How the Use of Technology Affects a Firm and its Employees: A Look at the 2019 Annual Business Survey

(*This is just a working title and can be changed*)

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Introduction:

Upon our group being first introduced to the data, we found we were really interested in looking at the impact of technology within a firm. We ultimately decided to focus on the Technology Characteristics of Businesses within the 2019 Annual Business Survey and examine the data in a way that piqued our individual interests. We came to the conclusion that we were all interested in how the use of technology within a company ultimately impacted individuals in different ways and the original motivations behind the implementation and production of technology at individual firms. More specifically, we narrowed down our focus to the impact of artificial intelligence and the implementation of robotics at a firm as these seemed to be the traditional forms of technology that may plague the anxieties of a "technophobe" (McClure, 2018).

  Methodology: Each analysis was done in Jupyter notebooks, using the official Census Bureau Api to gather data. The ETL for each analysis was done using the *pandas* library with Python 3.7.9. All visualizations were done with *Matplotlib* and *seaborn*. Data was transformed and cleaned according to the needs of the given analysis. More ETL information is provided within the .ipynb analysis files found on this project's Github.
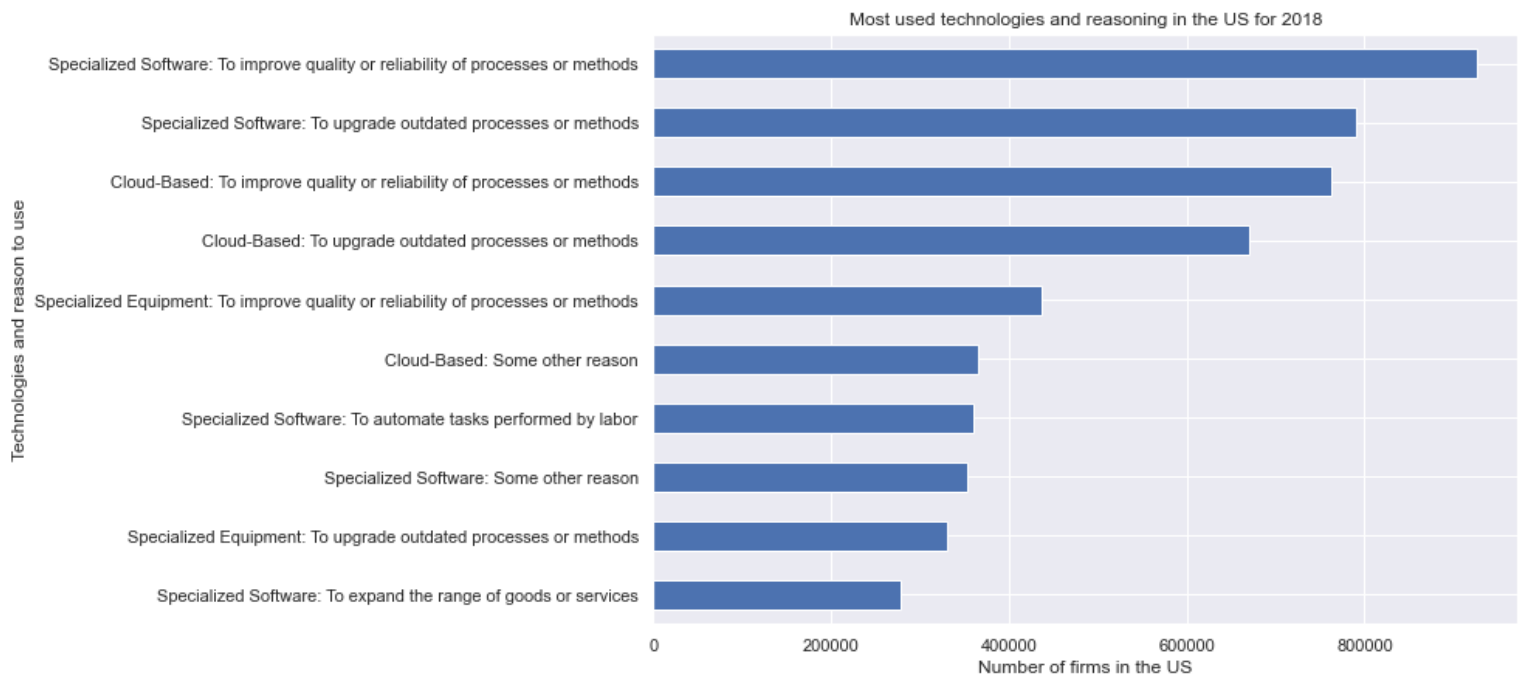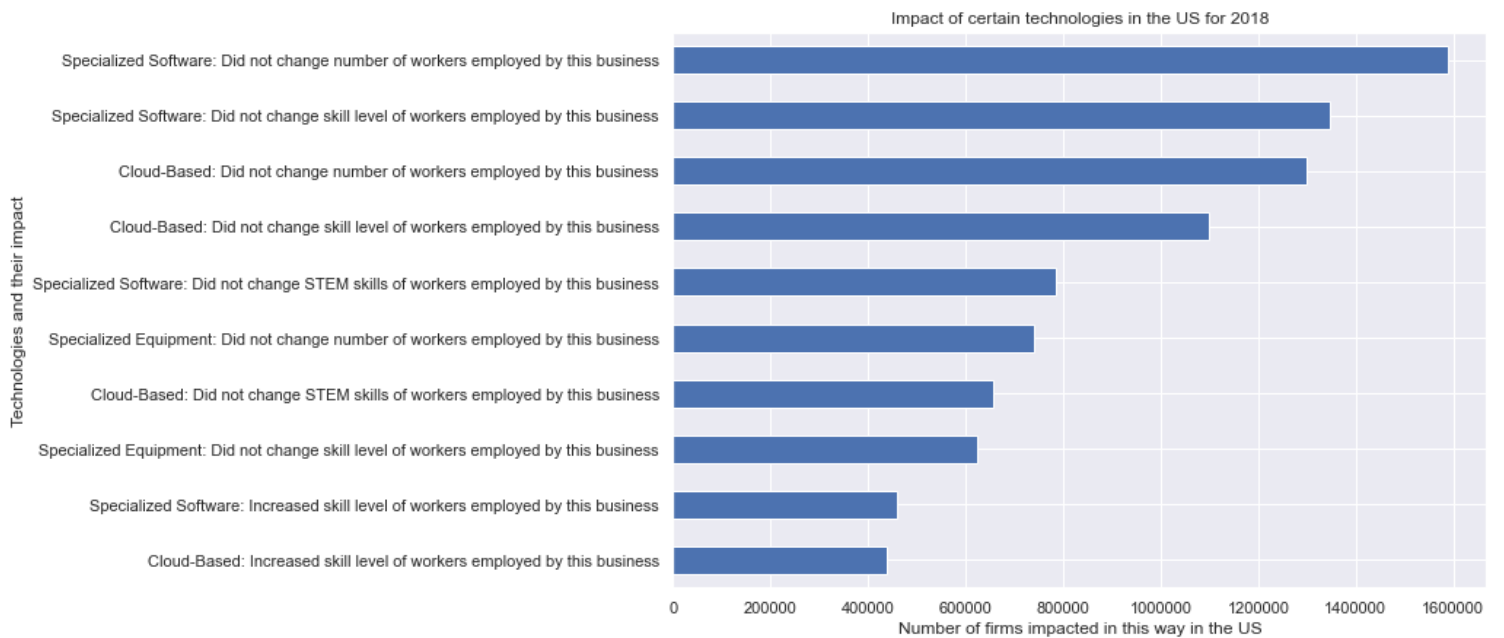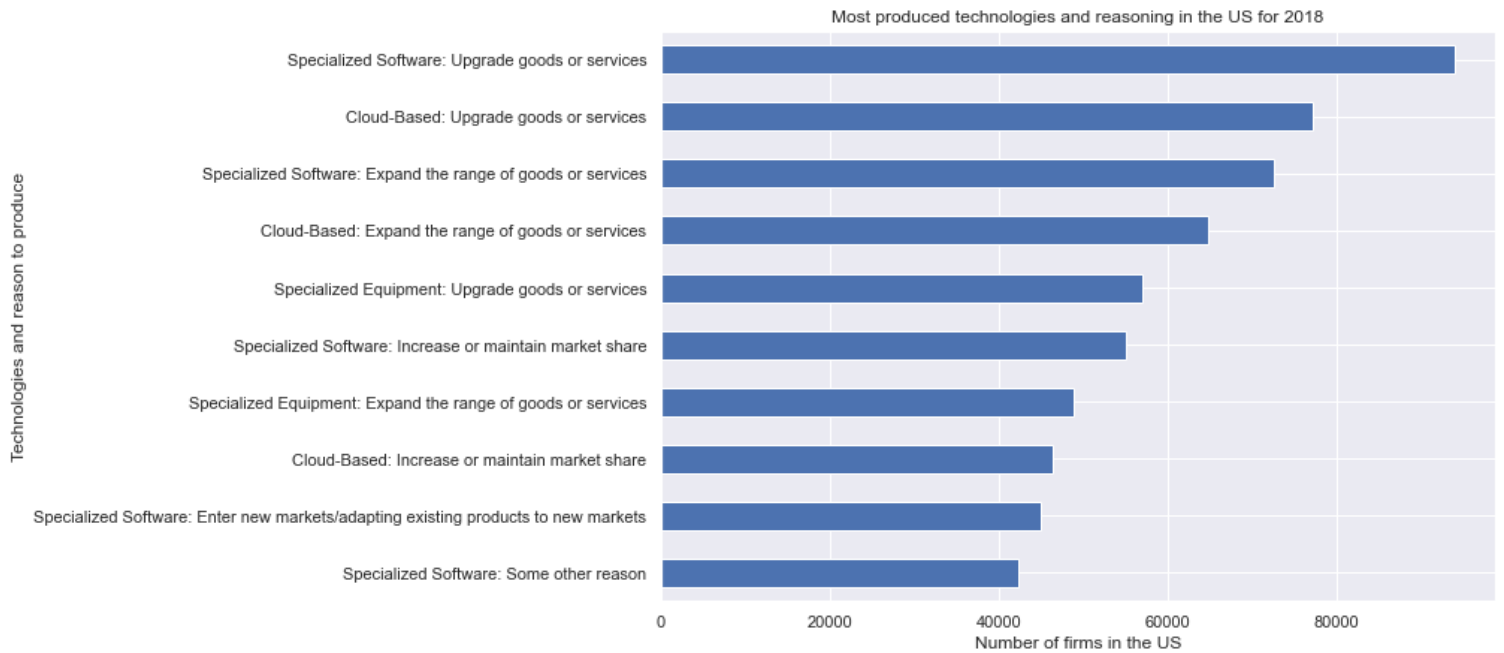
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  In this section, we'll be answering the question of "what were some of the most common motivations to use and produce each of the technologies found in the datasets and what was their impact in terms of the total number of companies in the US?"
  Looking at the US broadly, by examining all three of the graphs below, we find that the fields with the most number of firms paying attention to them appear to be specialized software

