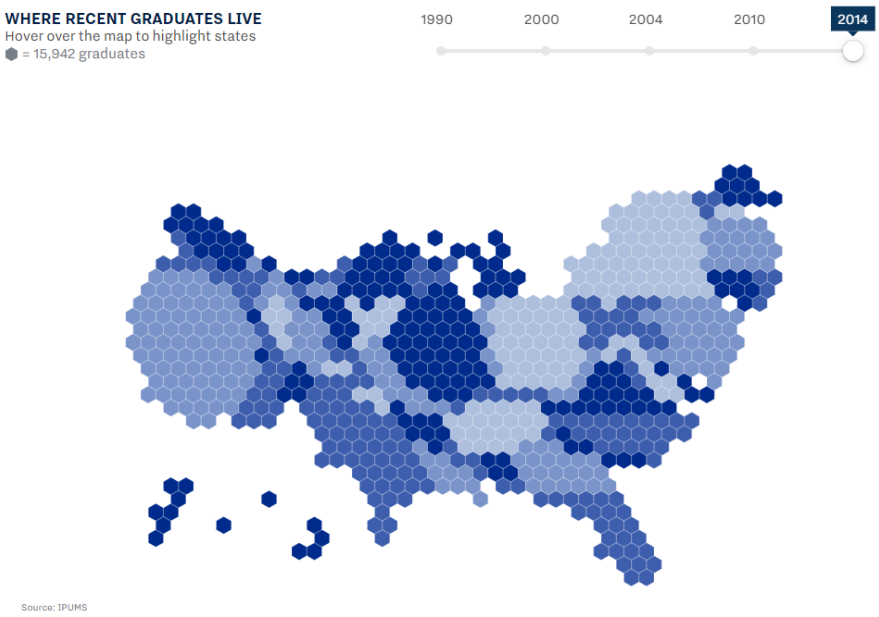


Figure 7. "Decisions Facing Recent Grads"

Another visualization, shown below from the US Census, shows the job outcomes per major. For an undergraduate student interested in switching majors, having this information is invaluable.

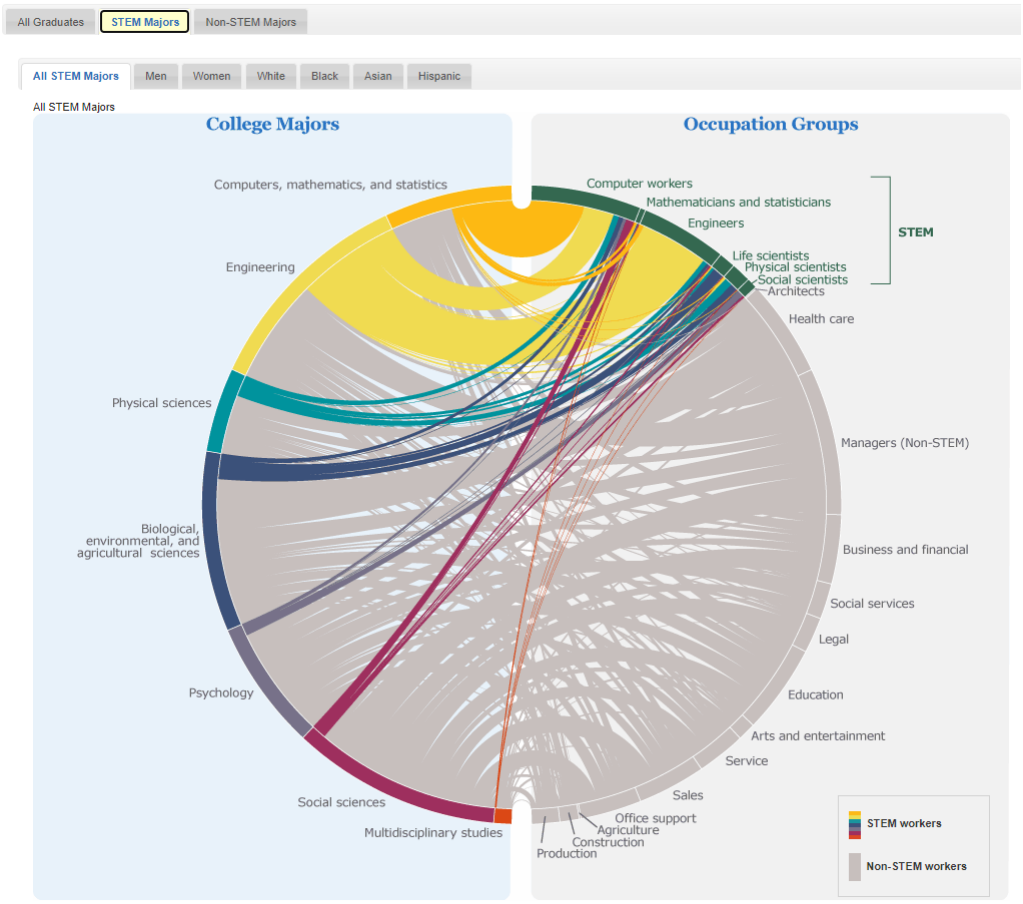


Figure 8. "Where do college graduates work?"

Unfortunately, all of these visualizations are scattered throughout the internet, and none are for WPI alumni. We hope to bring some of the power that these visualizations offer to the WPI community.

3.8.1 Data Implementation Evaluation

Initially, the data visualization software Tableau seemed as though it would be the best fit for this project. WPI already uses Tableau, so it made sense to invest time into a program that WPI staff could easily update in the future.

Tableau excels in quickly visualizing data for insights. However, anything past basic visualization requires an in-depth knowledge of Tableau as it essentially requires writing the visualization from scratch. Note that in this case, “from scratch” means that we had to calculate the location of all objects mathematically. For example, each point in every line in Figure 9 had to be individually calculated.

This computational overhead, alongside the time it would take to learn a new language, made it infeasible to develop in Tableau. Furthermore, for even a simple graph such as Figure 9, Tableau started displaying performance issues when rendering the visualization. Please note that this performance decrease was with only 500 rows within Tableau with minimal interaction. We planned to have thousands of rows of data for our final visualization, with active filtering and a fully interactive interface. With these requirements, Tableau simply would not hold up to our task.

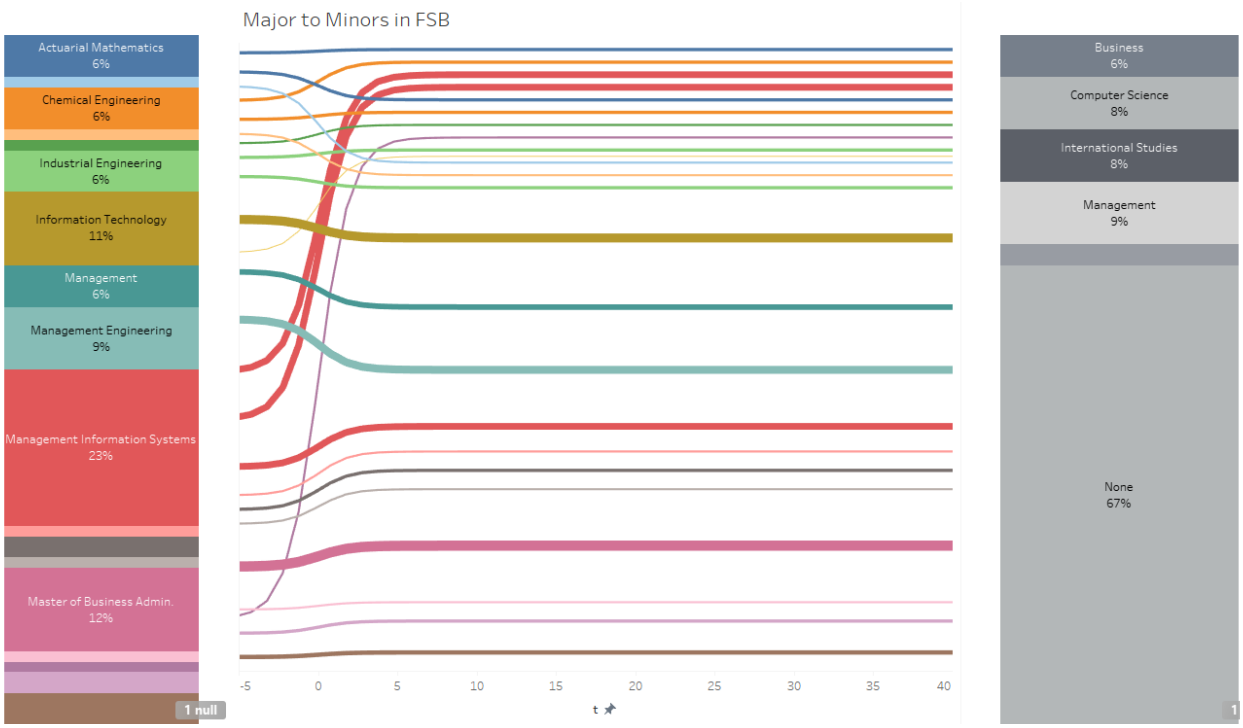


Figure 9. Tableau Sankey Diagram Attempt

After experimenting with Tableau, the team decided to switch to D3.js. D3.js is one of the most popular web visualization libraries, and we switched primarily for three reasons:

