Career Navigator: Improving the Career Search Experience for The Financial University under the Government of the Russian Federation

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An Interactive Qualifying Project
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements for the
degree of Bachelor of Science

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Date:
26 April 2019

Report Submitted to:

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Abstract

The purpose of this project was to develop a career navigator for the Financial University in the Department of Data Analysis, Decision Making, and Financial Technology. Utilizing data from employment websites and course catalogs from WPI and The Financial University, we developed a database that contained both skills acquired in academia and required in jobs. The database is essential for the navigator prototype, a website that the Russian university students can use to connect with potential employers and to forge suitable career paths in information technology.

Acknowledgements

We would like to thank Professor Svetlana Nikitina for making this project possible and preparing us to work in collaboration with the Russian students at the Financial University under the Government of the Russian Federation.

We would like to thank our sponsor, the Financial University under the Government of the Russian Federation for providing us housing and complete this project. We would like to thank Professor Anton Losev for his guidance and essential support and students Olya Skiba, Konstantin Antonov, Maxim Bauffal, Ilya Golyshkov for their substantial participation and contribution to this project.

Finally, we would like to thank Worcester Polytechnic Institute and again the Financial University under the Government of the Russian Federation for providing us an excellent opportunity and experience to complete this project in Moscow, Russia.

Executive Summary

Russia is among the world's most highly educated countries with an estimated 54% of Russia's population ages 25 and older holding degrees in tertiary education (Potapova, 2018). However, institutions like the Financial University under the Russian Federation (Financial University) are still currently looking for services, such as career development resources, to help students choose the right profession or to secure employment. WPI has its own Career Development Center and Alumni Office, which have great track records for assisting students and data recording. By researching the services offered by WPI, we believe we can create a career navigator that can assist Financial University students with career navigation and job searches in the IT field.

Our sponsor, the Financial University under the Government of the Russian Federation , is one of the top institutions in the Russian higher education system. However, it has limited means to assist students with career roadmaps and employment searches. After researching the current career development system at WPI, we believe that it can serve as a guide to introducing and maintaining a better career search system at the Financial University. Our sponsor believes integrating the WPI system into a career navigator at the Financial University can benefit the school substantially in regards to students finding jobs, acquiring relevant professional skills, and making fitting career decisions. The navigator contains career roadmaps and a database consisting of skills obtained from the student's current course history with links to employer requirements. From there, the navigator will be developed into a web application for ease of access for students and alumni.

To learn methods for collecting and maintaining student data for the database, interviews were conducted with different individuals from the Career Development Center (CDC), the Office of Lifetime Engagement and also various academic advisors at WPI. The CDC at WPI provides various resources for students to find their career paths, including websites that provide student-to-employer connections. The responsibility of the Office of Lifetime Engagement is to maintain connections with alumni. Implementation of an alumni connection at the Financial University can be beneficial, as there is currently no system in place to keep connected with alumni. An executive at the office gave us insight on several platforms that allow alumni to keep connected with alumni and other WPI graduates. Consulting academic advisors allowed us to understand how students typically advance in their disciplines and employee preferences. Both of these sources together allowed us understand how WPI assists its students and graduates, and how we can integrate it similarly at the Financial University.

Data was also collected through surveys to get a better understanding of interests and future plans for students in the Mathematical Sciences Department at WPI. The collected job and course data was used to create a web application that gives recommendations on finding jobs and choosing a career path. We worked with four students from the Financial University to collect data on students' coursework and potential job positions, designed a multi-functional database, and finally, developed the navigator in the shape of a website. The navigator will serve as a prototype and be implemented specifically in the Department of Data Analysis, Decision Making, and Financial Technology for the students. The students can use the tool by inputting their graduation information, personal skills and current curriculum after which the tool displays recommended job categories and their required skills.

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Introduction

The Financial University under the Government of the Russian Federation , a popular and prestigious institution in Moscow, is currently looking for ways to steer students to their optimal career paths. Conversely, Worcester Polytechnic Institute (WPI) has an established framework consisting of the Career Development Center (CDC), a department that helps students find suitable career paths, and the Office of Lifetime Engagement, a department that focuses on maintaining connections with alumni. The Financial University understands these services could also benefit its students and graduates when searching for careers. The final product of our project is a career navigator prototype consisting of a database of skills collected from employment websites and current courses offered at the Financial University and WPI. The navigator currently focuses only on the Department of Data Analysis, Decision Making and Financial Technology at the Financial University, but can be expanded to include the other departments for future projects.

The CDC serves as a good example of a resource that can help students find suitable jobs. It is divided into three divisions, one of which maintains the Handshake website, a job searcher used by WPI students and alumni. A service similar in structure to this could benefit both the current undergraduates and graduates from the Department of Data Analysis, Decision Making, and Financial Technology when searching for careers that can be amplified across other departments. Thus came the idea of the career navigator.

The navigator contains a database of courses and the skills acquired from completing these courses at both the Financial University and WPI. The skills acquired from the courses are

then compared to the skills employers are seeking in Russia and in the United States. For example, if a student is looking to become a data scientist, the navigator will suggest skills and courses for the student so that he or she can acquire the skills necessary to be qualified for the job. If the student lacks a certain skill for their desired career path, the navigator will recommend courses to take at the Financial University or WPI that can help the student acquire the needed skills. Based on the students' desired career path, the career navigator helps students steer them toward their preferred careers, both in Russia and in the United States.

Currently, the career system at the Financial University is looking to enhance the career search experience to help students after graduation. Students often have to resort to asking faculty for advice on careers after graduation, or through personal connections, due to their lack of knowledge on suitable career paths. Although these resources may be useful for students, the number of students outweigh the number of faculty which limits the access of information. There are more than 12,000 students that graduate from the University every year who require resources to help secure jobs and make informed career decisions. Our navigator solves this problem by allowing students access to the information provided by these resources in the form of a website.

Background

The following chapter is research covering background and methods of creating a navigator for professional growth and advancement catering towards undergraduate and graduate students at the Financial University. The first section will cover the Russian educational system, followed by an analysis on the current job market in Russia to establish the need of a career navigator. The chapter will then transition into the focus of the Interactive Qualifying Project (IQP), then the current career system at the Financial University, followed by limitations and constraints, and lastly tools used to implement our project referenced from the Career Development Center and Office of Lifetime Engagement at WPI.

Education in Russia

The educational system in Russia features a preschool level, primary, secondary and higher education. The Russian higher education system is rather successful: “Some 54 percent of 25 to 64 year old Russians held tertiary degrees as of 2015, making the country one of the most educated in the world” (Potapova, 2017). This indicates that students have a multitude of skills and prepared to entire the workforce. However, while institutions strived to provide more resources to assist students with finding suitable career paths, obstacles were encountered.

A study conducted by Elizaveta Potapova in 2017 reasons that the Russian higher education system is held back due to economic pressure, demographic pressure, and government corruption. Recently, the government cut education spending by 8.5 percent, around 1.1 billion US dollars (Potapova, 2017). The government also began a series of ‘reforms’ that led to the

closure of 14 percent of the country's institutes, causing some degrees to become useless, creating more problems for students. Inequality among the population also affects access to education, even after the collapse of USSR: "the inequality is noticeable in secondary education and is aggravated during the transition to higher education" (Konstantinovskiy, 2012). Compared to others, certain students may find it increasingly difficult to find jobs, creating an even bigger need for a resource to assist them. Government interference is also well documented as seen with the European University at Saint Petersburg. Russian officials have seen the college as too "liberal' and the teaching licenses were revoked. The issue was resolved but had an impact on students who had degrees during that time as they were deemed useless (Nechepurenko, 2018).

Students that go to institutes of higher education can pursue bachelors, masters, specialist degrees or PhDs. Like many other educational systems, Russia also encourages students to look at internships and seasonal job postings during their studies. Some of the most well paying jobs include electrical engineers, risk managers, doctors and pilots (Awara, 2017). The jobs mostly all require strong degree requirements, including the specialist degrees. The career navigator, beyond job opportunities, should also be able to indicate paths in further educations after graduation.

Current Career Market in Russia

Due to demographic and economic factors (See Appendix H), Russian job market has been favorable to newly graduated students, despite the impact of the sanctions imposed by the western world and a growing population of students. According to Gabriel (2019) from Trading Economics, the unemployment rate in Russia at the start of 2019 was lower than the average

between 1992 and 2018, at 4.8 percent. In September of 2018, the rate has reached a record low of 4.5 percent. Sudakov also states that in 2017 “the number of unemployed individuals holding higher education diplomas has decreased by 13 percent.” He proposed the reason to be the increase in demand for people with more specialized skills, pointing at those with secondary special education or higher. In addition, the effect of the ruble crisis has also faded, and employers have “start[ed] attracting workers more actively and they try to attract more qualified specialists” (Sudakov, 2017) to fill vital job positions.

One of the highlights of the career market in Russia is its information technology industry (IT). It is estimated that the industry grew 3.7% in 2017 and this is expected to continue. Demand for items such as smartphones, printers, computers, and cloud technologies grew substantially during this period (export.gov, 2018). With the industry rising, students will look to take advantage of the increase in demand of IT jobs such as software engineer and data scientist. Large tech companies in Russia such as *Mail.ru* and *Yandex* are also looking to hire students with specific IT skills. Understanding what these companies want in their employees is important, and there are times when students struggle to appeal to their employers. Graduate students are in need of other resources to help them understand the needs of employers to facilitate their job search.

To understand the job market for the new graduates in Russia, beyond looking at the economic statistics, we need to take into consideration the perspectives of both students and employers. Beyond going into local industries according to the student’s major, students have also been looking at opportunities overseas. According to the article “Most Russian Students Want to Find Jobs Abroad” (2014), “the survey revealed that 77 percent of Russian students

found the prospect of overseas employment more appealing than working at home." However, the tendency is divided between areas of studies, in which the oversea opportunities are more sought after by marketing and humanities students, in comparison to medical and pedagogical students.

Students have also started to work earlier, taking part-time or internship positions during their studies. Even though the financial gain is important, Roshchin & Rudakov (2016) found that another important motivation is to gain work experience and become more competitive in the labor market. The group suggested that "more talented students (or higher quality students) are more likely to combine study and work", matching the employment trend observed by another group (Vinichenko, Makushkin, Melnichuk, Frolova, & Kurbakova, 2016). The spontaneity of early job searching is also described in Annaraud's and Ibarrola et al.'s papers. The shift is likely caused by a change in company recruitment strategies in response to the increasing amount of applicants (Naric, 2013). However, despite being immediately employable in the industry, students prefer working part-time during school while pursuing academic achievement, such as secondary education (Annaraud, 2013; Roshchin & Rudakov, 2016).

When deciding between their offers, students often focus on the potential career growth of the position, sometimes even over the salary and benefits. According to Dyakova (2015), the most important factors that new graduates look for are opportunities for career and professional development, as well as opportunities to work on a variety and interesting projects. Students also emphasize on work environment and schedule flexibility while they are least interested in the reputation of the company among the list of options.

