MapMagnet: Your Interactive Job Search Companion

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As online job boards gain in popularity, they face the increasingly difficult problem of effectively allowing their job seekers find relevant postings based on their preferences. The more active postings searching for applicants, the more exploration and searching that the job seeker must do to find desirable positions. Leveraging interactive visualization techniques, we form a project proposal that will allow job seekers to quickly explore job board data to find open positions that fit their preferences. We also propose a method of visualization for analytic techniques of textual and historical data to help job seekers better prepare themselves for changing requirements and skills in their chosen career path. The project will focus on proper and effective visualization of the location, relevant skills and requirements, salary, and number of hiring jobs in a chosen field. For this project, the Federal Employment job board USAJOBS will be used.

CCS Concepts: • **Human-centered computing** → **Visualization systems and tools**.

Additional Key Words and Phrases: Jobs, Visualization, Interactive

1 INTRODUCTION

With over 2.1 million employees (about the population of New Mexico), the United States Federal Government is the nation's largest employer [10]. More than 1,200 jobs are being posted every day on USAJOBS, which acts as the central hub for all federal government job postings as the U.S. Office of Personnel Management works to hire qualified workers for each position [4]. However, without proper data visualization techniques, the USAJOBS website can make it difficult for aspiring employees to ingest all relevant data about open job positions that fit their preferences without having to use multiple searches and memorization of job specifics. In this project, we will use the USAJOBS Application Programming Interface (API) to visualize data about employment opportunities in the United States Federal Government to allow fast, interactive exploration for job searchers, allowing them to quickly find and prepare for relevant available positions based on location, career field and salary.

The rest of this proposal will be approached in the following phases. First, we will discuss the data mining and preprocessing phase of the project, where the data is cleaned and made ready to use in our visualization. The next phase will focus on the visualization itself, along with subsections dedicated to each aspect of the visualization to allow for more in-depth explanation of how we propose building a unique exploratory tool for the data.

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2 LITERATURE REVIEW AND STATE OF THE ART

Since our project is like a Google Maps for jobs, plus a word cloud linked to the data, we looked for visualizations that joined geographical and text data. Lei *et al.* [9] present an interactive layout for this task, where they use Mapbox for displaying the map, plus some panels that contain charts and keywords that also work as filters, and box for searching text, too, in order to refine the geographical search of a term. However, this is a desktop application that is based on training data on demand, which might make the tool, while powerful, too slow. However, it gave us an idea of how to display the graphs along with a map. Since we do not want to cover the map, we decided to put them beside the map, and not over it.

An interesting way of displaying the word cloud would be using topic analysis [8]. This would make the filtering by keyword much easier, since it would not only show the most popular words, but also group them by topics, so it is even more useful for the user. This is only a feature we would like to add to MapMagnet, but it also needs training on demand and might present a challenge to display it programatically. Thus, for now, it will not be added to our scope for now, but it might be added if the development schedule leaves us room for it.

Other tools, such as Apartments.com [1], a webpage for buying and renting real estate, have a similar idea of our own. It shows multiple filters on the top side for location, number of beds, type, price, lifestyle, move-in date and some more filters, the listings on the right side with a sorting feature, and the map with marks showing where each listing is located and that, when hovered on, they show a popout with the location, number of beds and price of the place, and when clicked, the listing is shown on the side list. However, it does not have any graphs for price or number of listing trends.

The GIS Jobs Clearinghouse, a website for finding jobs in the GIS business, has its own map [5], but it has no filters, just a list of job offers to the right and a map that has marks that, when clicked, show the job title and description of the position. Finally, Job-Mapper.com [7] is a website that lets users filter by multiple keywords, country, city and distance, and a map with marks with numbers that represent the number of jobs in the area and, when zoomed in, the marks are separated to show, in detail, where the job offer is located. If a mark is clicked, and it has a number, the map will automatically zoom in and show the area with the specific locations, and if a single mark is clicked, a popout will display the job title, description, location and a link to the job offer on indeed.com.

3 DATA PREPROCESSING

Perhaps the most time consuming and difficult phase of this project will be the data gathering and preprocessing. USAJOBS has two API ends for querying data; the first (/api/search) is used for searching for active job postings, or career opportunities that are currently open for accepting applications and will be called the Search API. The second (/api/historicjoa) is used for querying job postings that have been either closed or canceled, or as the name suggests, historic job posting data and will be called the Historic API. The differences between these two APIs extend further than whether the data is historical or not.

The Search API is structured to return the data at a more granular level and includes features that are not included in the Historic API. Some of these features include job description data and exact geolocation of the job posting. As a result, not all features in the Search API can be studied using time-series data but can only be explored by looking at the current, active job postings in the Search API.

Using the Search API and the Historic API, data will be gathered about current and historical job postings and then saved in a JSON file for use in visualization. Because of the data structure, the data will be systematically queried from the APIs by hiring department to avoid duplication of job postings.