1. **Performance & Tools** - As D3 is designed to create interactive visualizations, it is optimized for dynamically manipulating larger amounts of data. Additionally, D3 offers a lot of "helper" functions to prevent repeated computation. For example, the Sankey chart in Figure 9 had to be manually computed in Tableau; in D3.js, all notes and vertices are automatically generated and location-optimized.
2. **Larger Community + Support -** D3.js runs on JavaScript, which is perhaps the most ubiquitous front-end programming language as of 2021. Due to the language's popularity, the support community behind JavaScript (and D3.js) is significantly larger than Tableau,

enabling a quicker debugging and prototyping time. Additionally, with our implementations being written in a popular programming language, we are lowering the requirements for future teams to extend this project.

3. **Using a Turing-Complete Language -** Tableau's programming functionality is that of an advanced database. This works well with highly structured data, where the users know the exact number of columns, rows, etc. However, the data that we are considering is unstructured; for example, one alum might only have three jobs while another might have 14. As we do not know how many jobs a given alum will hold, there is no way to fully define the structure of the data. Therefore, not only do we need to do significant data processing *befor*e even touching Tableau, but we also cannot use other people's example visualizations because our data does not fit their structure.

In contrast, JavaScript is a general-purpose, fully-featured (aka Turing-Complete) programming language. Unstructured data is not only accepted by JavaScript but preferred; our data is stored as JavaScript Objection Notation--JSON--file. With JavaScript's abilities, we can quickly transform the data to fit any structure that we need. This data flexibility also enables us to use other developers' online D3 templates, yielding both a higher quality end product and minimal code redundancy.

As seen in the screenshot below (Figure 10), Observable allows for rich text formatting and displaying JavaScript visualizations in-line. Note that in the screenshot's visualization, the user can interactively filter out data points in real-time.

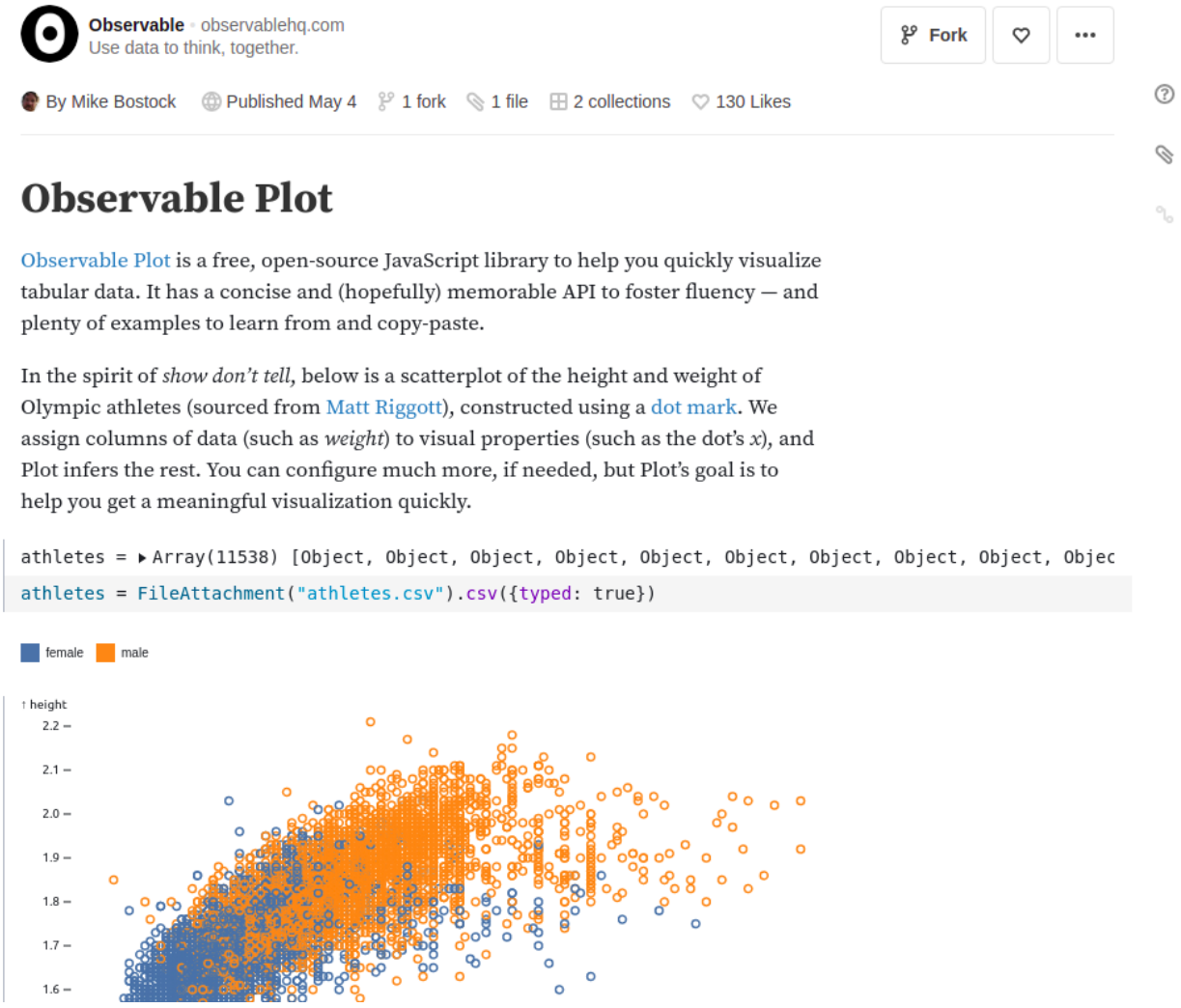


Figure 10. An example Observable notebook

Once we decided to switch from Tableau, we still needed to host our visualization. Initially, we thought to host our service on a WPI server, but that would lead to issues with server maintenance. Observable is an online service built around supporting D3.js visualizations. Observable will automatically host webpages (or *notebooks*, as Observable denotes them) with full support for D3.js functions. Additionally, Observable allows you to import visualizations from other notebooks--allowing us to code the visualization in one notebook but display it in another one to create a unified dashboard. Using Observable allowed us to create aesthetic

visualizations and keep them up for the WPI community to use in the future. To maintain the privacy of our users, all of our data is preprocessed and cleaned on WPI server and only the anonymized data sets are uploaded to Observable.

4. Project Outcomes

While it is invaluable for a range of WPI stakeholders to be able to interactively explore alumni career trajectories, the possibilities of data visualization have yet to be tapped. Further, in our review of existing best practices, we were not able to find examples of any other schools that had comprehensive, up-to-date databases to show where their students are after graduation.

In this section, we detail our four primary project outcomes: 1) a process for collecting an alumni career trajectory data set and the database itself; 2) meaningful data visualization tools; 3) suggestions for future refinement and development; 4) user-friendly dashboard prototypes.

The outcomes of this IQP can serve as a role model for other universities looking to publicize and promote their alumni's achievements, as well as provide insights into career trajectories.

4.1 Data Collection Process and Data Set

In this project, we successfully created a process for scraping the LinkedIn data for select WPI alumni. This process was used to collect the data of approximately 5000 Foisie Business School alumni.

We successfully developed a database combining data from Foisie alumni's LinkedIn profiles, as well as the internal WPI registrar data. More specifically, we scraped the following fields from LinkedIn:

- Name

- For each job they had:
    - `Position`
    - `Company`
    - `Start/End Dates`
- For every degree:
    - `Degree Type`
    - `School`
    - **Note:** Year of graduation could NOT be collected since LinkedIn does not publicly show that information.

However, the data we collected is only a "snapshot" of Foisie Business School for alumni from 1970-2021. Despite this initial foundational effort, ideally, the data set will be updated over time. To that end, we developed a scalable, repeatable process that can be used to update the current data set whenever needed.

Our code can be found at https://github.com/agupta231/career-trajectory-mapping (Figure 11), where it will be archived and available for future IQP teams. There are full environments set up and execution directions in the repository to assist future teams with all components of the project. Since we chose to use standard APIs and libraries such as Google Custom Search Engine and Selenium, we are confident that our tools will be supported for future teams.