Looking at both sides, students have put in plenty of effort to find a job that they love, while recruiters also invest plenty of resources to study and recruit the best talents. As the number of applicants pursuing higher education increase, recruiters need more information to filter out candidates (Naric, 2013). Work experience has become the primary distinguishing factor to filter students. Mentioned previously in Roshchin and Rudakov's paper, more talented students often seek employment early. In addition to that, recruiters also look at degree specialization, past courseworks, individual research subject areas, and thesis topics (Naric, 2013). Moreover, supporting Graham's argument from his book "Lonely Ideas: Can Russia Compete?", to bring new blood to the company and import the newest skills, sometimes companies prefer bachelor students over master students as they value the younger generation to be more adaptive and innovative.

However, multiple problems lie between information discovery, especially on the diploma issued by a Russian institute. First of all, there isn't a convenient comparator, such as a GPA, on the transcript (Naric, 2013). For students looking for jobs abroad, there is a difference between the perceived value of a Specialist degree between Russia and European nations--Russian institutes do not put in enough resources building reliable reputations for the degree, and the degree is rarely given outside of Russia (Lukichev & Skorobogatova, 2016).

Commonly, career resources at Russian Universities, such as career centers, are being underutilized. "Russian universities require students to register for an internship; but little help is given to Russian students in finding internship opportunities, or monitoring their progress if they obtain one and insuring that the internship is meaningful", reported in Annaraud's paper (2013). Ibarrola et al. (2015) has also concluded separately that "Many students felt that they could find

everything they needed to get a job or internship online and therefore did not use the career center." The majority of the students use career search websites, company websites, and social media to find jobs. Compared to these methods, company representatives, word of mouth, as well as campus career centers are less effective when it comes to job discoveries. In the study performed by Mironos, Bednyi, & Ostapenko (2015), the author states that the lack of an information collecting system, prevents both the students and recruiters from finding opportunities. The lack of resources provided from career services center and underutilization by students, inflates the lack of use in tools that can improve the job searching experience.

Focus of IQP

By connecting the undergraduate student body of the Financial University with major employers, the undergraduates will be able to learn how to shape their path during their time at university or pick a program that will get them to their desirable jobs. The assistance and information from the vacancy job postings help undergraduates get their desired positions, enter into higher education, gain a connection, or start their own businesses. By going directly to the source of the information, the vacant job postings can better prepare the students for the workplace. Making sure the student is best prepared and fully qualified to enter a job is the main focus of the project.

The proposed idea from the sponsor was to develop a career navigator, a web application that provides advice to students on skills they should develop to be on their desired career path, and express what major to pursue. Furthermore, we looked at some examples of job

requirements, or what was on the job market, and any opportunities or educational programs that allow for knowledge growth for personal development in the United States and Russia.

We limited the scope of the navigator to the Department of Data Analysis, Decision Making, and Financial Technology, and proposed a framework that can eventually be expanded to other departments within the Financial University.

In order to understand the possible career paths that students pursue, we conducted a preliminary study on students from the Mathematical Sciences Department at WPI (questions listed in Appendix I, and result published in Appendix A). This survey helped provide general job categories and tracks to examine during research and data collection that both Financial University and WPI students could achieve. Based on the survey results, the majority of the students (71.4%) seek employment after graduation, while 9.6% of the students will seek further education. The top five industries mathematics students want to work in are insurance, consulting, finance, technology, and research studies. Within the industries, the most sought after positions are actuarial, data scientist, software engineer, data analyst, and professor. The majority of the students either have no experience working, or have an internship. Even though the sample size is small compared to the population of the Department of Data Analysis, Decision Making, and Financial Technology at the Financial University, the results provide an excellent start for similar career tracks in Russia.

The stakeholders in our project are the sponsor, the Financial University, as well as the students who will be entering the job market and could use help with finding a favorable career path after college. The result of the project would provide useful information helping students

make better, and more informed decisions when choosing their field of study and careers. If implemented, a method to keep updating their skill sets to attain professional growth later.

The Current System of Career Services at the Financial University

The current system of keeping track of alumni at the Financial University is limited. While combing through the Financial University website, there was no clear sign of a department or section of the university dedicated to student/employer relations. An inadequate system presents a problem which will be the main focus for our project.

The main goal of Russian students is to get a job after finishing their degree. In the United States most job-seekers use employment websites to connect themselves to employers in their area. Some examples include applying online to the companies through *LinkedIn* or *Indeed*. These sites allow prospective students to apply to their desired jobs and the company to review their application all online. In Russia, there are similar tools such as Headhunter and moikrug.ru. Headhunter provides a similar services to Indeed, by listing jobs that people can pick from. With these tools, undergraduates and graduates can see qualifications that are required for the job and if they meet the needed requirements. As a result, the data collected from the sites could connect to our solution as it shows what is desired by an employer. The resources that are widely used in America such as *Handshake, Glassdoor* and *Indeed* promote looking into job opportunities and internships that are narrowed down to fit the desired major.

Every year, there are approximately 50,000 students studying at the university, with 12,000 of them graduating (Financial University, n.d.). Once these students graduate, their connection to the school thins even more, limiting their resources to find jobs. This system can

be improved using our career navigator. Providing a way for the students to get a broad range of possible jobs available after graduating and advancing their careers are two use cases of this tool. Additionally, the data collected during the development of the tool would forecast the current job market so students could adapt and gain the skills necessary to shift with the changing job market years after their graduation.

At the Financial University in Moscow, students have a wide variety of majors to choose from. The options range from Finance and Credit, Business Math, Management, Data Analysis, Account Analysis, and Financial Law, preparing students to work in a business environment. After completing four years of classes, the students come out with either a Bachelor of Economics or Management degree. Beyond these, the university has a Masters degree program where a student can focus on topics that are business related that are otherwise not available. Finally, the Financial University offers MBA programs that are more management and business focused. With vast resources allocated to the school, there is a surprising inadequacy of aid from the university in connecting students with job and internship recruiters.

Limitations of Implementation

Through our proposed career development navigation system we proposed, the students should expect to gain a better understanding of career paths they can explore. However, there were certain limitations to the navigator that can restrict the student from being employed in their specific major field. According to a study by MARS Consult from “Student Employment during College Studies and After Career Start" (Roshchin & Rudakov, 2016), college graduates had to go through rough employment processes with strict requirements of skills, as it is reported that

multiple employers have had at least one negative experience, mainly due to a lack of adequate skills. As a result, the "...efficiency of college work is down, career trajectories of young specialists usually look like a flat curve, and businesses and public authorities lack in a necessary resource that can deal with immediate issues and with challenges of a longer impact" (Vinichenko, Makushkin, Melnichuk, Frolova, & Kurbakova, 2016). With a lack of college work efficiencies, students struggle from gaining or mastering the skills required by employers, which can hinder the student's usage of the career development navigation system as the student will have to ensure that they acquire the skills necessary for employment after graduating. If not, they will have to pursue a more general path aside from their major in order to be employed and succeed, an example being entrepreneurship, which we tackle in the navigator. Throughout the years, the number of Russian graduates choosing to be an entrepreneur has increased (Tkachev & Kolvereid, 2010). Although finding a job that fits with your major is important, "...one finds that there is a large potential for entrepreneurship among young Russian students regardless of their demographic characteristics or their parents' employment status" (Tkachev & Kolvereid, 2010). Students not being employed in their major field can affect the navigator negatively as there will not be sufficient data to be collected to be used in the future for students trying to graduate.

Russia's media limitations can also hinder the amount of information accessible to provide accurate job placements for students at the Financial University. According to Awara, a consulting and outsourcing service in Russia, "Russia still maintains a centralized internet blacklist, known as the 'Single register of domain names, indexes of site pages in the information and telecommunication next "Internet", providing information and dissemination which are prohibited in Russia'" (2018). Although the ban will not limit the alumni graduate information, it

banned sites such as *LinkedIn*, a great resource for students to find jobs and network with other students and employers. The ban can be avoided using a VPN, however another law was passed in 2017 which prohibited these sites from being accessible even through a VPN (Awara, 2018). Russian students can still network using alternative professional networking sites such as *XING*, *Executive.ru*, and even *VK* to keep in touch with employers and follow company updates. Although these sites may not be as popular as *LinkedIn*, these alternatives can allow the Russian students to still have a better understanding of what kinds of job opportunities are currently available for them and the required skills necessary for the job.

Russian students, in general, prefer to work internationally rather than work in Russia. A survey from the Moscow Times showed that "...77 percent of Russian student found the prospect of overseas employment more appealing than working at home" ("Most Russian Students Want to Find Jobs Abroad", 2014). According to the same survey, students also did not have a preference whether or not the company that they work for in the future is a Russian company or not. Student preference can limit the navigator if more alumni are working internationally, the students who are not financially capable to work abroad will struggle to gain a clear path for employment. With many students looking to work abroad, the quantity of information present for the students from the navigator can also be affected as the Financial University might not be able to stay in contact with the Russian graduates. In contrast, if the student is working within Russia, it would be easier to stay in contact even well after graduating.

Tools and Organizational Structures for Implementation

The navigator includes ways to store data for certain career paths. Data can be collected from job websites such has *Handshake*, *Glassdoor, Indeed,* and *Headhunter (Russia)*. The organized data can allow students to better understand what they can achieve with their current qualifications and skills. Additionally, the navigator provides students with information towards other qualifications and skills they can pursue to grab the attention of employers. Once implemented, the alumni information can be used for organizing alumni events and for students to get a better understanding of career paths at the Financial University..

The CDC only keeps track of graduates up to 6 months after graduating, using *Handshake* as the core network building and data gathering tool. Approaching graduation, the CDC reaches out to seniors and keep track of their graduation plan, sorted by major. The data is published annually under Career Outcomes & Salary Data on the WPI website (Worcester Polytechnic Institute, 2018b). Categories of information being tracked include Post-Graduation Activity, Employer, Double Majors, and Graduate School. The list of post-graduation status categories are as followed: Employed, Graduate School, Military, Seeking Employment, Not Seeking, and Unknown. Students from the Financial University share most of these outcomes after graduation, one exception being students joining the military if they fail to find employment. Therefore it would be helpful for students to see similar data published by the Financial University.

We have also identified the overall structure of the CDC. The CDC is split into 3 groups, the student group, the employer group, and the operations group. The student group focuses on keeping in contact with students and their career goals, as well as helping them with any troubles

they may have with applying to jobs. The employer group maintains connections with employers to understand what they want from students, while also inviting them to career fairs on campus to recruit students. The operations group manages events such as on campus interviews and career fairs, where students can comfortably engage with employers. All three groups work together to help students' career goals. We believe that a similar system could be introduced at the Financial University by allowing their students to understand required qualifications, keep connections with employers, and by hosting events on campus to help engage students.

Methodology

Introduction

The goal of the Interactive Qualifying Project (IQP) to is to create a career navigator for Russian students in the Department of Data Analysis, Decision Making, and Financial Technology to find suitable career paths based on the skills they possess. Our first objective is to research the economic and the educational environment and to analyze the current job market in Russia. By assessing the current situation in Russia, we can better understand the typical job hunting process that students go through. Our second objective is to consult the Career Development Center, the Office of Lifetime Engagement and undergraduate academic advisors at WPI. These resources allow us to gain insight on how WPI currently maintains connections with students and alumni, while also providing career counseling services using student and alumni data. This insight will ultimately inform the development of our navigator. Our third objective is to compile data from current mathematics students at WPI through surveys, course data from WPI and the Financial University, and job data from various employment websites.