All the data will be saved into a PostgreSQL database for the text processing, so we can add a word cloud, which we will use for filtering. After the data is retrieved, we will remove non-alphabetic characters and stopwords, and apply lematization on the job descriptions using the NLTK Python library [2]. Then, we will index the resulting words in a database, where each word will be associated with the corresponding jobs. The data will be retrieved from the database by the web tool using an API. Both the web tool and the API will be built using the Django framework [6]. All the graphs will be displayed using D3.js [3].

4 VISUALIZATION LAYOUT AND DESIGN

The visualization will be laid out in the same fashion as Figure 1 and is built up of the numbered components which will be explained in-depth in their respective sections below.

- Interactive Filters
- Geographic Map
- Word Cloud
- Job Openings Trend
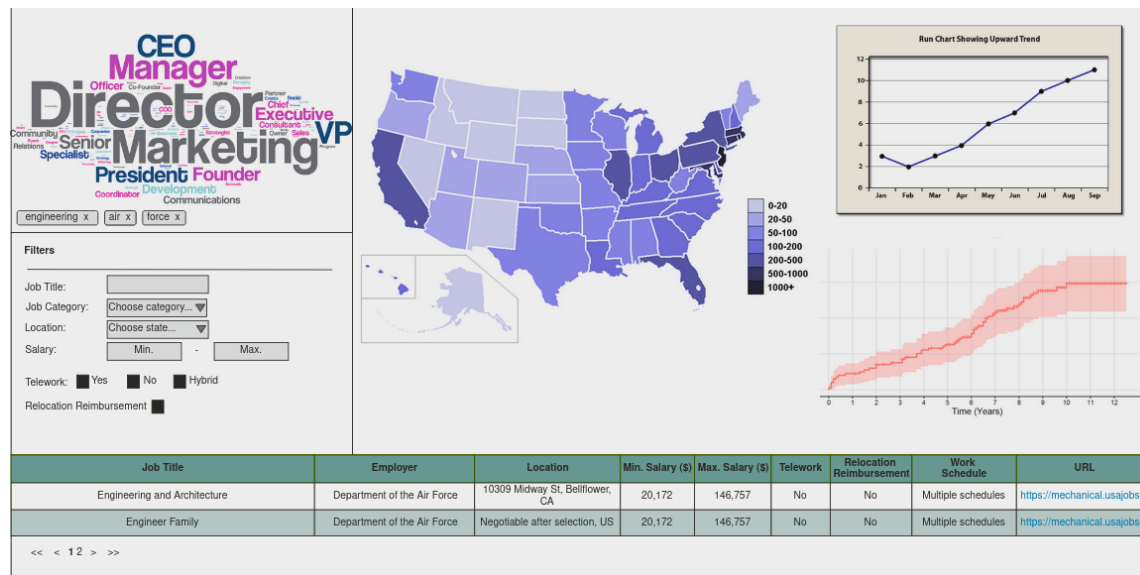- Salary Trend
- Data Table

Fig. 1. A sample image of the full view. It has a word cloud and a filter panel to the left, the choropleth in the center, and two trend charts to the right: a job count line chart (top) and a salary area+line chart(bottom) with minimum, maximum and mean salary. At the bottom of the image there is a table showing the filtered records of the search.

4.1 Interactive Filters

Filters will be associated with the visualizations to allow exploration of various preferences related to job postings. Such filters will include the following features: job title, hiring department name, location, job category, minimum/maximum grade, minimum/maximum salary, pay scale, salary type, security clearance, telework, relocation reimbursement, and work schedule.
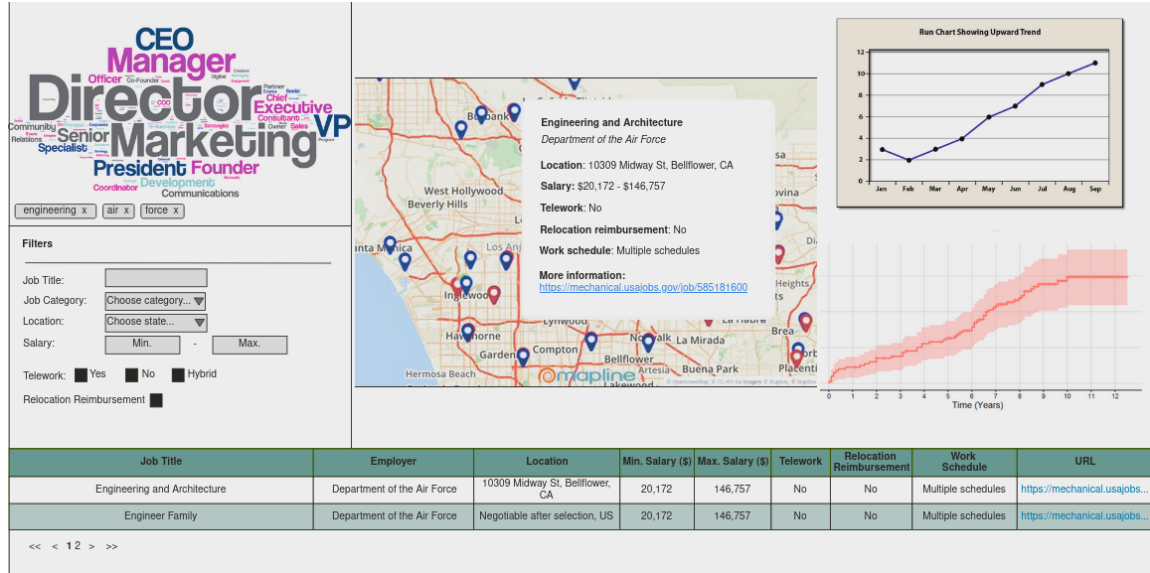
4.2 Geographic Map