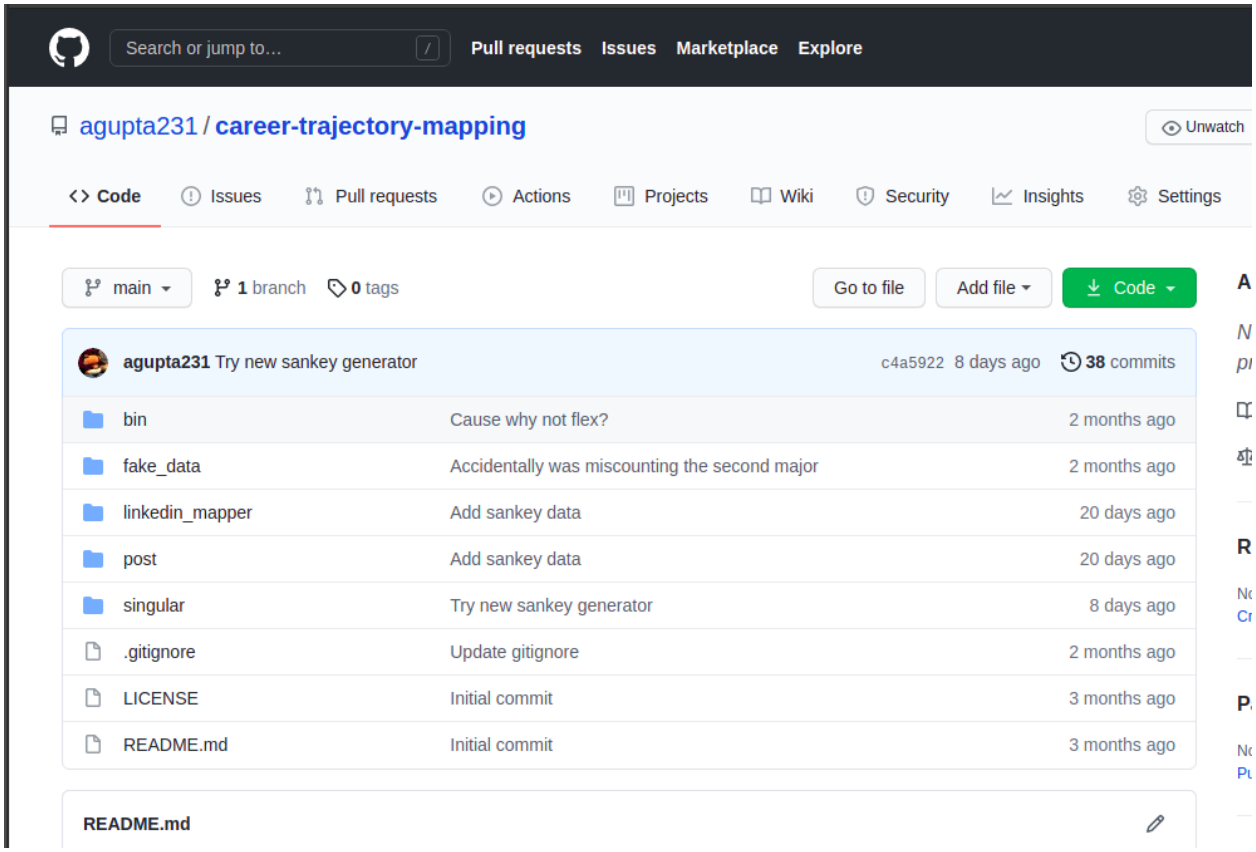


Figure 11. Our project code repository

Additionally, the software has been written modularly to allow for asynchronous execution of different parts of the pipeline. For example, the LinkedIn querying program can be run independently from the scraping script. This will prove useful when other IQP teams re-update parts of the database in the future without needing to run the entire pipeline start-to-finish.

The data we collected will be given to WPI's Office of Lifetime Engagement, through which other internal teams will be able to extend our visualizations and perform other analytics on the data. There is a lot to learn about the current and post WPI experience. We hope that our easily accessible alumni database will help WPI leverage our in-house talent to gain valuable insights.

4.2 Visualizations

This section outlines the specific data we gathered, the visualizations we created and why, and the potential insights that can be gained from our dashboard. The permanent link to the dashboard can be found at:

https://observablehq.com/@agupta/wpi-alumni-dashboard

4.2.1 Alumni Job Stability

The first visualization displays how quickly people change jobs. By following a user-centered design approach, we already knew that our stakeholders were interested in knowing how quickly alumni progress in their careers from our Need Identification Mapping in Figure 6. Considering the data that we have readily available, we plotted the job order against the job start date, as shown in Figure 12.

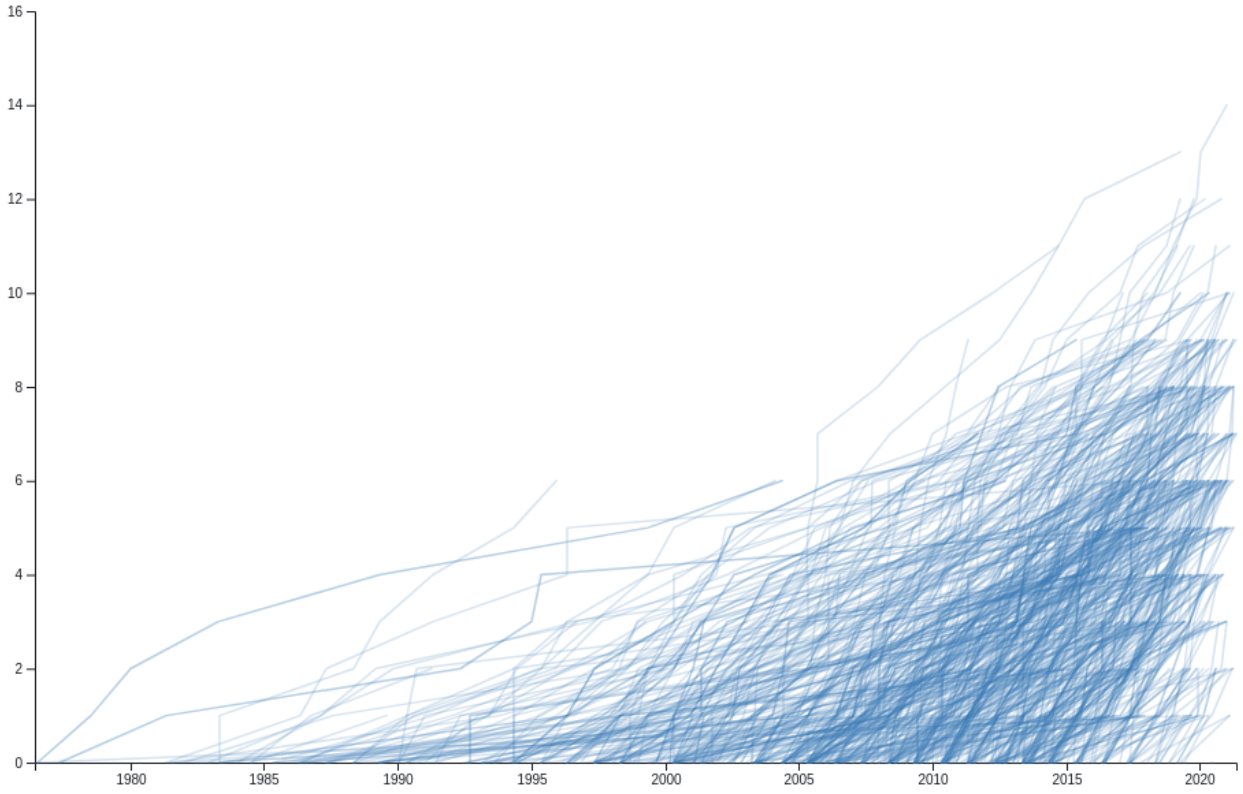


Figure 12. Alumni job number plotted against their position start date

The vertical axis shows the job number (1st job, 2nd job, etc.), while the horizontal axis shows when each person began working each job. Each path is a WPI Foisie Business School alumni, with their associated majors, minors, and career trajectories.

The interactive visualization contains filters, meaning that it is possible to view data specific to various undergraduate major and minor combinations. This could be useful when looking to see how an added major or minor affects job growth over time.