and cloud-based technologies, with the two taking at least the top four spots in relevance to firms in all three figures. Not only this, but the more specific category is also the same between the two categories, i.e. there are the most firms using these technologies to "improve quality or reliability of processes or methods" and "to upgrade outdated processes or methods" in terms of motivation to use these technologies. Specialized software and cloud-based technology were most often produced to "upgrade goods or services" or "expand the range of goods or services", and the most common impacts were that they didn't change the number of or the skill level of workers for these firms, and overall these findings seem to make logical sense, especially when compared to some of the other options. Considering that the other category options are artificial intelligence, specialized equipment and robotics, specialized software and cloud based technologies are both more flexible and lower commitment than the other options. They don't have the potentially costly hardware requirements of robotics or specialized equipment, and are relatively easier to work with and generally simpler to understand than artificial intelligence in addition to being faster to get value out of, as companies don't need to wait for shipping orders to arrive for equipment or employees to adjust to the relatively higher learning curve of artificial intelligence. Furthermore, the more specific motivations in each of the graphs all reflect the desire to improve company efficiency by improving the company's operational performance and service quality without costing their current employees anything as suggested by the fact that these technologies didn't change the skill or number of workers for the firms.

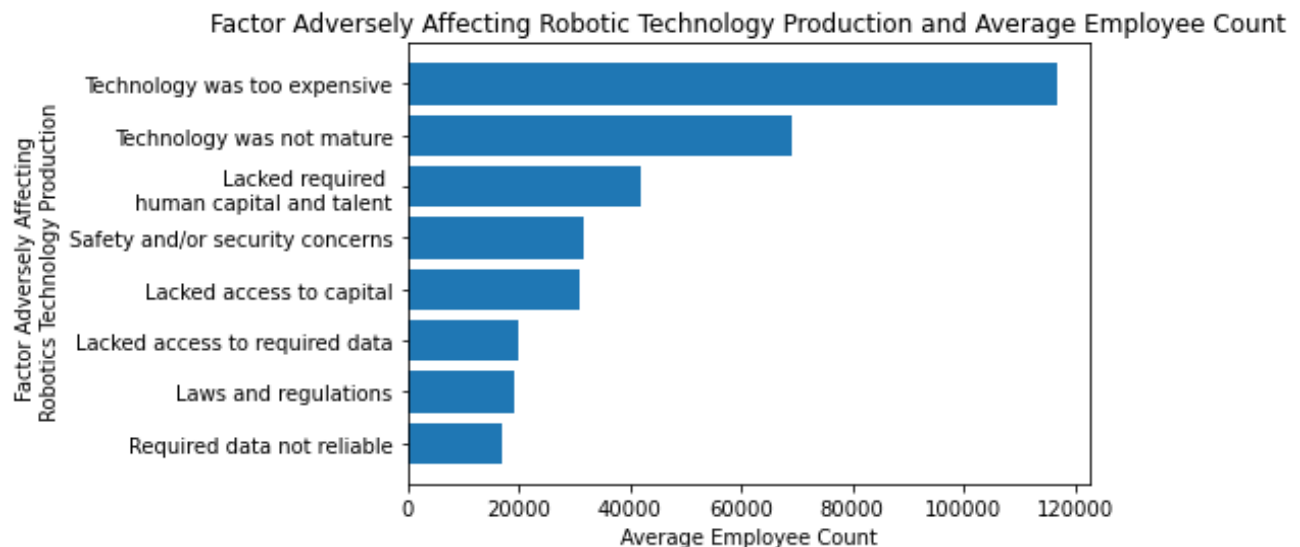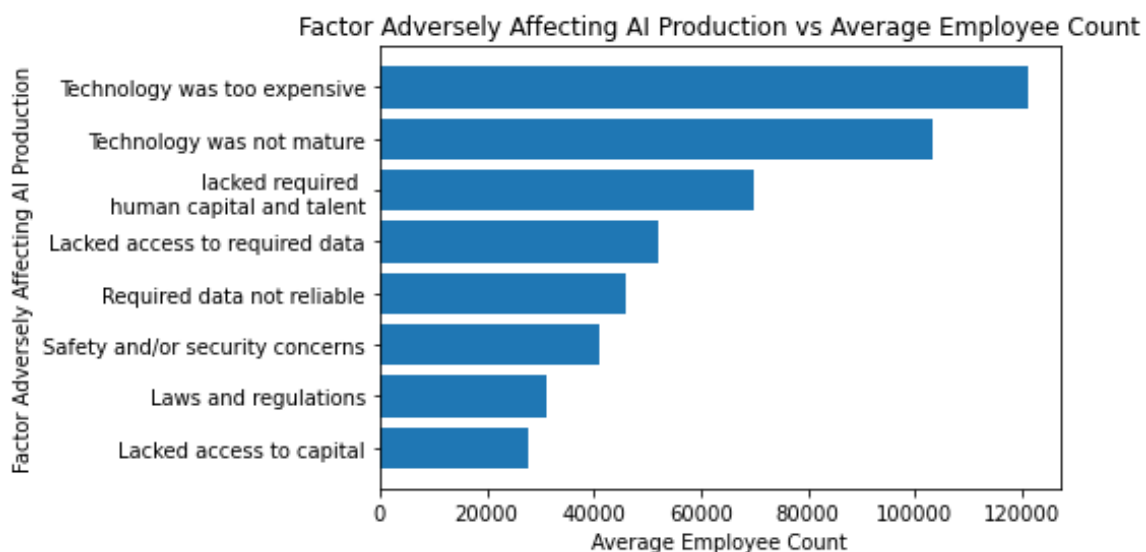Ultimately, by looking at the quantity of firms with certain feelings towards certain technologies, we can find themes that are commonly important to firms across the US. Here, these themes would be the improvement of the firm's operations and services at the lowest possible cost through the adoption of low-risk, digital technologies that can be quickly tested and deployed to get returns on them as soon as possible.