The data collected will provide a map between employer requirements and student skills learned through courses at their university or college. The point of collecting this data is to create a database that can match skills between student skills, courses, and jobs. Our final objective is to develop a combined database with employer requirements, student skills, and courses from both WPI and the Financial University to be used to build a navigator through a website for students at the Financial University. This chapter will detail the processes we used we used to complete these goals.

Objective 1: Background Research to Demonstrate the Need of a Navigator

Assessing the current situation in Russia is vital in understanding what students typically go through in order to seek employment. The education system impacts students' chances of finding suitable career paths. The mismatch between skills that the students possess and the skills that employers look for is also another important factor in job searches. To analyze the current situation, we conducted background research on the Russian education and the job market from articles, journals, former IQP papers, and websites. We also looked at the Financial University to get a clearer picture of the resources available to the students and after graduation decisions. The background collected allow us to understand the demand of the market and the feasibility for students to achieve their career goals.

Objective 2: Consulting the CDC, Office of Lifetime Engagement, and Academic Advisors to Learn Methods of Assisting Students with Their Careers

Our next objective was to consult the Career Development Center (CDC), the Office of Lifetime Engagement, and undergraduate academic advisors at WPI and to collect methods on how to gather data and information on select majors. We first set up appointments with several personnel to gain insight on the structure and the operations of the CDC. From these meetings, we learned about many of the resources provided to aid students in their career search. For example, Handshake allows students to find jobs and internships matching their majors and current academic status. It is one of the ways the CDC collects data from employers and students. By interviewing the executive from the Office of Lifetime Engagement, we gathered methods on how alumni are contacted by the school. Contacting alumni is an important process toward this project, that could be implemented in the future, as their career search experience is crucial to our database. Alumni have knowledge of the full-time employment seeking process, therefore can give us insight on what should be expected from the navigator. Consulting the academic advisors allowed us grasp what kind of companies typically hire students with certain degrees, informing us with what the companies look for in the new hires.

Objective 3: Data Collection for Combined Database Development

The third objective expands on the second objective, where data is compiled from current students at WPI through surveys. The collected data allow us to get a sense of how we want to structure our combined database. Surveys to WPI students were sent out through email, asking general questions about their experiences, their goals after graduation, and whether they have

been employed in the past. These surveys are conducted with the consent of the students that participated while also following the guidelines set by the Institutional Review Board (IRB). The information collected through these surveys were analyzed using Google Forms and Python scripts. The result of the survey identify job industries and job titles that provided us with an idea of jobs WPI math majors desire after graduation. We can then use the survey results to populate the initial database, as described in the Focus of IQP section.

The next step in our data collection was to look at courses offered by both WPI and the Financial University. Using the WPI course catalog, we recorded the course names, course numbers, and their descriptions in the Mathematical Sciences department. We then manually combed through the descriptions searching for pertinent keywords, and constructed a list of skills acquired from the course. The keywords found are a major part of our database and will be explained in our fourth objective. In addition, we also gathered information on specific course requirements in each degree to generalize the skills obtained from each program. Our Russian counterparts also did the same with their courses according to the system at the Financial University. To gather job information, we used employment websites such as Handshake, Glassdoor, and Indeed to find preliminary data on relevant jobs types that both the Financial University and WPI students could strive for and graduates could apply for. In addition to the company, job title, and salary of the position, we also recorded the specific requirements of each job, broken down into minimum and preferred requirements, required experiences and responsibilities. Similar to the courses, keywords were extracted to be used for matching and data analysis. Our Russian partners also searched for job data using the popular Russian

employment website, Headhunter. Once the datasets were cleaned on both sides, these data sets were then merged to form a combined database.

Once the skills were extracted from the description, they were organized in their respective cells using commas as a way to delineate each skill. The tags were further categorized, condensed, and translated into Russian using various functions in Google Sheets. To make the tags useful, we wrote a script in Python 3 to parse through the data, and represent the relationship of the data in a graph data structure, with nodes and edges. Using this technique, the data was made readily available to be exported into different formats of comma separated value (CSV) files to be analyzed and imported into the relational database for the navigator. The specification of the database is explained in Objective 4.

Objective 4: Developing the Navigator

The navigator was developed in collaboration with the Russian students at the Financial University. The keywords allow the backend code to identify a number of jobs the user is qualified for as well as classes to take to acquire skills that would boost their chances of being hired. By filtering out unnecessary words from job postings, the backend code can easily compare skills and produce results. Given the skillsets of the Russian students, we developed a navigator that provides job suggestions to the users based on their desired job preferences, skills they want to develop, and courses they take. The navigator also sets up a guideline that allows the Financial University to maintain the job and course database.

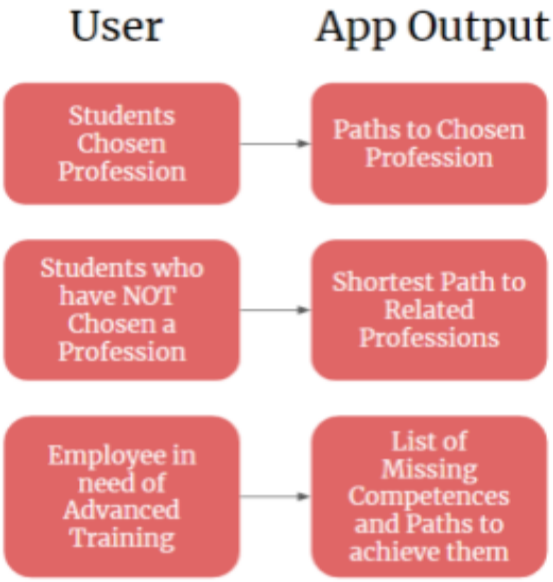

Figure 7.1 Use cases of the navigator application

Figure 7.1 shows the different situations that the application can address. For students that have a career goal in mind, the navigator displays the list of courses and skills that the student needs to obtain for a specific job. For students who are undecided on what path they want to pursue, the student can provide a list of skills/courses that they already have or a list of work preferences, and the navigator will provide a list of recommended career paths and their required skills. Lastly, for any alumni who are already in the field, the application can be used as a reference for what skills and requirements are needed to advance. The database is established using results obtained from surveys and consultations conducted as explained in Objective 3.

The web application is set up on a Golang (Bee go) web application framework running on a Ubuntu machine. The web page is modeled with Bootstrap 4, SCSS, and Tempus Dominus. Sigma.js is used to display the graphics. The job and course data were stored in a relational

database managed using SQLite. The specification of the server and the list of server requests are detailed in Appendix F.

Data Analysis and Findings

Introduction

The following chapter outlines the findings and analysis of the data we have collected. The first section reports on the analysis of course data from both WPI and the Financial University. The next section will discuss the results from the data collected from employment websites in the United States and Russia. The final section will detail the results found from matching the data obtained from courses and jobs.

Data Analysis and Findings 1: Course Data

In total, we gathered data from 259 courses between two universities, among which 101 are from WPI, and 155 are from the Financial University. The courses are distributed across 6 programs at WPI and 4 at the Financial University. After condensing the list of tags obtained from WPI course descriptions, 699 individual skills remained. 492 of these skills had only one occurrence, meaning they are unique to a specific course. Other skills such as communication and integration appear more frequently because they are much more general than skills such as prospective and retrospective studies. The total amount of tags obtained from the analysis of Financial University courses resulted in 322 individual skills, less than the American counterpart. This reflects the difference in policies from the institution with regards to providing course data; WPI is much more open whereas the Financial University is stricter. Similar to the data from WPI, 207 out of 322 skills occur only once, while communication and data analysis occur more frequently. It should be noted that both universities have different focuses in terms of degrees.

Unlike WPI, the Financial University data has large amount of economic topics. WPI has some economic courses but not has much as the Financial University, giving the latter an edge over jobs that require economic analysis and business decisions. On the other hand, WPI has a much higher variety of math courses; with many skills unique to a certain course. WPI students are able to study specific mathematical topics more in depth than students at the Financial University.

Data Analysis and Findings 2: Job Data

The delineated skills gathered within minimum requirements, preferred requirements, and required experience enabled us to compare job skills to courses and user skills. We looked at 100 vacancies across categories that would be relevant to career choices for both the students at the Financial University and WPI. These job categories included data scientist, artificial intelligence, machine learning, software engineer, and firmware engineering. Across the 100 vacancies, we generated 500 tags, with 344 only appearing once, to skills that are either required of the applicant or their responsibility on the job. The single tags are only pertinent to specific jobs, a way to easily narrow down what jobs the user is or isn't qualified for. We then formed mind maps of the top ten skills in minimum requirements, preferred requirements, required experience, and responsibilities to start looking for commonalities. Additionally, we created pie charts to quickly show the user the total percentage of common skills that show up in minimum and preferred requirements. To further generalize the skills for ease of use, we categorized them into job categories such as programming language and machine learning.

Our Russian counterparts provided us with Russian job vacancies from their major employment website, Headhunter, for us to analyze. Their extensive research generated 655 tags for us to sift through and categorize, similarly to what was done with the United States job data. The categories used were the same from the United States jobs to allow for easy cross referencing and a baseline way of comparing job skills from the US and Russia.

With the purpose of developing the navigator which would place students into these jobs, we combined the data from Russian and US jobs to look at similarities and differences. To begin preliminary data analysis across both US and Russian jobs, we looked at the top 20 skills from the jobs as seen in Appendix C. Since a major part of the navigator is looking at skills gain from classes and how they will better prepare a student for a job, a Python script was created and helped us quickly scan the combined 189 US and Russian jobs to see how many tags from the classes show up. In Appendix B, a network connecting the common skills with their job categories shows how often and how important 30 of the over 1900 skills collected pertain to each job. The combined database will be implemented in the prototype and tested for when a user inputs their skills.

Data Analysis and Findings 3: Data Matching

Once the WPI and Financial University datasets were compiled, they were combined to form a database and analyzed to see similarities. The course skills were compared to job skills and this resulted in the percent match between programs and the job categories. The percentage skill match between each degree and job category is presented in Appendix G. From this data, we discerned that both datasets do not have high percentage matches, meaning that both students

at WPI and the Financial University are limited in the skills they possess when compared to employer needs. The low matching percentages were a consequence of a large number of our jobs in the category of data science, while the majors that we analyzed from WPI were in the field of mathematical sciences. This led to many advanced computer skills such as C, Python, and C++ programming languages, that many of the jobs in the database looked for which were not taught in mathematical science courses, excluded in comparisons and reduced overall matching. Furthermore, skills extracted from the job descriptions tend to be general, while the skills from the course descriptions describes theories and methods taught, not knowledge required in the job market. Therefore, a job might require the candidate to know statistics, but it doesn't specify what topics within statistics are required. Lastly, the course skills are matched to all of the skills possible in one job category. Some of the skills are only required by one or two jobs, and should not be representative of what other jobs in that category generally need. Therefore, after normalizing the data and looking at the top 20 skills, we were able to calculate higher percentage matches between majors and jobs.

The combined dataset, mentioned in Objective 3 of our methodology, was then processed using Microsoft Azure Machine Learning Studio (MS Azure). Through MS Azure, we were able to analyze how accurately the tags are being matched to their respective job categories. Referring to the confusion matrix in Appendix D, the accuracy for the model to match a set of skills with a category is shown in the diagonal of the matrix. Within the diagonal of the matrix, the data scientist block is the largest followed by software engineer. This was mainly due to that fact that there were more data scientist jobs compared to other job categories in the job database. In order to fix this, we weighted every other job category greater than the data scientist (Data Science: 1,

Artificial Intelligence: 4, Machine Learning: 6, Software Engineer: 4, Firmware Engineering: 20), where the firmware engineering job had the greatest weight applied as there were only nine firmware engineering jobs. From this, we can see a relatively high percentage in each of the diagonal blocks with data scientist still having the greatest match percent of 92.1%.