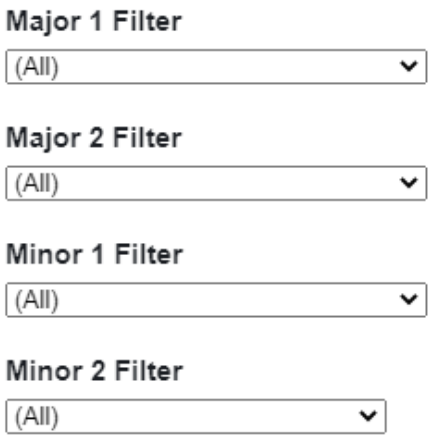
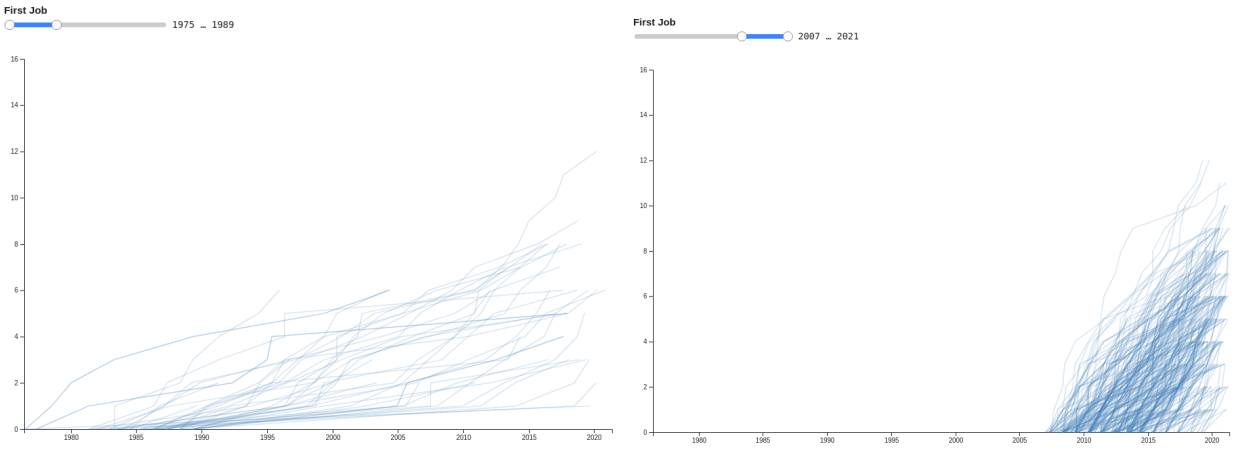


Figure 13. Filters to constrain major and minor combinations in visualizations

Another way to filter the data is by using the slider to look at a specific time period. It is possible to change the interval size to see job growth per interval. For example, by moving the slider, it can be seen that alumni who graduated in the 1980s tend to stay at the same job for many years, while newer alumni change jobs more often, as shown in Figure 14.



(a) (b)

Figure 14. A juxtaposition of alumni careers from the 80s and the last decade

Observe that the 80s alumni tend to switch jobs a lot less than newer grads.

This makes sense, with the recent rise of high-tech companies and the new trend to job-hop.

Granular Visualization by Job and Work Title Graph

User needs identification also pointed to interest in understanding the reason behind a job change and the range of titles and companies alumni might work at. Many alumni have a large number of "jobs" due to internships; however, those should be considered differently from promotions or transfers as alumni. To achieve this important nuance, the team added a textual overlay with details of each position over time, as shown in Figure 15.

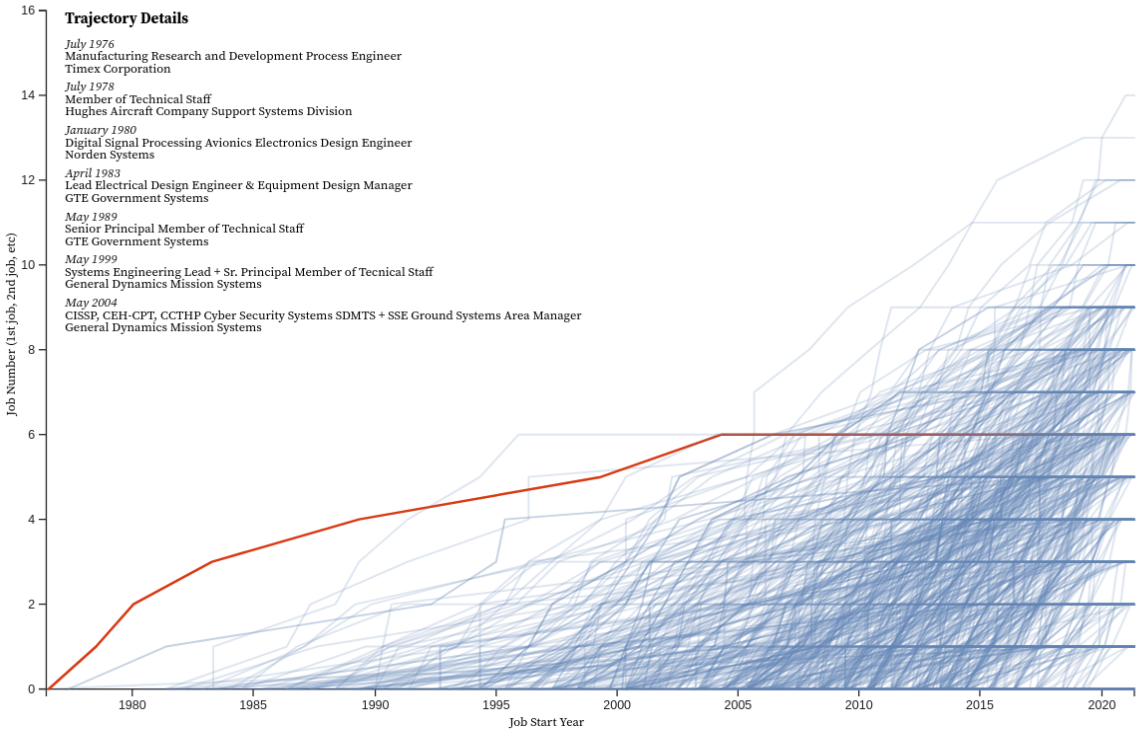


Figure 15. The final alumni job stability chart with axis labels and trajectory details

4.2.2 Major/ Minor Comparator

As discussed in Section 3.4.2, we used internal WPI registrar data to get the names of alumni to scrape. However, WPI's internal data set includes more information than just names. As stakeholders were also interested in the effects of major/ minor combinations (Figure 4), we used the following fields from the registrar data set:

- Degree type
    - Bachelors, Masters, etc.
- Degree year
- First major
- First major’s department
- Second major
- Second major’s department
- First minor
- First minor’s department
- Second minor
- Second minor’s department

We wanted an easily understandable way to show which undergraduate WPI paths are the most common, so we created a Sankey Diagram to show which undergraduate degree combinations are most prevalent.