Most produced technologies and reasoning in the US for 2018

Technologies and reason to produce	Number of firms in the US

- Specialized Software: Upgrade goods or services
- Cloud-Based: Upgrade goods or services
- Specialized Software: Expand the range of goods or services
- Cloud-Based: Expand the range of goods or services
- Specialized Equipment: Upgrade goods or services
- Specialized Software: Increase or maintain market share
- Specialized Equipment: Expand the range of goods or services
- Cloud-Based: Increase or maintain market share
- Specialized Software: Enter new markets/adapting existing products to new markets
- Specialized Software: Some other reason

X-axis: Number of firms in the US (0, 20000, 40000, 60000, 80000)

Impact of certain technologies in the US for 2018

Technologies and their impact	Number of firms impacted in this way in the US

- Specialized Software: Did not change number of workers employed by this business
- Specialized Software: Did not change skill level of workers employed by this business
- Cloud-Based: Did not change number of workers employed by this business
- Cloud-Based: Did not change skill level of workers employed by this business
- Specialized Software: Did not change STEM skills of workers employed by this business
- Specialized Equipment: Did not change number of workers employed by this business
- Cloud-Based: Did not change STEM skills of workers employed by this business
- Specialized Equipment: Did not change skill level of workers employed by this business
- Specialized Software: Increased skill level of workers employed by this business
- Cloud-Based: Increased skill level of workers employed by this business