Combining the two sets of data and conducting initial data analysis, expressed a need to reassess and find a cleaner way to model the data. The confusion matrix is significant to our project as it provides the accuracy of our model. With the matched data, the information can be added to the server end database of the website to be used during a search.

Conclusion and Recommendations

Conclusion

The ultimate goal for this project was to create a career navigator website prototype for the students at the Financial University using data compiled from surveys, course catalogs, and employment websites. The navigator we developed through the efforts of a joint Russian-American team serves three purposes. The first, is to guide prospective university students into a major by showing them available jobs after graduation and the general skills necessary to apply. Second, a student who is graduating and looking for employment in his or her desired field. Finally, for later implementation, we will be providing a way for alumni or established officials to look at job vacancies and the skills necessary to be gained (through online classes, for example). To do this, we looked at different employment websites, both US and Russian, to get a sense of what skills employers are looking for in new hires. We then analyzed the data and constructed a database and implemented it in the backend of the website.

In terms of our data, we can conclude that the data scientist job category has the highest probability of being paired to a user looking for jobs with specific skills. Most of the skills found from courses were math and data related due to earlier mistakes when determining which departments to focus on. Had we found the mistake sooner and looked into courses in the computer science department, we would have a much higher matching rate with the 4 other categories. Another factor is that data science has the highest number of jobs in our data set. We did not consider the need to find equal amounts of jobs for each category, resulting in biased data towards Data Science. Each job we found was also unequal in the numbers of tags. Some

companies may be much more descriptive with their requirements and experience needs whereas others may be much more general. Each job also had differing degree requirements. With our limited time and resources, we were only able to record and analyze 189 job entries. If the set had upwards of 500 to 1000 jobs, the data can be much more consistent and less biased. A better data set would have more than 189 entries, with each jobs having the same degree requirements and each category having the same number of jobs.

In conclusion, the data accuracy provided in this tool is sufficient for a prototype of a career navigator for the Financial University. It would provide a framework for future additions, such as more skills, more jobs and importantly, more disciplines like economics, mathematics, engineering, or liberal arts. This would then allow even more students to search more suitable career paths, beyond the scope of data science, artificial intelligence, machine learning, firmware and software engineering.

Recommendations

The job market as a whole is frequently changing, especially in the field of our focus, which is why we recommend for recruiters a way to seamlessly add more jobs to the database such as a website scraper that interfaces with *Headhunter*. To scale the application to other departments, we recommend creating an application programming interface (API) for the courses at the Financial University and WPI to quickly access them for analysis. As the number of classes grow, and with the addition of more jobs in this dynamic field, there must be a way to quickly analyze and tag the descriptions and requirements of each job. We recommend creating a natural language processor or word analyzer to do this. This recommendation would help to

quickly pick out keywords to be cross referenced with the classes and the skills from user input to generate more accurate results. Such systems allow the office to allocate resources specifically to each field of study and build a more detailed database.

Referring to the structure of the CDC at WPI, we also think that it is beneficial to share the database among the university instead of separate applications for each department, as a larger database produces more accurate prediction models. The reason why WPI decided against a distributed office is precisely because of its small student population of around 5,300 students (Worcester Polytechnic Institute, 2018a). The system is shown to be helpful in Weber et al.'s project in 2017. With the large student body at the Financial University, a number around 50,000 (Financial University, n.d.), can benefit from a centralized system due to the machine learning model used in the navigator.

To increase the involvement of alumni, we recommend that the career navigator includes an alumni feedback system. In our research and interviews with the Office of Lifetime Engagement, alumni are a key to finding jobs as they can be a potential resource and a way for students to make a connection with employers. With an alumni feedback system in place, students can see success rates acquiring of certain jobs based on the major or discipline the alumni pursued, serving as another resource for the students at the Financial University.

Completing this project, we have contributed to the development of some of the most important and dynamic professional fields today through helping college graduates find ways to enter those fields and to grow with them.

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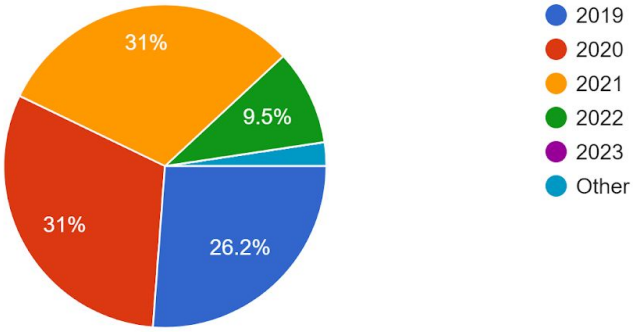
Appendices

Appendix A: WPI Math Department Graduation Desires Preliminary Survey Result

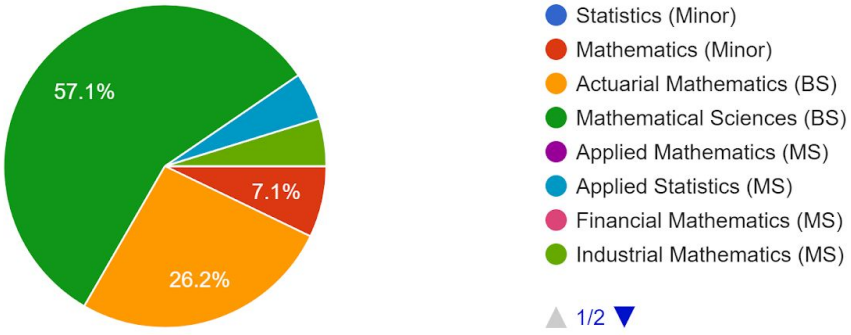
What year do you graduate?

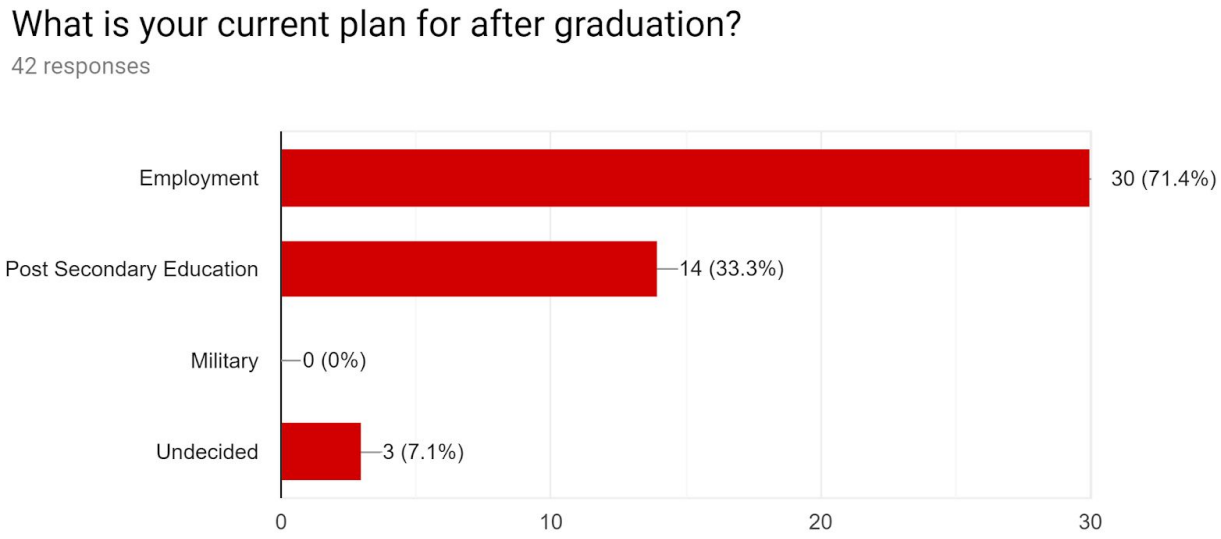
42 responses



What degree are you pursuing (Bachelor/Master) ?

42 responses




What is your current plan for after graduation?
42 responses
Employment
Post Secondary Education
Military
Undecided
30 (71.4%)
14 (33.3%)
0 (0%)
3 (7.1%)
0
10
20
30

Experience	Response count
internship	19
none	15
research	3
internship but not applying major knowledge	2
co-op	2
full time	1

Second Major	Response count
computer science	3
physics	3
minor in cs	1
society, technology & policy	1
management information systems	1
spanish	1
teaching prep.	1

Target Position For After Graduation	Response Count
actuary	8
data scientist	8
software engineer	5
data analyst	4
professor	3
teacher	2
trader	2
researcher	2
consultant	2
health insurance actuary	1
analyst	1
product analyst	1
quant	1
stock analyst	1
actuarial analyst	1
policy analyst	1
business owner	1
quant trader	1
teaching assistant	1
statistician	1
data mining	1
mathematician	1
mathematics professor	1
risk manager	1
investment banker	1
data miner	1
business analyst	1
applied mathematics research	1
operations research analyst	1
industrial engineer	1

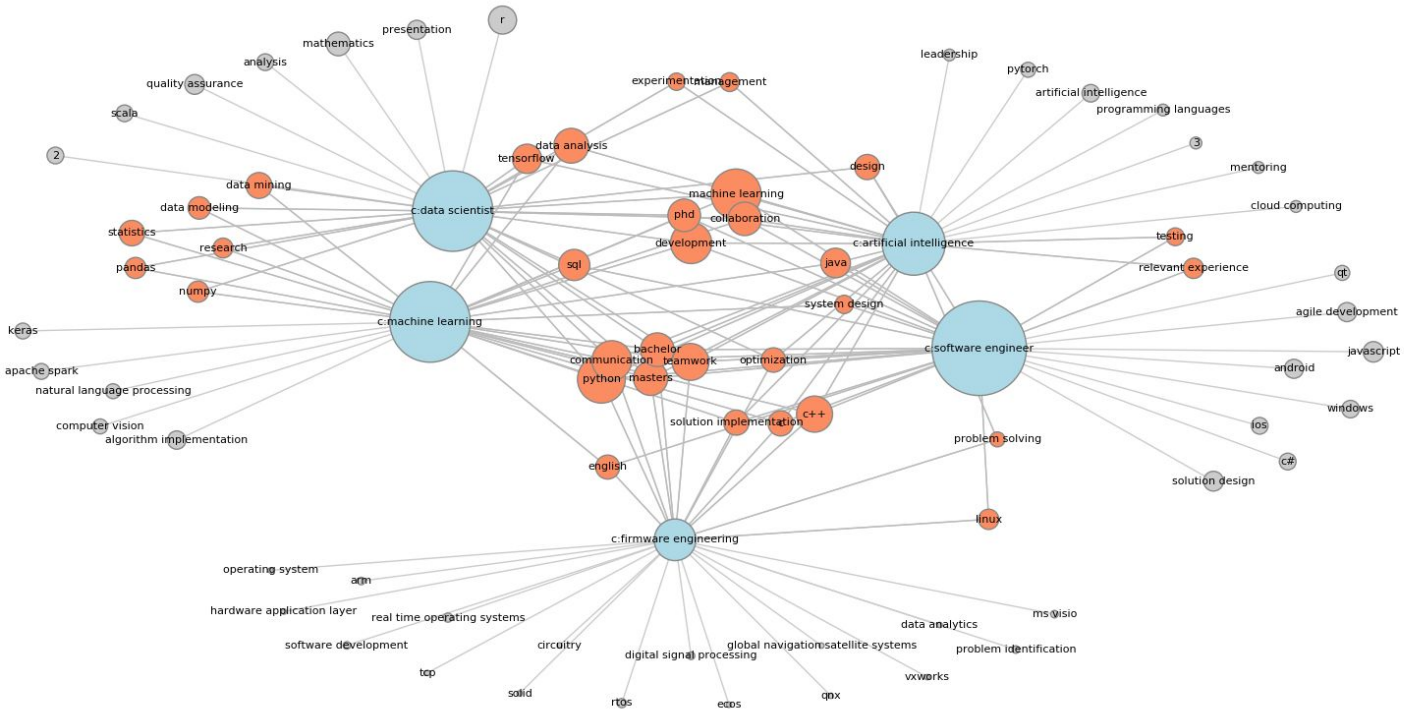
Target Industry For After Graduation	Response Count
insurance	8
consulting	7
finance	4
technology	3
research	2
government	2
investment	2
statistics	1
life insurance	1
health insurance	1
education	1
e-commerce	1
internet	1
marketing	1
softwares	1
data research/analysis	1
private colleges	1
investment banking	1
data analytics	1
pharmaceutical	1
software engineering	1
big data	1
defense	1
teaching/post-secondary ed.	1