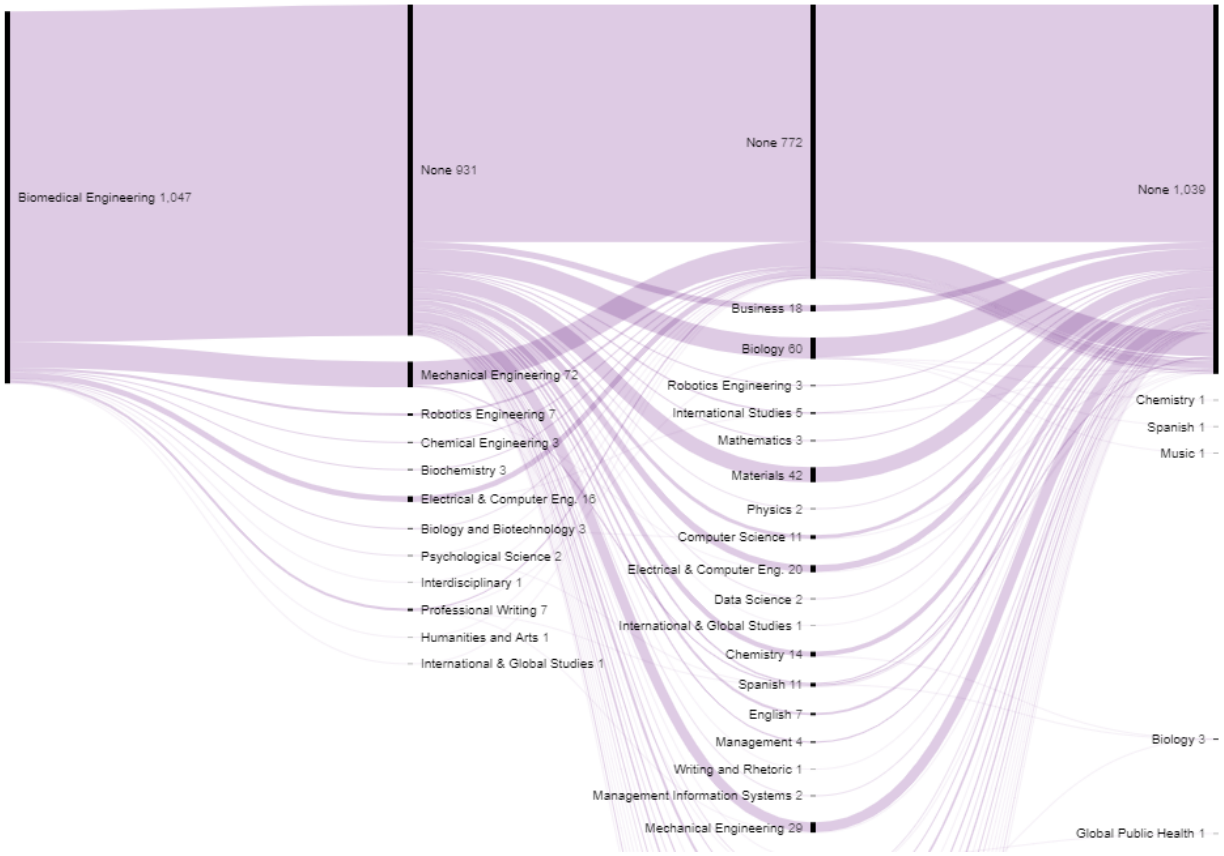


Figure 16. Major/ minor comparator with Major 1 filtered by BME

The first column shows someone's first major, and the second column is the second major. The third column is the first minor, and the fourth is the second minor. For each major and/or minor, it is possible to see how many people combined that with other majors and minors (or neither). Users can filter by major and minor, which is useful if someone is contemplating adding a second major or minor. Unfortunately, since the Sankey Diagram works off of aggregated data, users cannot dynamically filter based on years. However, we have computed the aggregates per decade so that users can see the history of WPI undergraduates' degrees over time.

A visualization like this could be invaluable to students who might have some extra time in their schedules and would like to do more during their time at WPI. For example, if a BME student wanted to explore adding an additional major or minor, they can constrain their first major to be BME to get Figure 16. With this visualization, the student could see that many BME majors tend to also double major in ME, or get a minor in Biology, Materials, and the other subjects listed. Having this aggregate data might inspire the student to explore these extra paths, especially if there is a big opportunity to double-count credits.

4.2.3 Combining Visualizations

While the visualizations are interesting on their own, powerful insights can be gained from combining the two visualizations. The major/ minor filters work for both, making it easy to see the benefit of adding various majors and minors. For example, consider a CS major interested in potentially adding a minor. By constraining their first major to be CS, they can see which path CS majors take the most, as shown in Figure 17.

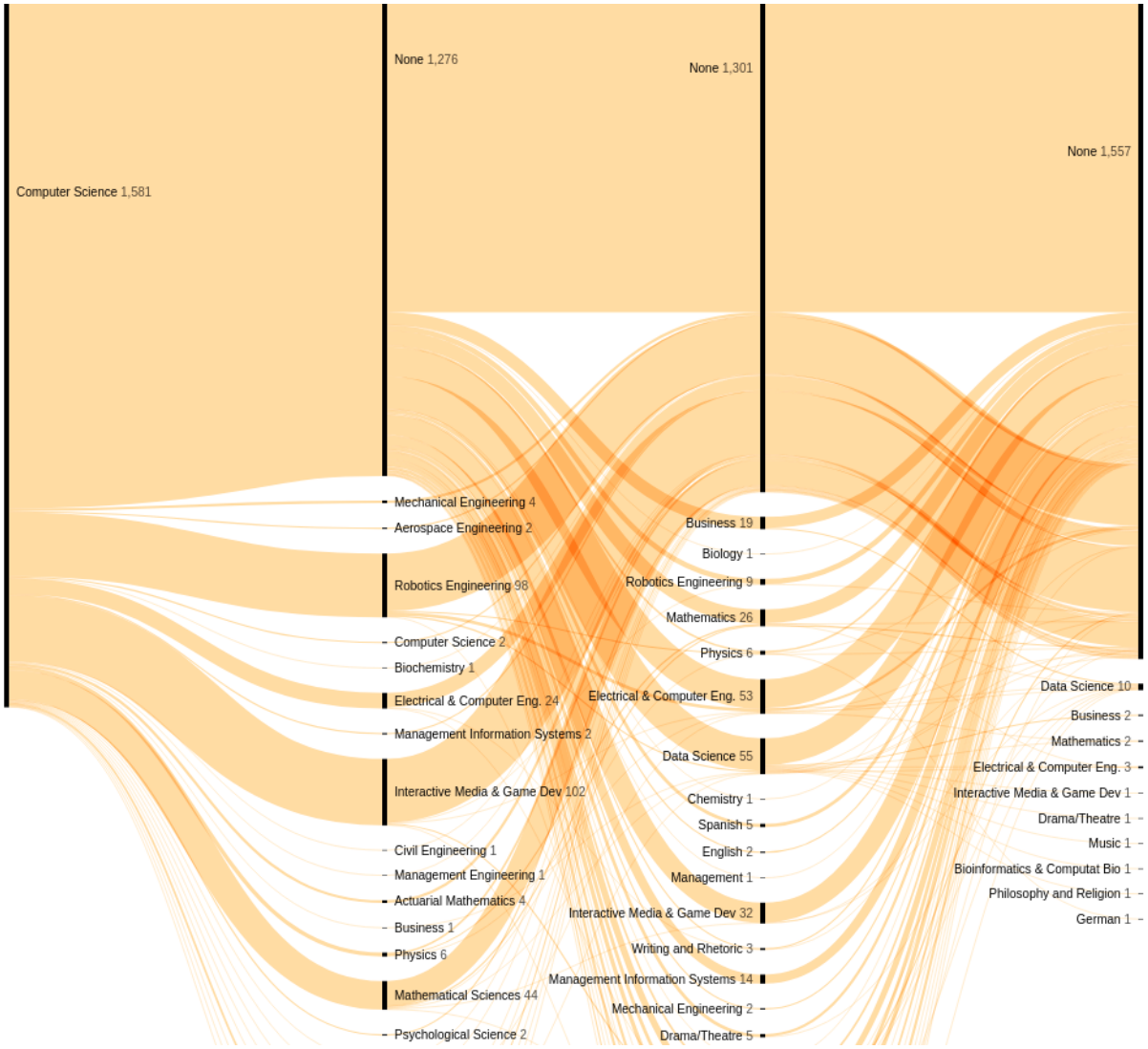
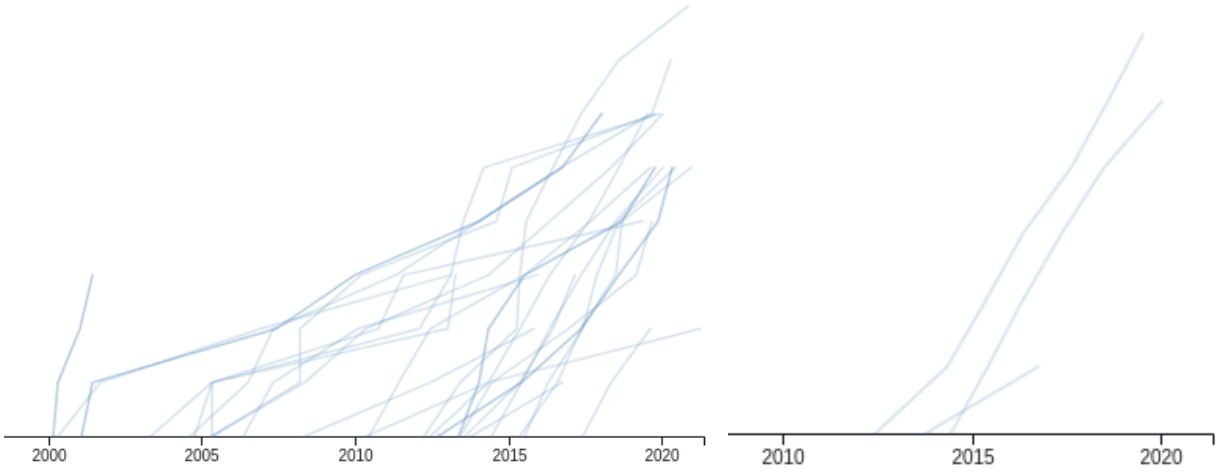


Figure 17. Major/ minor comparator with major 1 constrained to CS

Using this visualization, the student can see that BUS is actually one of the top 5 minors that CS students get--so there should potentially be a decent support structure within WPI. However, what about after WPI?