X-axis: Number of firms impacted in this way in the US (0, 200000, 400000, 600000, 800000, 1000000, 1200000, 1400000, 1600000)
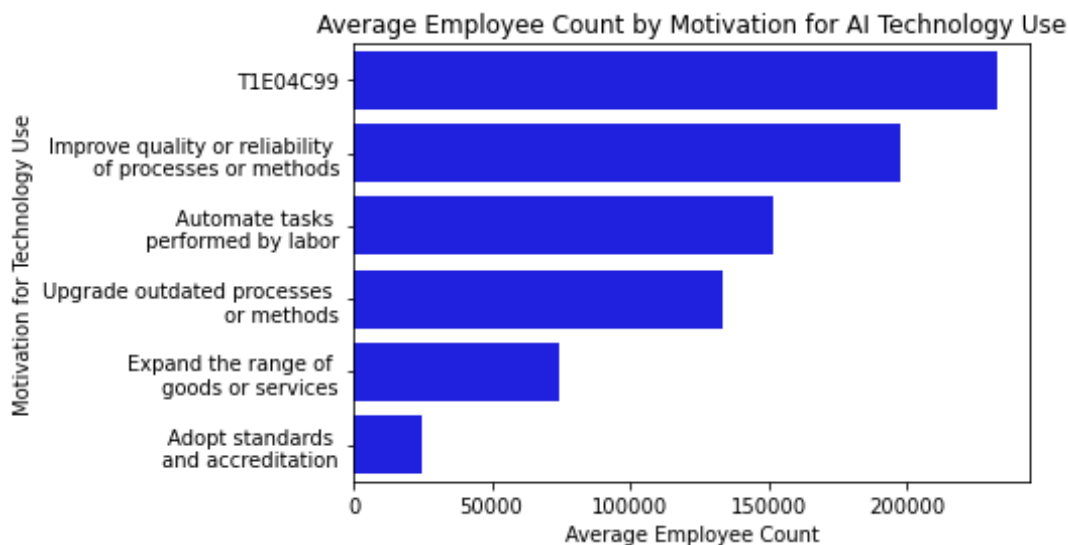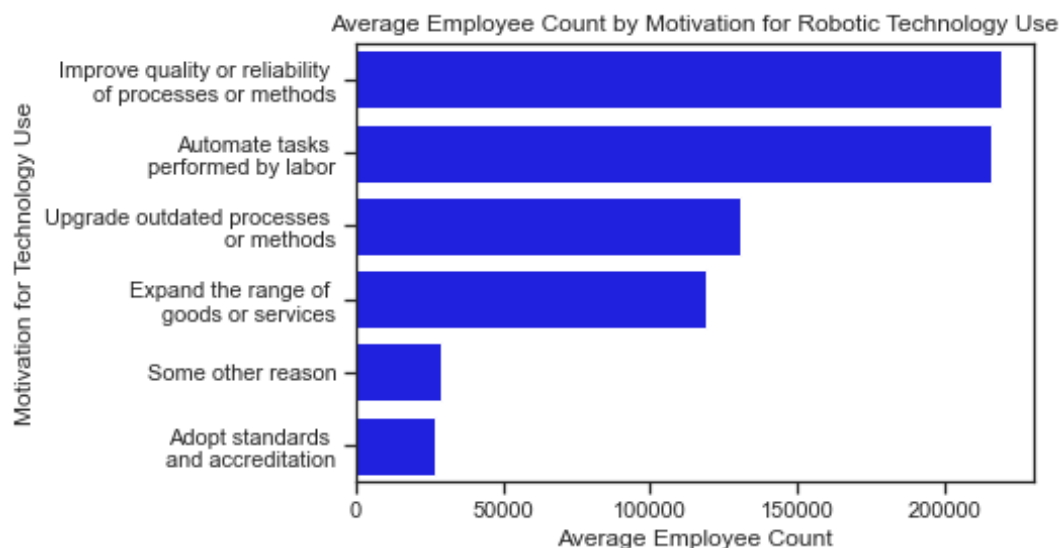
Jared's Analysis:

I wanted to examine how robotics and AI technology were related to the employee count of firms. Specifically, what was the average employee count for firms dealing with certain technological problems, and what was the average employee count for firms with certain motivations for using the technology in question. For example, what was the average employee count for companies that wanted to automate tasks performed by labor?

Factor Adversely Affecting AI Production vs Average Employee Count

Factor Adversely Affecting Robotic Technology Production and Average Employee Count

In both figures above, notice that firms that found the technology too expensive - both for AI and for robotic technology – had the most employees, on average, compared to the firms that had

other problems, on average. I personally would have expected that companies dealing with such costs would have fewer employees, but perhaps the concepts of each technology are different across firms. The census data does not define what technology is considered AI or robotics, so perhaps companies that were larger were more ambitious with their projects. The same can be said for the "technology was not mature" category. Therefore, more research may need to be done where the definitions of artificial intelligence and robotic technology are segmented or at least clarified. It's interesting to note that firms struggling with the laws and regulations, and lacked access to required data, were smaller, on average. This makes sense, as regulations may be easier to overcome as a larger firm; there may be exemptions for larger firms, and those firms may also simply have the money to pay off any fines to continue their work.

Average Employee Count by Motivation for Robotic Technology Use

Average Employee Count by Motivation for AI Technology Use

For both robotic technology and AI, automating tasks performed by labor was a motivation for firms with many employees on average. Large companies would love to lower their costs of

human capital, so automating processes through robots and AI would solve that problem, and larger companies would have more opportunities to do so. The same holds regarding upgrading outdated processes or methods and improving the quality or reliability of processes or methods. It's interesting that companies desiring to expand the range of goods or services tend to be middle-of-the-pack in terms of average employee count. Perhaps these companies are larger startups; it's possible that larger companies simply don't need to get involved with AI and robotic technology because they already have the goods and services they desire, or the cost of adapting robotic technology and AI would be too high for the benefits they would receive. I'm curious regarding what kinds of standards and accreditations could be met by robotic technology or AI, so there may be some more research needed. Regardless, it appears that companies that have the desire to meet accreditation or standards through AI or robotic technology are smaller than the other firms surveyed, which is intriguing.

Jared's Conclusion:

Ultimately, my data has shown that firms of different sizes have different problems with respect to different pieces of technology, and the automation push is a real phenomenon in larger companies as well. Unfortunately, the definitions of AI and robots in the census data is not clear enough to understand the data very well. Hopefully, future research can be more thorough.