Company	Response Count
John Hancock	3
Hanover	3
Aon	2
Goldman Sachs	2
Google	2
Deloitte	2
Sun Life Insurance	2
Travelers	1
Liberty Mutual	1
Bloomberg	1
State Street	1
Bank of Boston	1
Billiman	1
Tufts Healthcare	1
HPR Group	1
Rowdy LLC	1
Two Sigma	1
Microsoft	1
Government	1
Amica	1
JP Morgan	1
Morgan Stanley	1
Bridgewater Associates	1
McKinsey	1
BCG	1
Bain	1
Bank of America	1
BlackRock	1
Boston Scientific	1
Vertex	1
Bluebird Bio	1
UNUM	1
Mitre	1
Lincoln Labs	1
Raytheon	1
Nuance	1
The Mitre Corp	1
Universities	1

Tesla	1
Northrop Grumman	1

Appendix B: Job Data Visualization

The most sought after 30 skills in each category is presented in the graph below:



Blue circles: job category names

Orange circles: skills demanded in more than one field

Grey circles: skills demanded in one single field

Edge/connection: a skill is frequently needed by jobs in a category

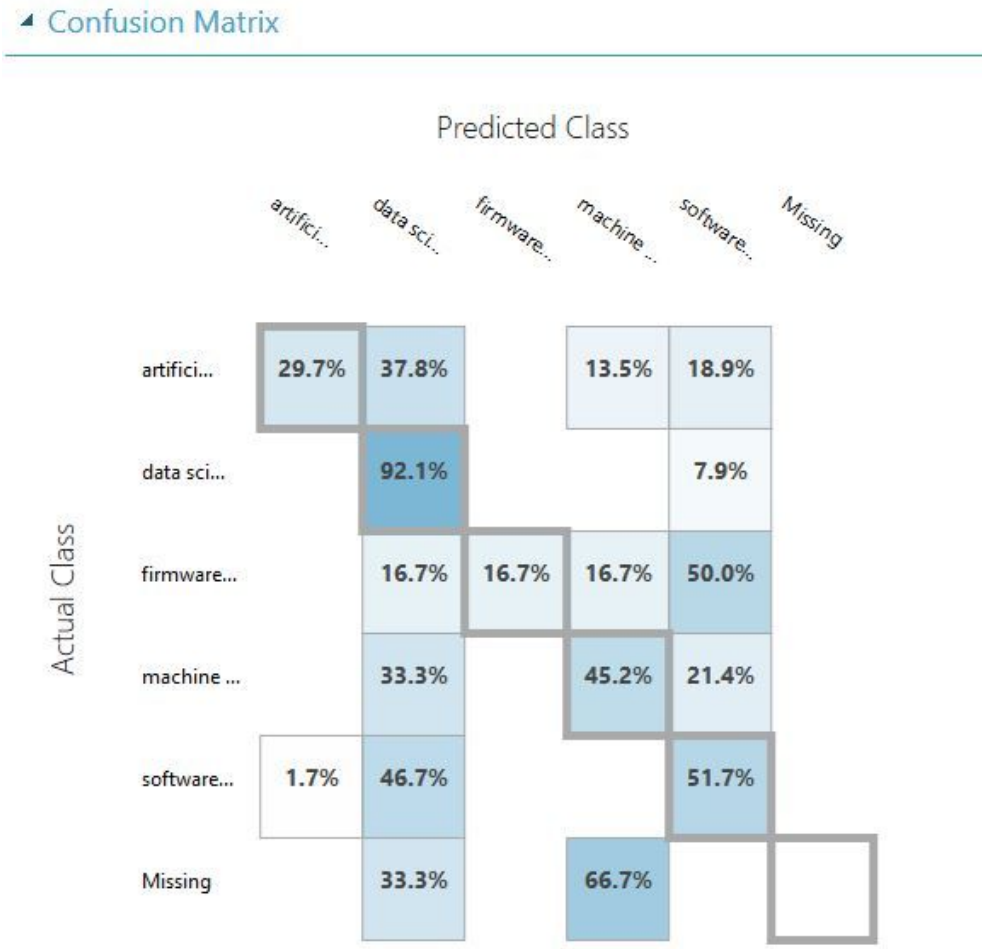
The diameter of each skill circle linearly corresponds to the frequency the skill appears in the whole database. The diameter of each category circle linearly corresponds to the number of skills required by each category.

Appendix C: Top 20 Skills of Each Job Category

all	**us**	**ru**
machine learning	machine learning	machine learning
python	communication	python
development	python	development
communication	masters	c++
c++	development	data analysis
teamwork	collaboration	english
data analysis	teamwork	linux
masters	phd	teamwork
bachelor	bachelor	mathematics
collaboration	java	sql
phd	c++	data mining
java	data analysis	tensorflow
sql	sql	numpy
tensorflow	solution implementation	java
solution implementation	r	pandas
data mining	design	statistics
statistics	optimization	testing
r	relevant experience	communication
design	c	data modeling

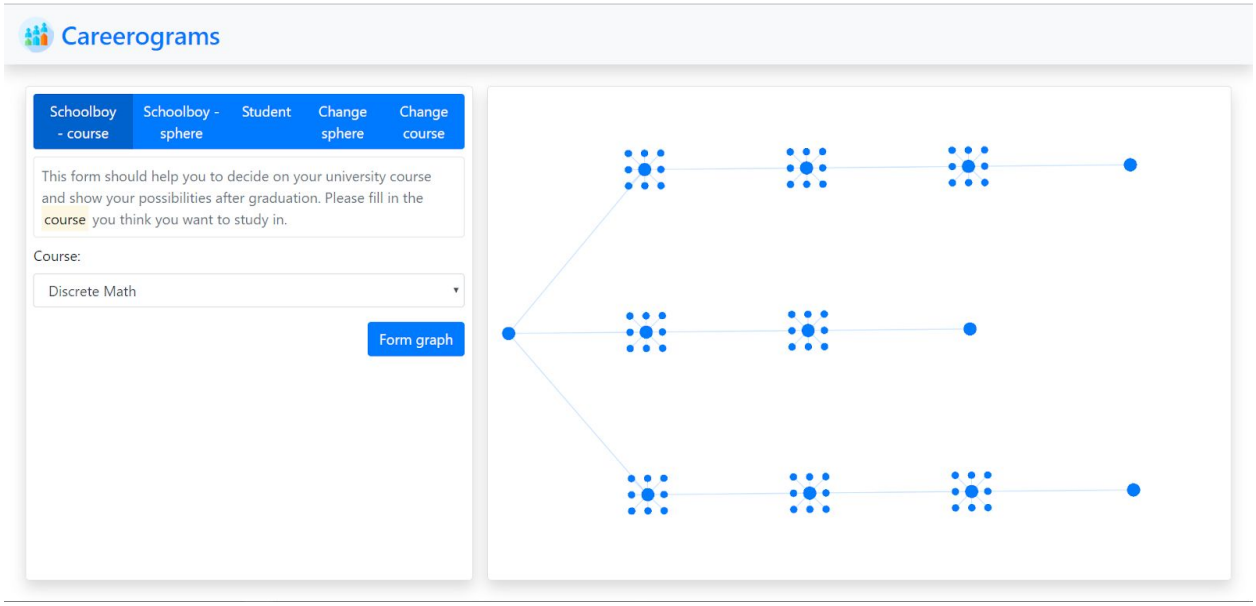
artificial intelligence	**data scientist**	**firmware engineering**	**machine learning**	**software engineer**
machine learning	machine learning	problem solving	machine learning	c++
development	python	solution implementation	python	development
communication	data analysis	c	c++	python
python	sql	c++	tensorflow	communication
tensorflow	development	linux	data analysis	bachelor
collaboration	masters	rtos	statistics	teamwork
phd	r	real time operating systems	java	java
teamwork	communication	english	phd	linux
c++	data mining	teamwork	algorithm implementation	english
relevant experience	phd	ms visio	data modeling	design
artificial intelligence	teamwork	optimization	solution implementation	collaboration
masters	collaboration	bachelor	collaboration	c
java	statistics	communication	development	javascript
bachelor	mathematics	software development	communication	solution implementation
pytorch	data modeling	arm	bachelor	solution design
c	pandas	masters	teamwork	android
problem solving	numpy	problem identification	english	agile development
testing	management	digital signal processing	data mining	masters
optimization	quality assurance	python	research	windows