(a) (b)

Figure 18. A cropped view of the alumni job stability viz
Both (a) and (b) have major 1 constrained to CS. In (a), the minor 1 filter is set to None while in (b) the minor 1 filter is set to BUS.

The student can then refer to Alumni Job Stability visualization to see how that affects job growth once they leave. They can set the minor 1 toggle to be None--what they currently have--or BUS--what they potentially want to get. These yield Figures 18 (a) and 18 (b), respectively. In Figure 18 (b), we can see that the students with a BUS minor tend to accelerate much quicker throughout their career.

The most significant limitation is that the data is currently limited to FBS alumni, yielding a small sample size. In future years, when the data set gets extended, students will get more substantial insights. Fortunately, the visualizations have been designed to work with any data set, so updating the visualizations with new data should be a minimal effort.

4.4 Integrating User Feedback and Possibilities for Future Iterations

Following our user-centric design philosophy, our team wanted to create visualizations and ensure that they are useful for our stakeholders. After we built a semi-refined dashboard, we had follow-up interviews with the subset of our stakeholders that had availability: students, WPI administration, and faculty. As detailed in Section 3.5, these usability tests were designed to give us both explicit feedback from the user and implicit feedback by observing the user navigate the dashboard. This section describes several points of feedback that we received and implemented so future teams can conduct a similar refinement process. Due to time constraints, not all of the feedback could be implemented. The full feedback can be found in Appendix I.

4.4.1 Unintuitive Filtering

In the initial dashboard that we presented to our stakeholders, there were minimal instructions supplied to gauge how intuitive the visualization controls were. A trend that we noticed was that our double-ended slides (as shown in Figure 19) had a lot of hidden functionality that our users did not discover by themselves.

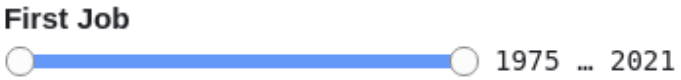
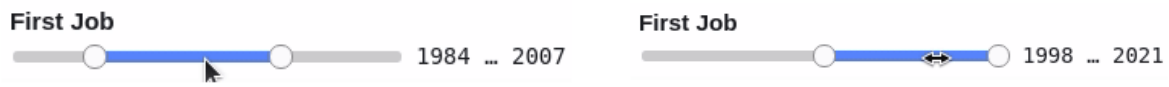


Figure 19. Alumni job stability year slider

The slider is adjustable from both ends, and the entire slider is draggable if it is smaller than the entire range. This behavior can be seen in Figure 20. Our users sometimes did not realize that both ends were draggable nor that the entire slider could move. To fix this, we have added

animated GIFs showcasing the slider's complete behavior above the visual. We found that these visual instructions showcase the filter's functionality most effectively.

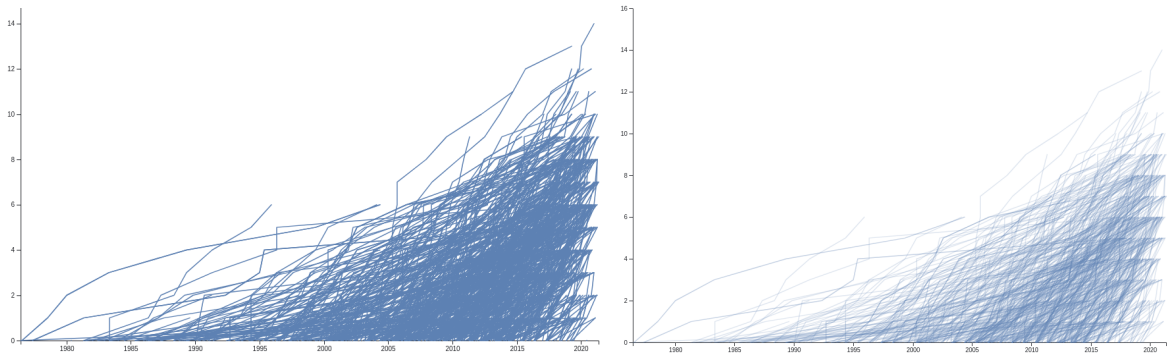


(a) (b)

Figure 20. An example of the job year filter being dragged

4.4.2 Difficult to Observe Trends

In our original alumni job stability visualization, all of the trajectories were represented as full opacity lines. This behavior, shown in Figure 21 (a), makes aggregate trends very difficult to observe. Some of our users had difficulty understanding the visualization because all the paths merged into each other.



(a) (b)

Figure 21. Alumni job stability opacity change

By adjusting the opacity, the trends become more apparent as they get darker with a higher frequency, as seen in Figure 21 (b). Users who saw the visualization with this change responded positively, immediately recognizing different trends as they adjusted the filters.

4.4.3 Unclear Comparisons

As described below, in the final version of the dashboard, we include directions on how to properly use the visualizations, implementing the changes in Section 4.4.1. However, we observed a point of confusion around the exact values being plotted on the alumni job stability graph. Even though this information was encased in the directions, we got direct feedback to add axis labels for clarity. This taught us an important lesson: just because the information is on the page, it may not be necessarily read by the users.

4.5 Final Public Facing Dashboard

After implementing the stakeholder feedback feasible in our remaining time, we created the final versions of our visualizations. The major/minor comparator remained mostly unmodified; however, the alumni job stability chart underwent a few iterations, as discussed in Section 4.4. The final version of the visualization, which can be seen in Figure 21, features trajectory details as well as a hover overlay to clarify what each position was.

Our stakeholders encompass many different parts of the WPI community and we wanted our tool to be as accessible as possible. Our team is in conversation with the Career Development Center and Office of Lifetime Engagement about how to use our tool to help WPI make data-driven decisions and hosting it on their website for more visibility. On a WPI website, this would likely be in the form of a screenshot of our tool, such as in Figure 22, which would be a hyperlink to our Observable notebook. We hope that as more of the WPI community uses our tool, more interest will come in to extend it as well.

How to Use this Dashboard

We visualized alumni data from both their time at WPI and their career data via LinkedIn. We've added filters that work on both visualizations to offer a comprehensive story on how a particular alumnus' career. Below, we'll describe our visualizations and tips/tricks for getting the most out of them.

Major / Minor Sankey Chart

We've aggregated all of the WPI registar by major/minor per decade. You can use the degree filters to select specific combinations:

For example, for a curious Bio-Medical Engineering student who wants to pick up a minor or perhaps a second major, they can simply set **Major 1 Filter** to *Biomedical Engineering* to get:

Figure 22. Screenshot of our dashboard's landing page

5. Conclusions

5.1 Summary

We hope that the interactive database and visualization mapping the career trajectories of Foisie Business School alumni provides WPI students a better understanding of the paths available to them. The tool will be implemented, and users will continue to generate ideas which will contribute towards future refinements. Future IQP groups will be able to see how the tool performed and make improvements accordingly.

5.2 Social Benefits

The stakeholders we spoke with will benefit from their participation in our research by both gaining insights into career trends to help students and alumni make informed decisions and allowing WPI's administration to better understand the university's overall performance and any changes that need to be made. The career decision process has historically been a grueling cycle of talking to on-campus resources to get advice, and cross-referencing LinkedIn. This tool will offer a large database and extensive filtering options, streamlining the entire process.

It is no secret that gathering and maintaining accurate data about alumni career paths is a difficult feat. In the past, most data has been self-reported, meaning it is often sparse and unreliable. A database built off of LinkedIn will have the most up-to-date and accurate information. Accurate data presented in a flexible visualization will not only help WPI make data-driven decisions more quickly but also increase WPI's confidence in those decisions.

We had initially intended for select alumni to be interviewed and for their stories to be displayed within the visualization. Alumni interviewees would have gained greater insight into their career pathways. Adding alumni stories to the visualization tool also offers an invaluable way for WPI to better engage alumni after they graduate.

All stakeholders, including WPI students, alumni, and faculty, will gain greater insight into their career pathways. Furthermore, this tool could be used to investigate trends of WPI alumni to answer retrospective questions about the WPI experience as a whole.

5.3 Limitations and Future Project Directions

Our main priority when working on this project was to create a working prototype. Future IQP groups will modify and improve upon our initial design. They will also have the opportunity to further analyze data to gain valuable insights.

The biggest limitation we faced was time. We were not able to complete everything we had initially planned to, since collecting the data was a bigger task than we had initially anticipated. Although there were limitations within our tool, as discussed in Section 4.2, we were still able to gain basic insights from the data and visualization.

5.3.1 Implementation and Sustainability Considerations

As previously discussed, this project was designed to enable future IQP groups to easily continue our work. The code is easily extendable and online. We chose to write the code in popular

languages using highly-supported frameworks. Additionally, the data is stored within WPI so that teams can easily access it in the future. In addition, we maintained strict records of user feedback for future teams. As for the WPI community, both WPI's Career Development Center and the office of Lifetime Engagement have expressed an interest in using our dashboard and integrating it on their websites.