Mikhaela's Analysis:

After our group decided to focus on how technology impacts a firm, I wanted to specifically look at the use of technology and how it may impact the average person at a firm. I am particularly interested in the average worker's view of technology in the workplace and after conducting a bit of online research, found an indication of negative outlooks, especially relating to job retention (McClure, 2018). In his paper first published in 2017, McClure found that around 37% of his research participants expressed having anxiety-related mental health issues and feared unemployment and financial insecurity with the increase of technology in the workplace. My idea was to see if there was any validity to the fear that the increase of technology would ultimately cause a lack of employment.

Given the data from the US Census Annual Business Survey: Technology Characteristics of Businesses from 2019 I was able to narrow down the data to the extent of technology use in the 'TECHUSE' column and how it related to the number of employees in the 'EMP' column. I narrowed it down further to the use of robotics specifically to look at how physical implementations of technology performing labor were impacting workers. Once I had the technology data narrowed down, I wanted to provide support to my hypothesis by providing data on each state and its corresponding population.

In these first 2 graphs, you will see the states with the highest amount of listed employees at a firm compared to the states with the lowest amount of listed employees:
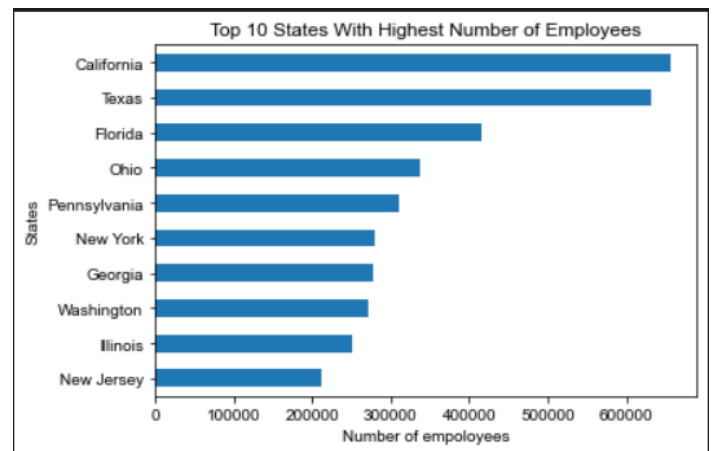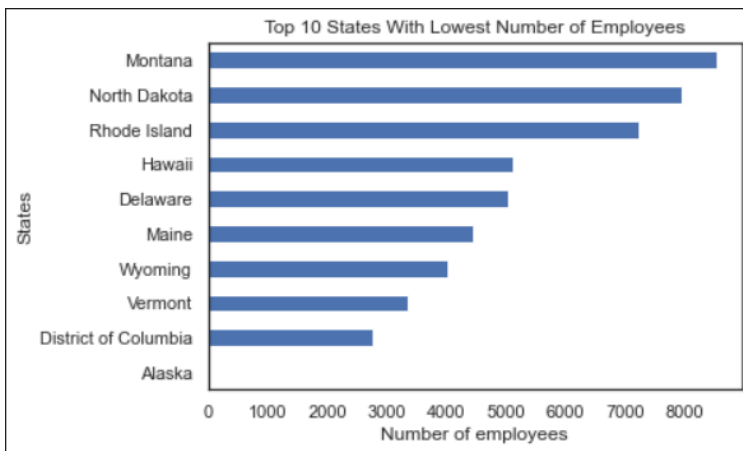

In my next view of the data, I wanted to see if there would possibly be a shown correlation between the average number of employees at a firm and the level of robotics use. Because there wasn't a number range associated with the amount of robotics use at a firm, I determined that a scatter plot would not be able to display the data in a form that I found useful. Because of this, I decided to show the data in a bar graph that graphed the average number of employees in conjunction with the level of robotics use. My hypothesis was that with the increase of the use of robotics at a firm, there would be less employees compared to a low use of robotics. Please find the graph containing the described data on the next page:

Average Number of Employees by use of Robotics Tech
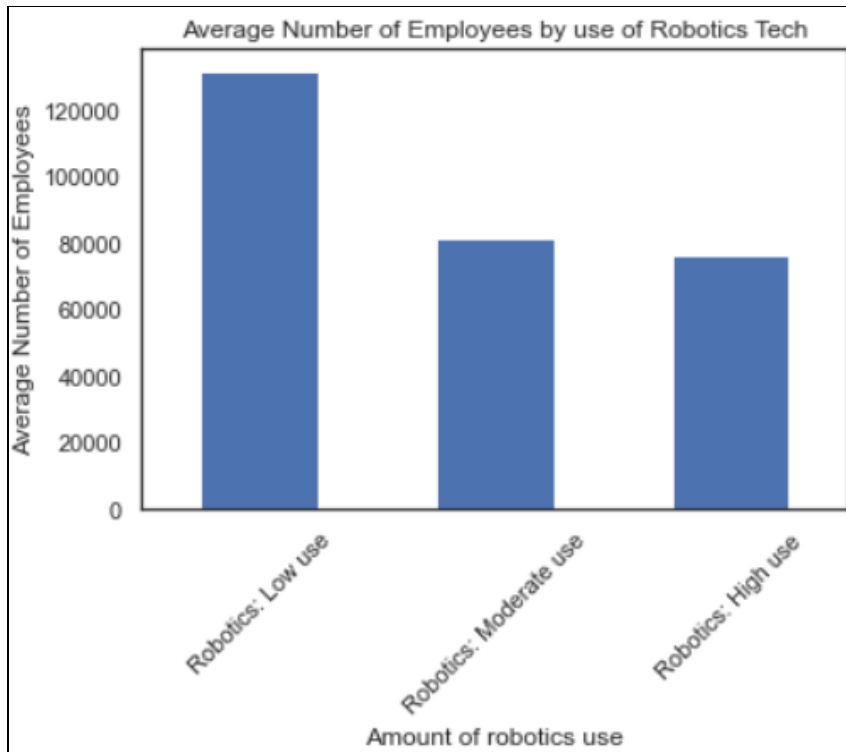
Upon looking at the graph, you will find that my original hypothesis of what the graph would look like was correct. The average number of employees at a firm is higher at firms with a lower use of robotics and the number of employees is lower when there is a higher use of robotics.