Fig. 2. A sample image of the full view. It has a word cloud and a filter panel to the left, a city map with the marks and a popout showing the detailed information of a selected job, and two trend charts to the right: a job count line chart (top) and a salary area+line chart(bottom) with minimum, maximum and mean salary. At the bottom of the image there is a table showing the filtered records of the search.

One of the main features of the dataset that will be focused on in this project is the location of the hiring position. This information helps the potential employees see where the hiring job is located and decide how far they would need to relocate if accepted. Seekers may be interested in exploring how many relevant open opportunities are within their state, city, or within a specific mile radius of their current location.

To help job seekers visually explore the USAJOBS location data, a geographic, choropleth map will be utilized to show the number of open positions per state. Upon selecting a specific state, the map will transition to a drilled down version of the chosen state and show a proportional symbol map with the symbols shown for each city within the state. Upon selection of the specific city of interest, the map will once again zoom in and show a symbol map representing the exact geolocation of the hiring position. A tooltip will be utilized to show relevant features when hovering over the geolocation of the job position to allow for exploration of specific job titles, minimum/maximum salary, security clearance, relocation reimbursement, telework opportunity, travel requirements, hiring department, hiring agency, and work schedule and link to the USAJOBS webpage to apply. Figure 2 shows an example of this detailed view.

4.3 Word Cloud

To help aspiring federal employees prepare themselves to successfully apply, interview, and get hired, a textual analysis and visualization of job descriptions from the Search API will be shown in the form of a text cloud. The job descriptions will be analyzed to find the most common skills or requirements asked for in the job descriptions. The most asked for skills will be shown in larger text while the less common are in smaller text. The visualization will also be filtered by location based on the map selections. This will show the most required or in demand skills by location. Filtering by their preferences using the other interactive filters, job seekers will find the most relevant skills and requirements to prepare for an eventual government career. Upon selecting one of the words shown in the word cloud, the visualization will be filtered to show only the jobs whose descriptions contain that word.

There is a risk in attempting this sort of analysis using the postings from USAJOBS. There is a possibility that the technical, legal jargon of federal job postings may make analysis of jobs for the relevant skills more difficult. As a result, the textual analysis of the data will involve removing irrelevant words that are in the job description. This will be done by generating a list of common irrelevant words that will be removed from the job description to isolate only the skills and requirements. Another risk is that some postings have a link to the employer's website instead of putting the description along with the offer.

4.4 Job Openings Trend

With the Historic API, data can be extracted to visualize trends over time in the job postings of the federal government. As such, a trend line will be shown tracking the number of open job postings based on the selected interactive filters. This will allow job seekers to track historic trends and plan accordingly to give themselves the best chance of starting their federal career.

4.5 Salary Trend

In addition to the trend line showing the overall trend in the number of open jobs, a trend will also be made for following the minimum, maximum, and mean salary for the jobs over the same amount of time as an area+line chart. This trend will allow potential job applicants to see whether or not they can expect the salary for their career field to increase or decrease over time. It will also allow potential applicants to see what positions and fields are the best compensated so they may plan their career paths accordingly.

4.6 Data Table

A data table will be included to help job seekers quickly see all relevant information for making a decision about whether or not to apply for a job. The table will dynamically filter allow for interactive sorting by any column. Features will include job title, hiring department, location, min salary, max salary, paygrade, pay scale, telework, relocation reimbursement, work schedule, and the URL to the webpage for the job posting.

5 SCHEDULE

- `10/30 to 11/05`: Data retrieval and preprocessing.
- `11/06 to 11/12`: Create the website. Create the choropleth and word cloud.
- `11/13 to 19/11`: Create the other charts and the data table. Create the API.
- `11/20 to 11/26`: Add the filtering capabilities.

- 11/26 to 12/04: Fine-tuning.

6 CONCLUSION

With access to so much detailed data about job postings, many possible visualizations can be made to help explore and filter the data. In this project we will focus on the three mentioned above, but tweaks may occur to make the visualizations easier to understand and explore. Upon completion, this project will allow for easier exploration and identification of available career opportunities in the United States Federal Government. Future work could include using job posting data from not only USAJOBS but other popular online job board services as well to help job seekers explore jobs in the private sector.

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