5.3.2 Wish List

In this project, we successfully developed tools to identify and scrape the LinkedIn profiles of WPI alumni, cross-referenced them with internal registrar data, and created visualizations to gain some preliminary insights.

Due to the ordeal of querying and scraping LinkedIn, the team only had time to create the visualizations, but was not able to perform an in-depth analysis of the data set. In considering both the current state of the data and code as well as the feedback that we have received from our stakeholders, we have generated a list of potential next steps to be taken by future teams:

- **Extend the data set:** Our data scraper was only run on the subset of the data which encompassed the Foisie Business School. However, the tools work for any LinkedIn profile. These tools could be run to gather the LinkedIn histories for all alumni.
- **Create more visualizations:** As the data scraper returns data in the exact same format, more visualizations can be developed using the smaller data set. Once more data is added, the visualizations should automatically update. After talking to the stakeholders, some visualizations that can be developed *with the currently available data set* are:
    - Company distributions for major/minor and time (where were WPI MA students working in 2013?)

    - Graduate school distributions for major/minor and time (where did most WPI ME students go for doctorate programs?)
    - Effects of higher education (filtering by masters, phd programs)
    - Extend the major/minor comparator to consider students *only* coming to WPI for a graduate degree
- **Data Augmentation**: As mentioned in Section 3.3.2, the LinkedIn data set is self-reported. This causes heavy variation in user typed fields, such as position. For example, one employee might put down their job title as "Software Engineer" while another might simply abbreviate it as "SWE". A major opportunity for future research could be finding intelligent ways to standardize these fields, as they could offer some valuable insights when combined with other aspects of the data. In addition, future teams might look at salary data and leadership positions.
- **Data Analysis:** The team only had time to visualize the dataset and could not perform an in-depth analyzis into it. Just by using the visualizations that we have provided, we have been able to infer some exciting insights. However, more sophisticated techniques such as machine learning (ML) can be utilized to identify more obscure trends. For example, ML could be used to infer which job changes are promotions versus a firing or a simple transfer. This could then be combined with our existing visualizations to see which degree combinations best set WPI students up for success.
- **Interview FBS Alumni**: Through alumni interviews, we hope to "put a story behind the numbers" when it comes to our visualization tool. To showcase the versatility of the tool, alumni stories could be paired alongside preset filters aimed to answer a specific question. For example, the tool could be configured to show the effect that double major

has on long-term job prospects. In this configuration, the tool could have toggles for different degrees and company position distributions over time; users could use this configuration to help evaluate their decision to get a second major. A paired alumni interview would be of alumni who had gotten two majors and reflected on how that helped them in their career. These alumni stories offer the chance to gain insight into the responsibilities of a job past the job description.

In our project, we have been able to utilize our tool to elicit some initial insights. We are incredibly excited for what the future holds with respect to this tool and its ability to help understand our alumni. With the ability to collect LinkedIn profiles, we have enabled future IQP and MQP teams to explore and extend alumni career data at will. Furthermore, by offering the data back to WPI, we have given the tools for WPI admins to make stronger, data-driven decisions. We hope that this IQP is the first step towards creating a collaborative initiative here at WPI: one where students and admins work together to understand how effective WPI is for our alumni and use that inference to make targeted decisions for improvement.

5.4 Reflections and Lessons Learned

5.4.1 Emily Bendremer

Working on this IQP taught me how to manage a long-term project spanning a little over three months. We were constantly scheduling meetings with our stakeholders and adjusting our ideas as we learned new information. This taught us how to quickly adapt to new information and alter our plans accordingly.

We spent several weeks learning about the design thinking process and actively implementing this thinking way into our work. Basing our design process on our initial need-identification interviews ensured that our tool is useful and meaningful to those that will use it.

The work we did on good team practices before starting our project helped us to stay ahead of any potential problems. Our group dynamic was built upon mutual trust and respect. Open and honest communication was the backbone of our team and was what led us to success.

5.4.2 Kayla Fabry

Working on this project allowed me to delve into the problem-solving process. Conducting stakeholder interviews taught me the importance of understanding their needs before jumping into a project.

The biggest challenge I faced was recognizing the limitations of Tableau. Not only was it non-intuitive and challenging to learn, but Tableau did not comprehensively display the data we had collected. We quickly pivoted and decided to use Observable, which was much easier to pick up. Additionally, there were more resources, and our visualizations looked much better.

We struggled with the ambiguity of choosing the best platform to build the visualization. We gave Tableau a good try, but after looking at the tradeoffs of both

platforms, we decided to proceed with Observable. It was not easy to realize that our initial plan was not suitable for this project, but we adapted well to Observable and built an incredible visualization.

5.4.3 Ankur Gupta

As a senior who is about to enter the workforce as a Software Engineer, I think that this project gave me a taste of my next few professional years. Throughout the course of our project, we ran into several breaking issues that resulted in major pivots. In our initial scoping, we knew that the data scraping would be a momentous task, but hoped that the data visualization wouldn't be nearly as bad. We wanted to leverage Tableau due to its popularity and alleged ease of use. Additionally, as Tableau claims to be non-technical, we were planning on having another teammate work on the visualization at the same time as the data was being scraped.

However, Tableau turned out to be significantly more convoluted than we had initially anticipated. In Tableau, the visuzlation is heavily linked to the structure of the data, so we couldn't utilise many of the examples online--rather we would have to code each visualization from scratch. On top of that, Tableau's end visualizations ended up looking cumbersome and started having performance issues with only 500 or so data points.

These issues were almost enough to kill the project on the spot. Since we were operating under the assumption of using Tableau, when the team realized that Tableau would be infeasible, we only had a few weeks left in the project. Switching from

Tableau to another platform (we chose D3.js/Observable) would mean that we would essentially have to recode all visualizations from scratch in roughly a quarter of our initially expected time. Additionally, as D3.js requires a CS background, we wouldn't be able to parallelize our work like we initially planned to.

In retrospect, what I'm impressed with the most is how we handled this ordeal. Luckily, due to our user-centered design approach, we already knew what was important to the stakeholders and what parts of our project would actually be useful. With this, the team was able to sit down and make data-driven decisions to maximize our project's usefulness to our stakeholders. And personally, I'm really happy with our decision. We were able to make visualizations that look nicer and perform faster than Tableau--and our stakeholders loved it! Additionally, we've properly packaged our tools so that future teams can easily continue our work, meaning that our project will only become more useful over time.

I can't wait to take these lessons with me into the workforce. By keeping the users first, we were able to not only keep sight of our end goal, but also quantitatively evaluate how useful our decisions are to our stakeholders. While we were skeptical at first, I now see that the approaches used in this project are built around keeping your goals and your stakeholder's goals as synchronous as possible. That way, when (not if!) the project breaks, we know that the decisions we make are in the best interest of all parties involved.

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Appendix A: Stakeholder Interview Questions

- Can you talk a little about your process of helping students figure out their career paths and opportunities and how you give advice to them?
    - What types of questions do students typically ask?
    - Do you have any career resources that you commonly refer students to? What do you wish they have that they don't?
    - Have you ever been asked any questions about FBS statistics that you haven't known the answer to? If yes, what information do you wish you'd have had access to?
    - Are there any particular majors that need help imagining their prospective career paths?
    - If a student asked you what types of careers they could have after graduating with a specific degree, where or to whom would you refer them?
- How can we make your life easier with some kind of tool?
    - Brief description of what we're imagining: LinkedIn data scrape, searchable database
    - What information would you hope to see in a tool like this? What would be valuable to you?
    - Are there any unique qualities of the Foisie Business School and their Alumni that should be reflected in this tool?
    - What can we include that might help you recruit students to WPI?
- Do you have any resources that could help us in building this?
    - Please feel free to send us an email if there is anything else you think of

Appendix B: Stakeholder Interview Data

Features to include

- Big issues with the FSB marketing - could be an opportunity to work upon
- Major/ minor combinations and how that affects all of the below
- Career growth speed (years between job position, promotion, etc)
- How long it takes to move into a leadership role (2)
- Jobs out of college (companies) over time--maybe three 3 year span? (2)
- Split by job type, not necessarily companies (accountant @ Bose) (2)
- What the job actually entails (via interviews)
- What students felt was missing from WPI (via interviews) (2)
- Salary data (*)
- Job titles
- If students switched fields (2)
- 2nd degree data (with this degree, after x years, this percentage of people came back for a second degree)
- Career expectations per degree

Common student questions

- “Where does this degree lead to?”
- Show off success stories
- Roles
- Career growth speed
- Job switch rate

- Major/ minor combinations and their effects
- Never had a job/internship can I get an FTO?
- Can I get an internship after senior year
- What about co-ops? Will I be behind?
- Negotiating salaries
- Job location
- How to manage going to work + potentially getting a graduate degree
- Working for a couple of years then starting a business?
- Which classes will help them get which job?