However, I will say that because I only calculated the average number of employees at a firm in relation to the level of robotics use, that we may not be looking at the full story and that ultimately, more data is needed to determine whether the participants in McClure's original survey have valid anxieties. You will see in my next 2 graphs how the data shows that the analysis is not as clear cut as this graph may lead you to believe.

In the next 2 graphs on the following page, I wanted to show how robotics use at a firm affects the number of employees in regards to each stat so that was can see if there is any correlation between the states with the highest number of listed employees and lowest number of listed employees and the increased use of robotics in firms. You may expect to see the states with the highest number of listed employees showing that the highest number is directly correlated to a low use of robotics at a firm and the lowest number of employees will imply a high use of robotics. However, as you will see, this is not always the case:

Top 10 States With Lowest Number of Employees and Robotics Use
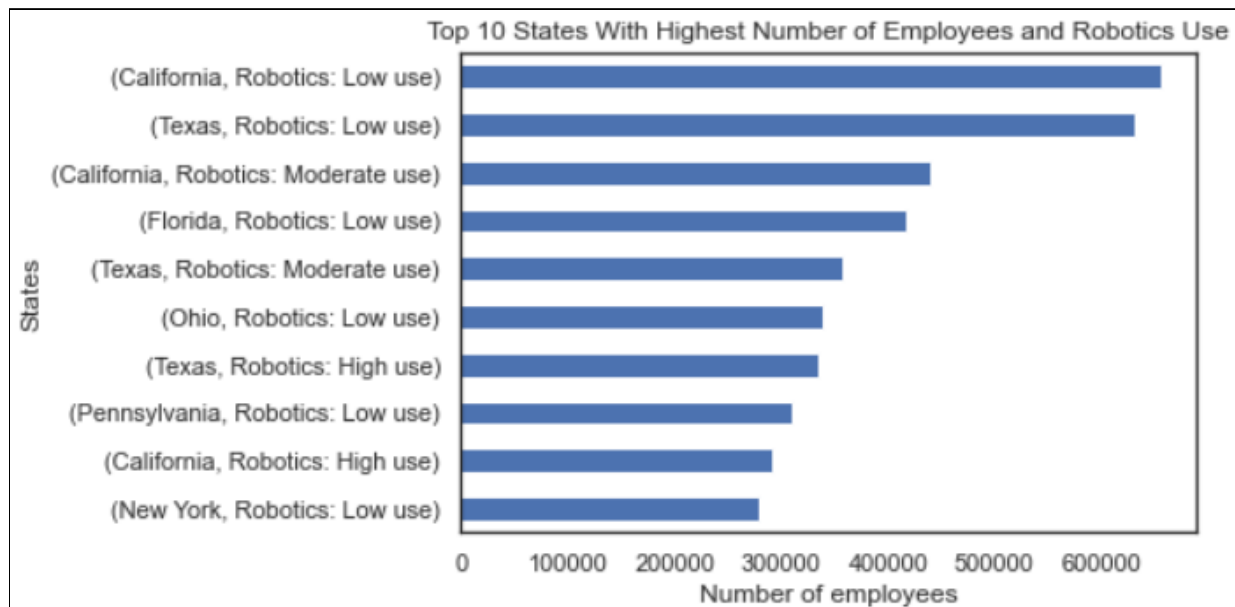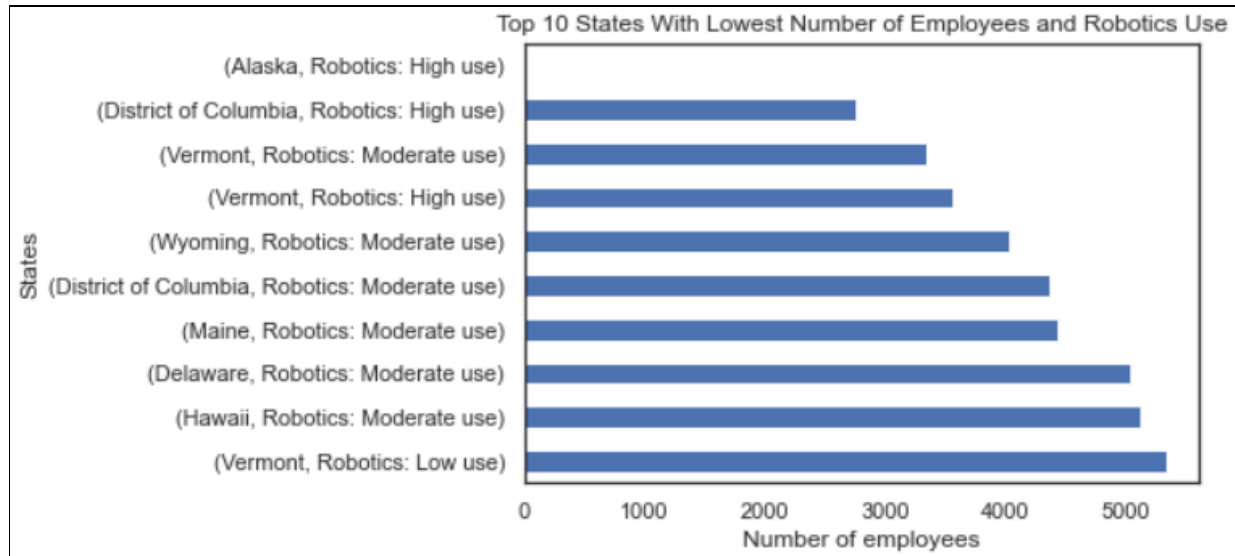
As you can see from the graphs, the data shows that there may be some correlation between states with a larger amount of employees and a lower use of robotics and vice versa, but there are some instances that are contrary to that conclusion. One these contrary instances include a firm in Texas having a large amount of listed employees but also a high use of robotics as well. This may indicate that there are other factors at play in determining the number of employees at a firm other than just the level of robotics use at that firm. That could include firm profits, the type of industry and whether robotics usage would have an impact on production, or even the state population. Texas and California are the top 2 states with the highest populations in the United States, in that regard, you may expect the industries in those states to employ more people.