Appendix D: Machine Learning Model Result

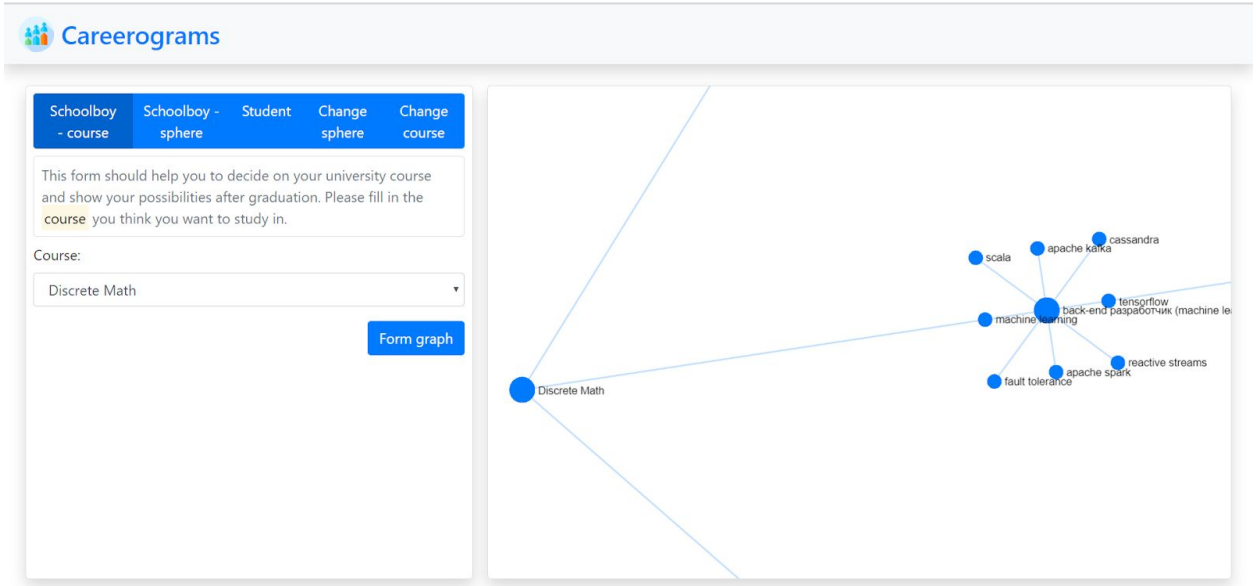


Appendix E: Navigator Interfaces

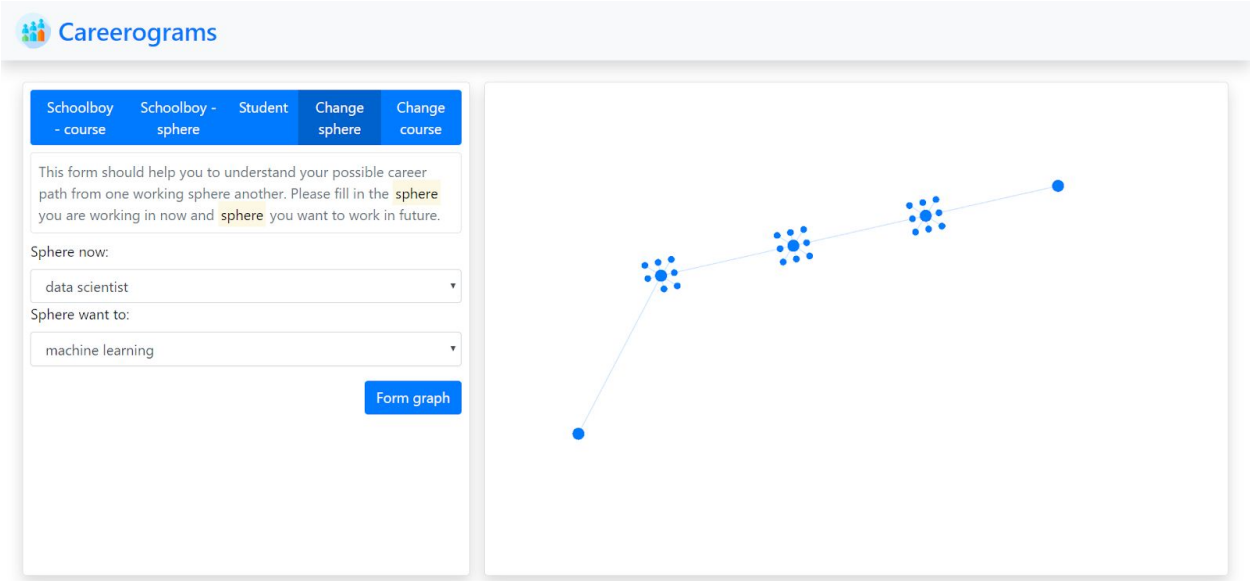
Request 1 (See appendix F) with result, default view



Request 1 with result, zoomed in

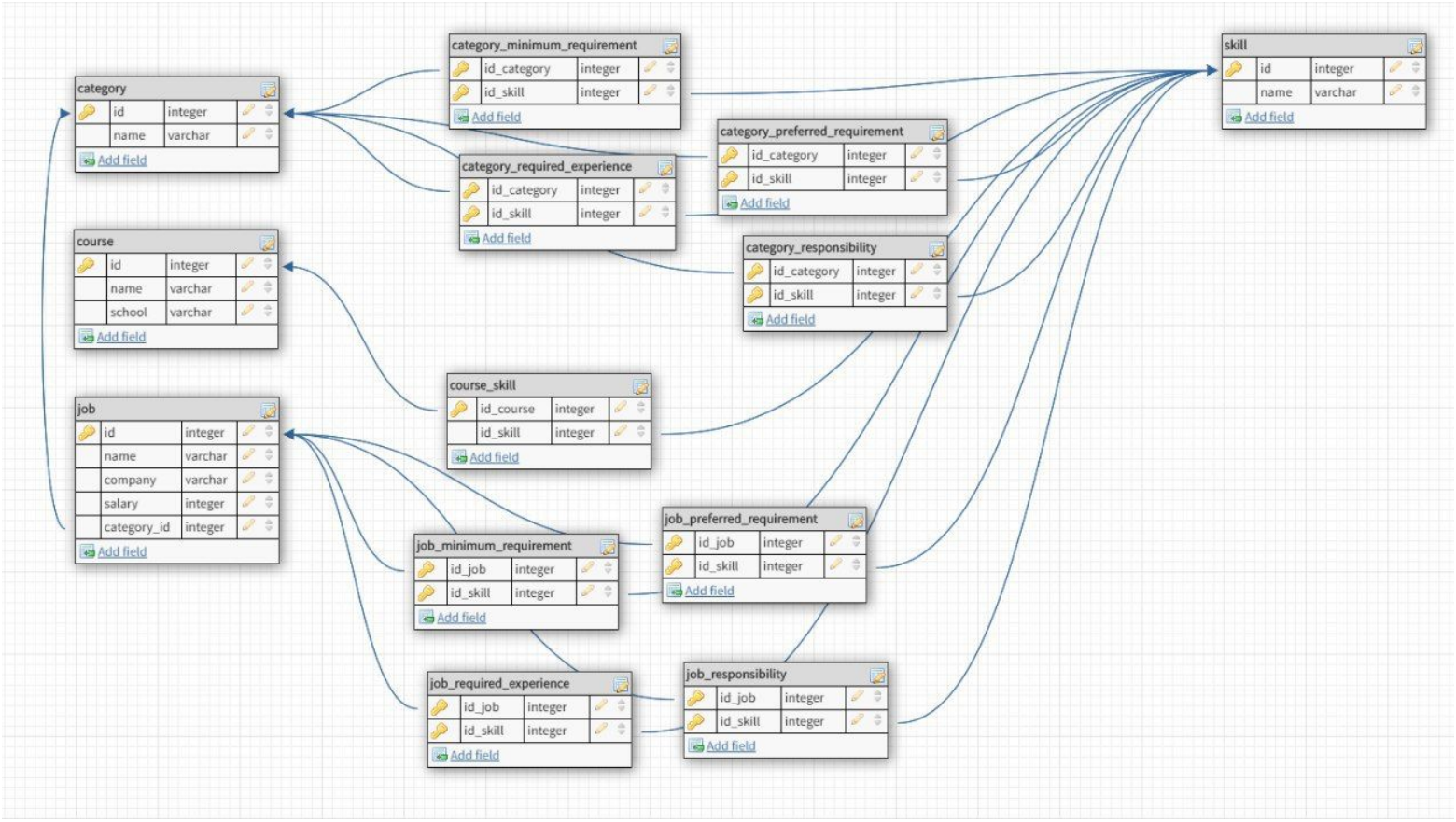


Request 4:


Careerograms
Schoolboy - course
Schoolboy - sphere
Student
Change sphere
Change course
This form should help you to understand your possible career path from one working sphere another. Please fill in the sphere you are working in now and sphere you want to work in future.
Sphere now:
data scientist
Sphere want to:
machine learning
Form graph

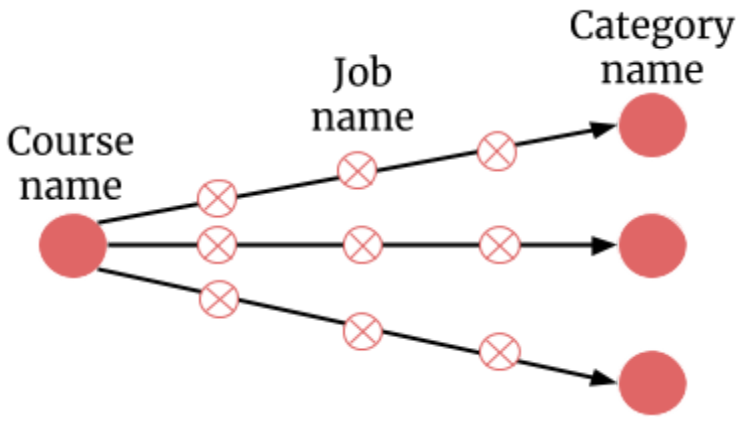
Appendix F: Navigator Design Diagrams

Database Specification:

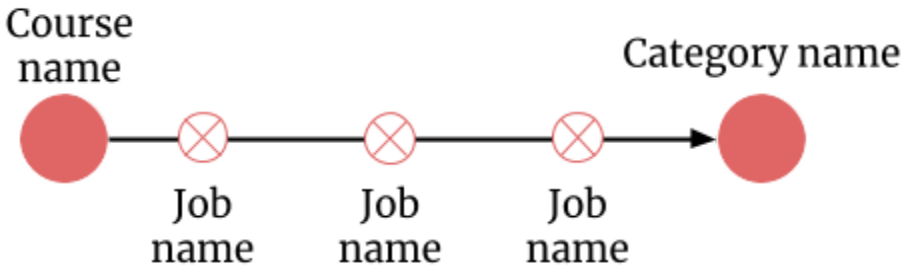


Server Requests:

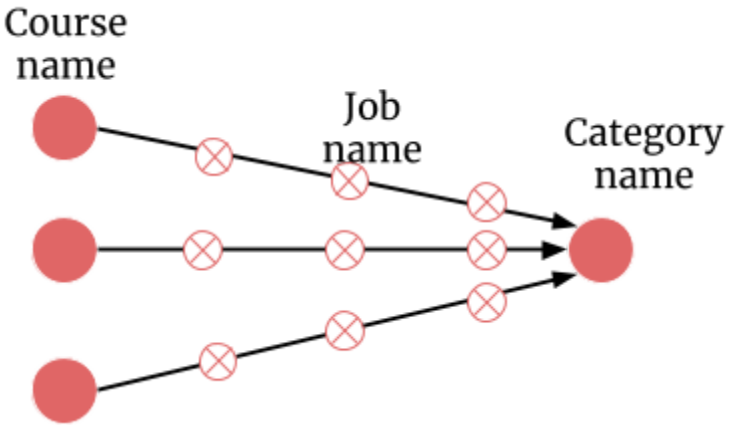
Request 1: Given a course, the request returns a list of jobs in different job categories that require skills from that specific course. This request intends to help students on deciding what courses to take and what opportunities exist by taking that course.



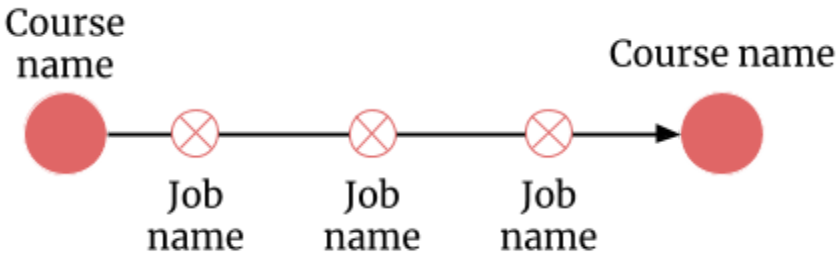
Request 2: This is a simpler version of request 1. If the student knows what job category he/she is looking for, given the category and a course, the request returns a list of jobs that require the skills taught by the course.