Resources

- CDC (3)
    - Job & personality tests
- WPI Alumni Relations (3) is all self-reported data
    - Gets out-dated pretty fast
- Right now FSB basically just scrapes linkedin
- Faculty Advisor (3)
- Other students
- OAS
- SDCC (mindfulness)
- LinkedIn, Indeed, Monster, Handshake
- Give students a chance to *look* at job posting
- Organization website

- https://www.wpi.edu/academics/business/careers
- BLS - bureau of labor stats
- “Friends of WPI”

Processes for Helping Students Figure Out Their Careers

- Students have an idea of what they want, advisor helps them pick out classes (2)
    - Focus on students’ skills, help them choose classes based on their desire for better quantitative, qualitative, other skills, etc.
    - Understand the professional goals of student (current students, alumni, candidates) & evaluate how useful each degree is per demographic and overall
    - Discuss what degree is best for what career
- Ask students about their personalities to help them figure out their “dream job”
- Talk to students about their professional work experience
    - Help students understand their past work experience: ask about their preferred management styles & how working in non-technical jobs translates to acquisition of soft skills
- Helping students figure out their specialization
    - I.e. I want to do chemistry--what do you want to do with that degree?

Differences Between Undergrad vs Graduate Mindset

- Undergrad is a lot more “experimental”
- Graduate students have more of a clear view of their goals (3)
- More students transfer into business programs than come in as business majors

- Undergrads go into internships and find out that they don’t want a fully technical degree

Appendix C: Email Invitation to Participate in Focus Group

Dear (Stakeholder Name),

We are an IQP group working towards building a database and visualization of the career trajectories of WPI students after they graduate. As part of this project, we hope to conduct focus groups with those who will benefit from this tool.

We want to reiterate that we fully respect your desire for confidentiality and would like to assure you that anything you write in response or say during our interview or focus group will be kept completely confidential. All information gathered from the focus group will solely be used to improve upon the tool. Subsequent to completing our work, we will be happy to share our findings with you.

If you have any questions or are interested in participating, please contact us at gr-career-path-iqp@wpi.edu.

We look forward to hearing from you.

Best regards,

The Mapping Career Trajectories IQP Team

Appendix D: Verbal Informed Consent Agreement for Participation in Focus Group

Introduction:

Thank you for taking the time to participate in this user study focus group. Before you agree to participate, as per the Institutional Review Board, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks, or discomfort that you may experience as a result of your participation.

Purpose of the Study:

This project aims to produce a visualization of WPI alumni career trajectories with the purpose of helping past, current, and future students realize career paths available to them.

Procedures to be Followed:

If you agree to participate, you will be asked to continue in this focus group with researchers. All results of the focus group will be kept confidential. We will ask that the focus group be recorded. However, this is not required for you to participate in our study, and we will only record with your consent. Further, you can ask to stop being recorded at any time.

Record Keeping and Confidentiality:

Your confidentiality is very important to us, and we are taking several steps to ensure this for you. Your feedback will only be used in revising the tool and the meeting recording will only be accessible to the interviewers in this call. Once the project is completed, all recordings will be

destroyed. Records of your participation in this study will be held confidential so far as permitted by law. Any publication or presentation of the data will not identify you.

Risks to Study Participants:

There are no risks to participating in this study.

Benefits to Research Participants and Others:

You will have a database and visualization of potential career paths available to you after the completion of this project.

Compensation or treatment in the event of injury:

Participating in this research does not put you at risk for being injured. You do not give up any of your legal rights by agreeing to this statement.

For more information about this research or about the rights of research participants, contact: gr-career-path-iqp@wpi.edu or Professor Kent Rissmiller, Tel. 508-831-5019, Email: kjr@wpi.edu) and the University Compliance Officer (Michael J. Curley, Tel. 508-831-6919, Email: mjcurley@wpi.edu

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time.

We will now ask for your verbal consent to participate. Do you consent to participate?

We would like to record this focus group for our internal reference, but we can turn off the recording at any time if needed. Is that alright?

Appendix E: Email Invitation to Participate in Interview

Dear (Alum Name),

We are an IQP group working towards building a database and visualization of the career trajectories of WPI alumni after they graduate. As part of this project, we have performed a retrospective analysis on the WPI experience and identified you as a notable alumni. We were wondering if you would be interested in participating in an interview so that we can learn more about your personal story.

While we are interested in showcasing your story on our tool, we want to reiterate that we fully respect your desire for confidentiality. Anything you say during our interview will be confidential and you will decide exactly what data you want to be public. Subsequent to completing our work, we will be happy to share our findings with you.

If you have any questions or are interested in participating, please contact us at gr-career-path-iqp@wpi.edu.

Thank you for your time and we look forward to hearing from you.

Best regards,

The Mapping Career Trajectories IQP Team

Appendix F: Alumni Interview Data Storage Protocol

(Found within the written informed consent agreement for participation in interview)

IRB Application Project Title: Mapping Career Trajectories at Worcester Polytechnic Institute

Principal Investigators:

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Kayla Fabry (kafabry@wpi.edu)

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Advisor: Elizabeth Long Lingo (ellingo@wpi.edu)

Title of Research Study: Mapping Career Trajectories of WPI Alumni

Introduction

You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the Study

This project aims to produce a visualization of WPI alumni career trajectories with the purpose of helping past, current, and future students realize career paths available to them.

Procedures to be Followed:

If you agree to participate in our study, you will be asked to continue in this individual interview with researchers. All results of the interview will be kept confidential. We will ask that your interview be recorded. However, this is not required for you to participate in our study, and we will only record with your consent. Further, you can ask to stop being recorded at any time.

Record Keeping and Confidentiality:

Your confidentiality is our primary concern, thus we are taking many steps to ensure your comfort. Only researchers will be able to see the raw information gathered from the study (interview transcriptions).

While we are planning on publicizing your story as a notable alumni, you have complete control over which details will be made public. At any point, please feel free to let us know if you would like any information withheld from the final visualization. All records of your participation in this study will be held confidential so far as permitted by law. Any publication or presentation of the data will not identify you beyond what you have consented to.

Risks to Study Participants:

There are no risks to participating in this study. It is possible that you could feel uncomfortable reflecting on your experiences in advancing your career. You are encouraged to share only as much as you feel comfortable.

Benefits to Research Participants and Others:

Research participants (WPI alumni), as well as current and prospective WPI students, will have a database of potential career paths available to them.

Compensation or treatment in the event of injury:

Participating in this research does not put you at risk for being injured. You do not give up any of your legal rights by signing this statement.

For more information about this research or about the rights of research participants, contact: gr-career-path-iqp@wpi.edu or Professor Kent Rissmiller, Tel. 508-831-5019, Email: kjr@wpi.edu) and the University Compliance Officer (Michael J. Curley, Tel. 508-831-6919, Email: mjcurley@wpi.edu

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the project at any time they see fit.

We will now ask for your written consent to participate. Do you consent to participate?

(Signature will be handled electronically via a Google Form)

Appendix G: User Feedback

Notes from focus group #1

First visualization

- X-axis is job start date
- Y-axis is which number job they're on
- How quickly the line slopes up is how quickly people are moving through jobs
- Wasn't sure what the lines are
- Dragging the entire blue line wasn't intuitive

Second visualization

- Was confused about the link between major/minor combinations, and the resulting career trajectories
    - The two visualizations will be linked
- Where is info being pulled from?
- How did we get the info?
- Can we add BS/MS info?
    - Right now we're seeing MS in management instead of business minor
    - Could a future IQP group do this or can we?
- We want the lines on graph to show what exact positions people had
- Will we be able to search by person?
    - No
    - Just says positions and companies
- Is there a way to say "X number of google alumni stay at google for Y years"
- What happens after our project is done?

    - Given to WPI
    - We want our thing on the CDC website

Notes from focus group #2

- Had to scroll down to get to the interactive parts
- We had to tell him to scroll down to see all visualizations (bc they are connected)
- Add an auto zoom
- Add axis label (to show job growth over time)
- Say “If the data stops, that’s the last known data point”
- How do people discover how to move the slider?
- Feedback
    - Axis labeled
    - Defining endpoints
    - Loves sankey chart, curious what the largest data points are
    - Say what the total n number was, say where things came from (linked in, registrar)
    - Can there be an end count showing how many lines there are when limited by year and major & minor, when slider moves