Ultimately, my data has shown that there is a higher possibility that the increase of the use of robotics at a firm may decrease the number of employees at that firm, but that more data is needed to come to a more concrete conclusion.

Charlie's Analysis:

Keeping on the theme of robotics and artificial intelligence, I decided to look at how many firms are adopting the use of AI and robotics technologies, the impact these technologies had on the workers and how many firms are selling these technologies and creating new job opportunities. Looking at how these variables interact will give us a better idea of how robotics and AI is affecting the job industry as whole and what trends we might expect moving forward.

Starting with what factors may have adversely affected a firm's adoption of robotics and AI technologies, we see that in most cases the technology is either not applicable to a firm's operations or the technology was integrated without much friction. The companies that have had issues implementing these technologies are doing so mostly because it's too expensive to implement and not because of a lack of efficacy. As this technology develops, it'll most likely become cheaper, meaning even less of a barrier to entry for companies looking to implement it.

Because robotics and AI are becoming more and more prevalent among businesses in the United States, it would be interesting to look at how it's affecting the workers. Looking at the bar plot below we see that, of the companies where this technology is implemented, the number of workers employed by a given firm is not affected by AI and robotics. Of the different worker types, production workers seem to be the most affected. However, this is only at a fraction of the firms with many more claiming no loss of production workers

Knowing how this technology can affect other fields, one would be curious if what we lose in other fields we are gaining in the robotics and AI market. Are jobs in other industries being replaced by jobs developing the technologies replacing them? It would seem like it's not looking at the chart below. Firms profiting off of robotics and AI technologies make up a small number of the total firms in the United States. The exact number of employees is covered in a separate part of this analysis so I won't touch on that but robotics and AI sales in the United States is only done by a handful of firms in the United States.

AI and robotics are changing the way firms are operating in the United States which is affecting the workers as a result.

Conclusion: Many firms are readily adopting artificial intelligence and robotics, and the ones that are have seen an overall decrease in the number of workers and money paid to workers. However, firms that are selling technology account for a small part of the total amount of money paid out to workers.

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Discussion/Conclusion: - insert your conclusions here and I will format them into a paragraph

Overall, our analysis on the effect of technology on the work-force could be valuable in assisting to understand the impact it has had while the push for increasing technology doesn't relent. Beginning on the broad spectrum of a firm, we have found that Many firms are readily adopting artificial intelligence and robotics. The effect this has had on the employees shows that there is a higher possibility that the increase of the use of robotics at a firm may decrease the number of employees at that firm. For the firms that have adopted artificial intelligence and robotics, they have seen an overall decrease in the money paid to workers. However, firms that are selling technology account for a small part of the total amount of money paid out to workers.

Once a firm has adopted the technology, the issues they experience after may be dependent on the size of the firm. Ultimately, we have found that firms of different sizes have different problems with respect to different pieces of technology, and the automation push is a real phenomenon in larger companies as well.

Though we feel confident in our conclusions of the data, we are also confident that further research is necessary to solidify our conclusions. Unfortunately, the definitions of AI and robots in the census data is not clear enough to understand the data very well. Hopefully, future research can be more thorough.

Data Sources:

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