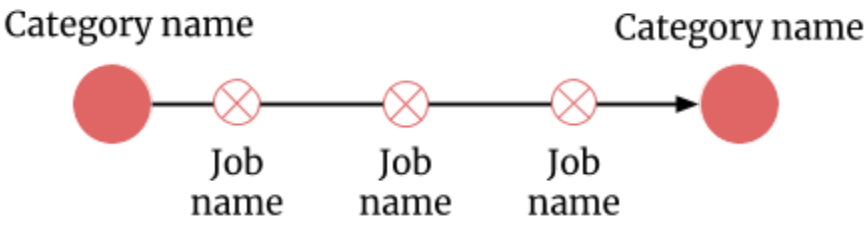
Request 3: This request is used to help the user to decide what courses to take to become an expert in a job category. Given a job category, the request shows the list of courses that the student can take to prepare for jobs, as well as a list of jobs that they can obtain to work in the job category.



Request 4: This request is used when a student wants to take an advance level course (potentially from another university). Given the course that the student is currently taking and wants to take, the request returns a list of jobs that can help the student to learn necessary skills to tackle the new course.



Request 5: This request is used when the user wants to transition from a job in one job category into a job in another category. Given the current job category and the target job category, the request returns a list of jobs that helps with the transition.



Appendix G: Literal String Job-Course Matching Result

Degree at WPI	Category	Skill Count in Category	Count (all skills)	% match (all skills)	Count (top 20)	% match (top 20)
Actuarial Mathematics	data scientist	346	22	6.36%	7	35.00%
Mathematics - Algebraic and Discrete Mathematics	data scientist	346	22	6.36%	6	30.00%
Mathematics - Computational and Applied Analysis	data scientist	346	19	5.49%	6	30.00%
Mathematics - Operations Research	data scientist	346	26	7.51%	8	40.00%
Mathematics - Probability and Statistics	data scientist	346	19	5.49%	6	30.00%
M.S. in Applied Statistics	data scientist	346	4	1.16%	2	10.00%
M.S. in Financial Mathematics	data scientist	346	6	1.73%	2	10.00%
M.S. in Data Science	data scientist	346	21	6.07%	9	45.00%
Master of Business Administration	data scientist	346	19	5.49%	5	25.00%
Actuarial Mathematics	artificial intelligence	212	21	9.91%	6	30.00%
Mathematics - Algebraic and Discrete Mathematics	artificial intelligence	212	22	10.38%	6	30.00%
Mathematics - Computational and Applied Analysis	artificial intelligence	212	19	8.96%	5	25.00%
Mathematics - Operations Research	artificial intelligence	212	23	10.85%	5	25.00%
Mathematics - Probability and Statistics	artificial intelligence	212	20	9.43%	5	25.00%
M.S. in Applied Statistics	artificial intelligence	212	4	1.89%	0	0.00%
M.S. in Financial Mathematics	artificial intelligence	212	6	2.83%	1	5.00%
M.S. in Data Science	artificial intelligence	212	20	9.43%	4	20.00%
Master of Business Administration	artificial intelligence	212	12	5.66%	5	25.00%
Actuarial Mathematics	machine learning	348	22	6.32%	8	40.00%
Mathematics - Algebraic and Discrete Mathematics	machine learning	348	21	6.03%	7	35.00%
Mathematics - Computational and Applied Analysis	machine learning	348	19	5.46%	7	35.00%
Mathematics - Operations Research	machine learning	348	24	6.90%	9	45.00%
Mathematics - Probability and Statistics	machine learning	348	21	6.03%	7	35.00%
M.S. in Applied Statistics	machine learning	348	3	0.86%	2	10.00%

M.S. in Financial Mathematics	machine learning	348	5	1.44%	2	10.00%
M.S. in Data Science	machine learning	348	19	5.46%	8	40.00%
Master of Business Administration	machine learning	348	13	3.74%	3	15.00%
Actuarial Mathematics	software engineer	478	24	5.02%	5	25.00%
Mathematics - Algebraic and Discrete Mathematics	software engineer	478	24	5.02%	6	30.00%
Mathematics - Computational and Applied Analysis	software engineer	478	22	4.60%	5	25.00%
Mathematics - Operations Research	software engineer	478	27	5.65%	5	25.00%
Mathematics - Probability and Statistics	software engineer	478	23	4.81%	5	25.00%
M.S. in Applied Statistics	software engineer	478	3	0.63%	0	0.00%
M.S. in Financial Mathematics	software engineer	478	5	1.05%	1	5.00%
M.S. in Data Science	software engineer	478	20	4.18%	3	15.00%
Master of Business Administration	software engineer	478	15	3.14%	4	20.00%
Actuarial Mathematics	firmware engineering	92	8	8.70%	6	30.00%
Mathematics - Algebraic and Discrete Mathematics	firmware engineering	92	8	8.70%	7	35.00%
Mathematics - Computational and Applied Analysis	firmware engineering	92	7	7.61%	6	30.00%
Mathematics - Operations Research	firmware engineering	92	8	8.70%	6	30.00%
Mathematics - Probability and Statistics	firmware engineering	92	8	8.70%	6	30.00%
M.S. in Applied Statistics	firmware engineering	92	1	1.09%	0	0.00%
M.S. in Financial Mathematics	firmware engineering	92	1	1.09%	1	5.00%
M.S. in Data Science	firmware engineering	92	6	6.52%	3	15.00%
Master of Business Administration	firmware engineering	92	7	7.61%	2	10.00%

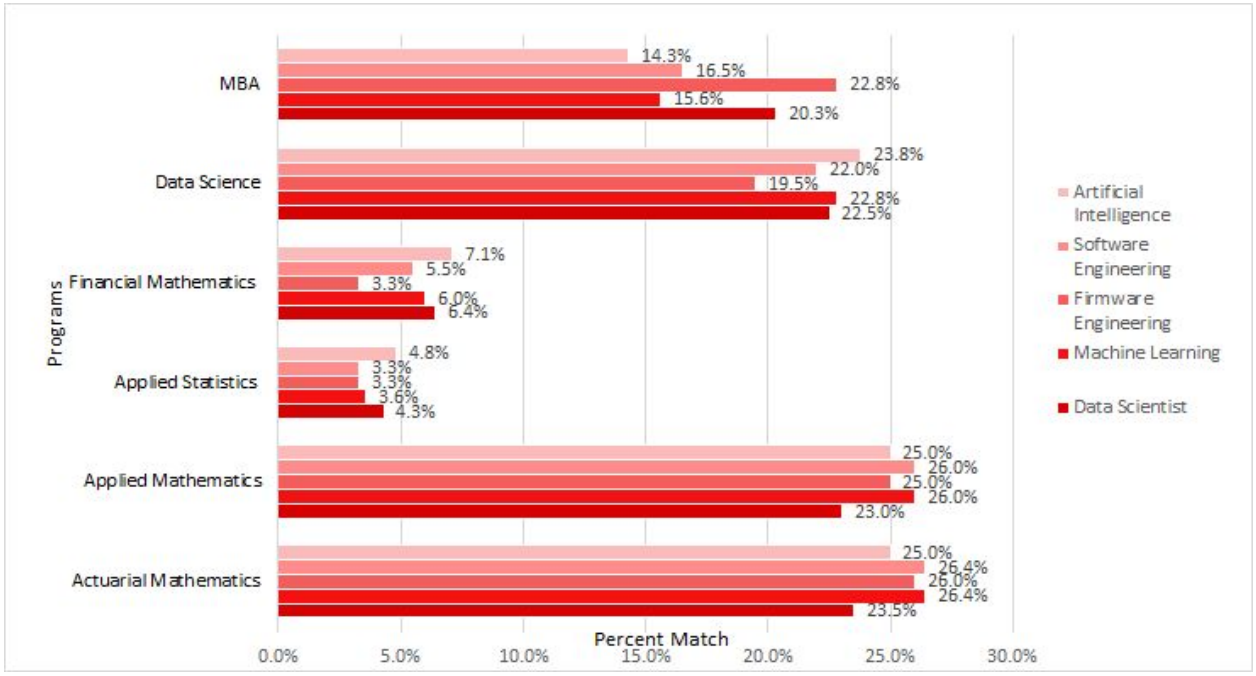
Degree at Financial University	Category	Skill Count in Category	Count (all skills)	% match (all skills)	Count (top 20)	% match (top 20)
Applied Math	data scientist	346	23	6.65%	8	40.00%
Information Security	data scientist	346	20	5.78%	6	30.00%
Прикладная информатика (Applied Informatics)	data scientist	346	34	9.83%	7	35.00%
Бизнес-информатика (Business Informatics)	data scientist	346	30	8.67%	11	55.00%
Applied Math	artificial intelligence	212	16	7.55%	5	25.00%
Information Security	artificial intelligence	212	17	8.02%	6	30.00%
Прикладная информатика (Applied Informatics)	artificial intelligence	212	24	11.32%	5	25.00%
Бизнес-информатика (Business Informatics)	artificial intelligence	212	26	12.26%	7	35.00%
Applied Math	machine learning	348	21	6.03%	6	30.00%
Information Security	machine learning	348	19	5.46%	5	25.00%
Прикладная информатика (Applied Informatics)	machine learning	348	24	6.90%	7	35.00%
Бизнес-информатика (Business Informatics)	machine learning	348	24	6.90%	8	40.00%
Applied Math	software engineer	478	20	4.18%	3	15.00%
Information Security	software engineer	478	20	4.18%	5	25.00%
Прикладная информатика (Applied Informatics)	software engineer	478	27	5.65%	4	20.00%
Бизнес-информатика (Business Informatics)	software engineer	478	26	5.44%	7	35.00%
Applied Math	firmware engineering	92	5	5.43%	4	20.00%
Information Security	firmware engineering	92	9	9.78%	5	25.00%
Прикладная информатика (Applied Informatics)	firmware engineering	92	11	11.96%	5	25.00%
Бизнес-информатика (Business Informatics)	firmware engineering	92	12	13.04%	7	35.00%

Degree at WPI	Category	Skill Count in Category	% match (all skills)	Normalization %
Actuarial Mathematics	data scientist	346	6.36%	23.5%
Applied Mathematics	data scientist	346	5.49%	23.0%
M.S. in Applied Statistics	data scientist	346	1.16%	4.3%
M.S. in Financial Mathematics	data scientist	346	1.73%	6.4%
M.S. in Data Science	data scientist	346	6.07%	22.5%
Master of Business Administration	data scientist	346	5.49%	20.3%
Actuarial Mathematics	artificial intelligence	212	9.91%	25.0%
Applied Mathematics	artificial intelligence	212	9.43%	25.0%
M.S. in Applied Statistics	artificial intelligence	212	1.89%	4.8%
M.S. in Financial Mathematics	artificial intelligence	212	2.83%	7.1%
M.S. in Data Science	artificial intelligence	212	9.43%	23.8%
Master of Business Administration	artificial intelligence	212	5.66%	14.3%
Actuarial Mathematics	machine learning	348	6.32%	26.4%
Applied Mathematics	machine learning	348	6.90%	26.0%
M.S. in Applied Statistics	machine learning	348	0.86%	3.6%
M.S. in Financial Mathematics	machine learning	348	1.44%	6.0%
M.S. in Data Science	machine learning	348	5.46%	22.8%
Master of Business Administration	machine learning	348	3.74%	15.6%
Actuarial Mathematics	software engineer	478	5.02%	26.4%
Applied Mathematics	software engineer	478	4.81%	26.0%
M.S. in Applied Statistics	software engineer	478	0.63%	3.3%
M.S. in Financial Mathematics	software engineer	478	1.05%	5.5%
M.S. in Data Science	software engineer	478	4.18%	22.0%
Master of Business Administration	software engineer	478	3.14%	16.5%
Actuarial Mathematics	firmware engineering	92	8.70%	26.0%
Applied Mathematics	firmware engineering	92	8.70%	25.0%
M.S. in Applied Statistics	firmware engineering	92	1.09%	3.3%

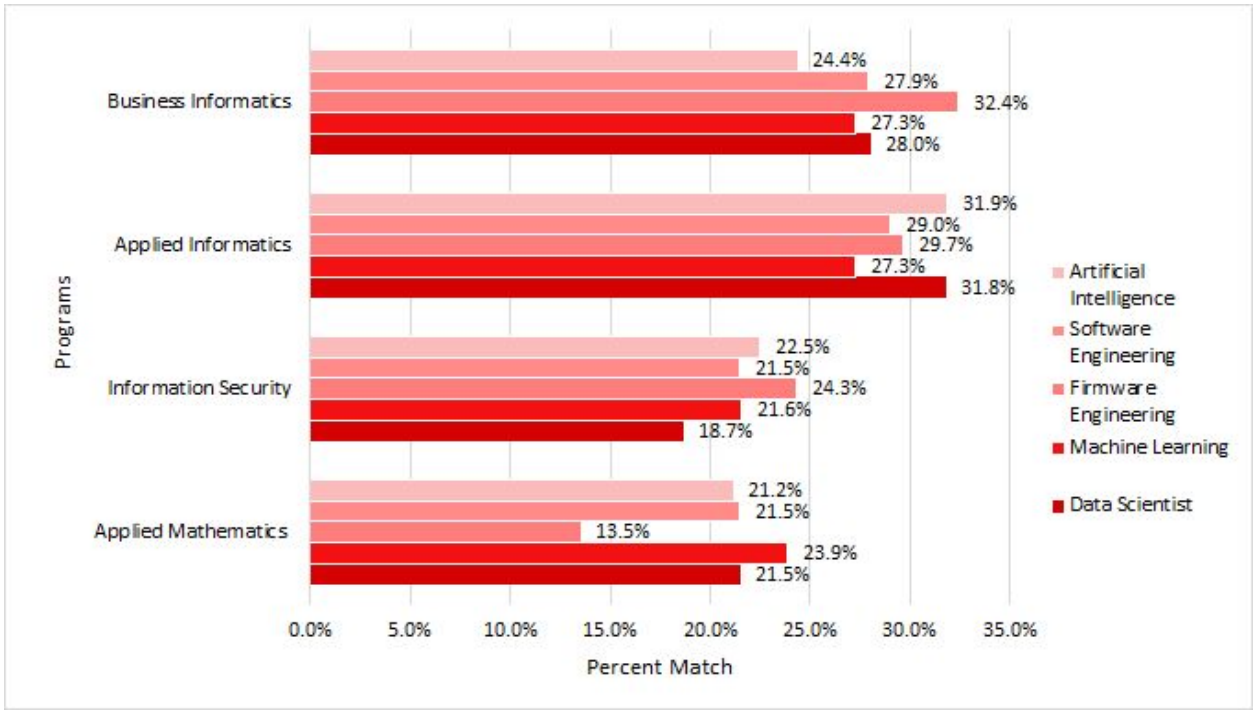
M.S. in Financial Mathematics	firmware engineering	92	1.09%	3.3%
M.S. in Data Science	firmware engineering	92	6.52%	19.5%
Master of Business Administration	firmware engineering	92	7.61%	22.8%

Degree at Financial University	**Category**	**Skill Count in Category**	**% match (all skills)**	**Normalization %**
Applied Math	data scientist	346	6.65%	21.5%
Information Security	data scientist	346	5.78%	18.7%
Прикладная информатика (Applied Informatics)	data scientist	346	9.83%	31.8%
Бизнес-информатика (Business Informatics)	data scientist	346	8.67%	28.0%
Applied Math	artificial intelligence	212	7.55%	21.2%
Information Security	artificial intelligence	212	8.02%	22.5%
Прикладная информатика (Applied Informatics)	artificial intelligence	212	11.32%	31.9%
Бизнес-информатика (Business Informatics)	artificial intelligence	212	12.26%	24.4%
Applied Math	machine learning	348	6.03%	23.9%
Information Security	machine learning	348	5.46%	21.6%
Прикладная информатика (Applied Informatics)	machine learning	348	6.90%	27.3%
Бизнес-информатика (Business Informatics)	machine learning	348	6.90%	27.3%
Applied Math	software engineer	478	4.18%	21.5%
Information Security	software engineer	478	4.18%	21.5%
Прикладная информатика (Applied Informatics)	software engineer	478	5.65%	29.0%
Бизнес-информатика (Business Informatics)	software engineer	478	5.44%	27.9%
Applied Math	firmware engineering	92	5.43%	13.5%
Information Security	firmware engineering	92	9.78%	24.3%
Прикладная информатика (Applied Informatics)	firmware engineering	92	11.96%	29.7%
Бизнес-информатика (Business Informatics)	firmware engineering	92	13.04%	32.4%

WPI Match Data (Normalized)



Financial University Match Data (Normalized)



Appendix H: The Economic History of Russia

Russia has seen its fair share of a turbulent history, from the invasion of the Mongols to the Revolutions of 1917 and 1991, and these events shaped Russia to what it is today. The economy of the country has also often undergone many reforms. Yet there are also still many lingering aspects from the past. Russia has been under authoritarianism control for nearly all of its history. Therefore, the economy has been mostly dominated by the state in every period of Russian history. As Loren Graham stated, "The tsars, leaders of the Communist Party and now leaders of post-Soviet 'sovereign democracy' have determined the policies….often ignoring market forces and 'best practices'" (Graham, 2013). Graham insists that one of the many reasons Russia falls behind compared to the west is that the head of state dominates the economy, education, and lives of the people. Government dominance is shown in the recent history of Russia starting with the rising of the Bolsheviks during the 1917 Revolution until the end Gorbachev administration.

Influenced by the communist ideas of Karl Marx, Vladimir Lenin built the Union of Socialist Soviet Republics, or the Soviet Union, and he along with his successor Stalin, rebuilt the Russian economy based on communist ideals. After Lenin's victory against the White Russians, he instigated his "New Economic Policy." The government introduced a new currency and a new state bank. Industry was also divided into 2 sectors, with government owning one and individuals owning the other. However, the state owned sector employed about 84% percent of the workforce (Ascher, 2017). Later attempts by Lenin's successors to further "communize" the country led to times where students were often forced to study the development of industries, agriculture, the military and above all, socialism. However, Russian economic growth never

truly surpassed its rival, the United States or even other countries. By 1970, the average income in the United States tripled that of Russia (Nintil, 2016). In the end, the Russian economy during the 1970s was dominated by the government. Nearly all prioritized production was not for the benefit of the people but rather to achieve victory in the Cold War. The result ended in a economically depressed nation by the end of 1970s and eventually the final collapse in 1991.

The modern Russian economy was started by Mikhail Gorbachev with his famous reform perestroika. He moved to inspired citizens to be creative and later also allowed the creation of a "capitalist" sector of the economy (Ascher, 2017). These new policies, however, did not remedy the issue as the economic downturn grew much worse starting in 1990. Many prominent economists believed the only way to maintain a stable economy is to decentralize the control of the economy. Gorbachev's successor, Boris Yeltsin began another series of reforms on the economy. He lifted the price control by the government and also allowed for privatization. These methods soon proved to be futile as inflation rose rapidly along with unemployment. By 1998, the country was on the brink of economic collapse as it defaulted on debts and the ruble was severely devalued. However the privatization did change the Russian economic system completely, as by 1994 nearly 40 percent of the Russian labor force was employed by private businesses (Ascher, 2017).

On December 31, 1999, Vladimir Putin was named president of Russia. In 2004, oil prices rose dramatically and a economic boom was experienced in Russia. However, Putin did little with the funds to further modernize the economy or education. Recent incidents in Crimea and Ukraine also led to a series of sanctions being imposed on the Russian economy by western nations. There is much argument on whether these sanctions have actually weakened the Russian

economy. The ruble did fall when the sanctions were imposed but it is believed it may be due to fluctuating oil prices instead: “We can conclude that the present Russian economic condition depends….on the current market prices on oil” (Tyll, Pernica, & Arltová, 2018). Falling oil prices devalues the ruble since the Russian government uses oil in the foreign exchange market. (Brokes, 2018) It has also been reported that unemployment and inflation rates have decreased recently. Inflation decreased from a peak of 17.3 percent to recently 2.3 percent and unemployment fell from 5.2 percent to 4.8 percent. The result is a rather stable economy (Troianovski, 2018). The sanctions however have prevented economic growth as Russian trade is restricted, resulting in lost businesses and opportunities: “International Monetary Fund completed a regular review of the Russian economy in May, the Washington-based organization’s staff cautioned that the country’s income growth has ‘stalled’...” (Troianovski, 2018). To remedy the decline, the Kremlin has attempted to apply new taxes but failed due to fear of losing investors in the economy. The current Russian GDP is estimated to be 1.578 trillion USD and is forecasted to grow albeit slowly. The current GDP is down substantially from the height of 2.3 trillion USD in 2013 (The Worldbank, 2019). The decline is also what motivated Russia to slash 80 billion rubles (1.1 billion USD) from educational funding. Hence with certain jobs being valued more than others, the interventionist foreign policy and resistance to modernize education, students are in need of more resources to help them find a suitable career path.

Appendix I: WPI Mathematical Sciences Student Survey

For Students from the Mathematics Department at WPI (Master + Bachelor)

- What year do you graduate from WPI with your highest degree? (drop down)
    - 2019
    - 2020
    - 2021
    - 2022
    - 2023
    - Other
- What discipline are you currently studying in the Math Department? (drop down)
    - Actuarial Mathematics (BS)
    - Applied Mathematics (MS)
    - Applied Statistics (MS)
    - Financial Mathematics (MS)
    - Industrial Mathematics (MS)
    - Mathematical Sciences (BS)
    - Mathematics (Minor)
    - Mathematics for Educators (MME)
    - Mathematics for Educators (MS) (MMED)
    - Statistics (Minor)
- What is your secondary major? (Text box)
- Have you been ever been employed in your current field? (check all apply)
    - Internship
    - Co-op
    - Full time
    - Other (Text Box)
- What is your plan for after graduation? (check all apply)
    - Employment
    - Master/PhD
    - Military
    - Undecided
- If you chose employment or undecided, is there any positions/industry/companies you want to work in? (separated by commas)
    - Position Title (Text Box)
    - Industry (Text Box)
    - Company (Text Box)