Navigating Salaries and Rent Across Cities

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Abstract— **Our project aimed to develop an interactive circular map that effectively compares the cost of living, specifically rent prices, to the median software developer salaries across various cities in the United States. Utilizing data from the U.S. Bureau of Labor Statistics for salary information and Zillow's research data for rent prices, our objective was to allow users, particularly students and job seekers, to make informed decisions on their careers based on optimal salary-to-cost-of-living ratios.**

I. INTRODUCTION

Software developers have dynamic career opportunities in numerous cities around the United States. As geographical factors are important in a person's career decision, we thought of a tool to help software developers make life-changing decisions. Realizing the complex nature of the decision, our project aimed to address the fundamental question: how can individuals make informed decisions about where to work and live, considering the complex relationship between software engineering salaries and the cost of living across various cities in the United States?

So, our objective was to develop an interactive map that juxtaposes software engineering salaries with rent prices, enabling users to assess the financial landscape of different cities. We achieved such by leveraging data from reputable sources such as the U.S. Bureau of Labor Statistics and Zillow and delivering a reliable and user-friendly tool that represents such data with clarity and simplicity.

Our mission will be a valuable resource for those navigating the complex landscape of careers, rent, and geography. In the following pages, we provide our objectives, motivations, and outcomes of the project.

II. MOTIVATION

The motivation for our project lies in the realization that the job market and cost of living are hard to grasp. By incorporating advanced comparative features and visual modeling into our tool, we aim to address the complex nature of these factors. Acknowledging that future prediction models can introduce complexities and uncertainties, our focus is on delivering a reliable tool that aids users in making informed decisions based on existing salary and rent dynamics. By concentrating on the present, we aim to provide a straightforward and dependable resource that aligns with users' immediate needs, ensuring clarity and simplicity in their decision-making process.

III. OBJECTIVE

With the steadily increasing rent prices across the United States, it can be difficult to decide if moving to a new city for a software developer role is worth it based on the offered salary. The objective of this project is to analyze the rent prices and software developer salaries across various cities within the United States. To accomplish this, we decided to create a map of the United States, displaying various cities with their average rent prices and median software developer salaries. We aim to provide an interactive, accessible way for individuals to evaluate the ratio between salaries and rent prices to get a better estimate of how much of their potential salary will go toward rent. Alongside this, we want to provide a feature that allows users to quantitatively compare two cities. Having this tool will enable users to make more informed decisions about potential relocation for software developer roles.

IV. DATA

For the rent prices, we decided to use the Zillow Observed Rent Index dataset for all metro and U.S. geographical areas. This provided us with a substantial amount of rent data from 2015 to 2023 for all cities across the country. As for the salary data, we decided on the U.S. Bureau of Labor Statistics occupational employment and wage statistics datasets for software developers in multiple geographic areas. This dataset gave us access to various measurements for software developers in all cities across the country. It includes measurements such as annual median wage, annual wage percentiles, and employment per 1,000 jobs.

To begin processing the data, we first read in each dataset and extracted each of them into their own data frames, creating consistent city and state formatting. This was done because the U.S. Bureau of Labor Statistics dataset contained unconventional city names that combined multiple cities into one. For example, "Anniston-Oxford-Jacksonville, AL". To fix this, we simply kept the first city name and the state name. Having this consistent format then allowed us to combine the datasets into one singular data frame containing all salary and rent data for each city in the United States. Next, we found that while the Zillow dataset provided rental data up to September 2023, the U.S. Bureau of Labor Statistics dataset only provided salary information for software developers up to May 2022. Since this was the case, in the combined dataset we only included rental data for May 2022. After combining these data frames, we then had to clean the resulting one by dropping all NaN values and "-" values. Doing this allowed us to have a complete dataset containing only the locations

with complete rent and salary data. We then wrote this combined, clean dataset into a new CSV file for later use.

Fig. 1. Integrations implemented

The data itself was integrated into the application in various ways. On our interactive map, we display points for each of the cities that we have data for. Each of these points has a varying size and color, dependent on the ratio calculated between the rent price and annual median salary for software developers in that city. Higher ratios indicate that a larger percentage of the annual median salary will be spent on rent. The higher the ratio, the larger the city marker is on the map. Alongside this, when two cities are selected on the map to compare, we display the annual median salary, the average rent, and the calculated ratio for each city. We also display various graphs, one of which displays a boxplot for each city and its annual wage percentiles. We also created a line chart, comparing the overall trend of rent prices for each of the two cities. The line chart also includes the rent trend for the entire United States, providing more context as to how the two cities compare to the overall trend. These integrations, found in Figure 1, allow users to truly compare the differences between two cities and assist in making a more concise decision when it comes to potentially moving for a new opportunity.
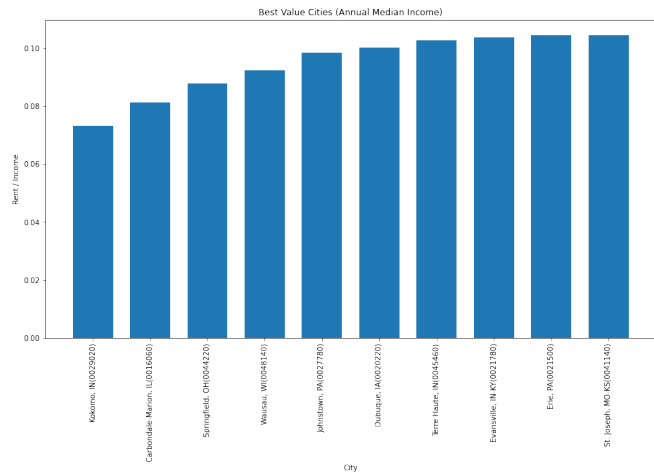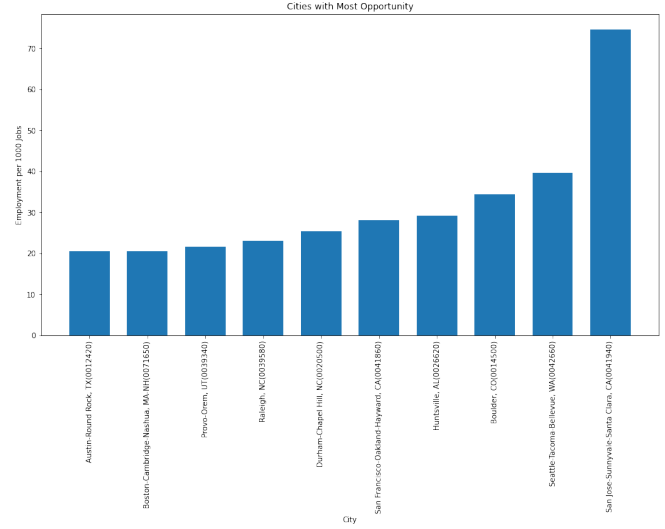

Fig. 2. Best value cities.
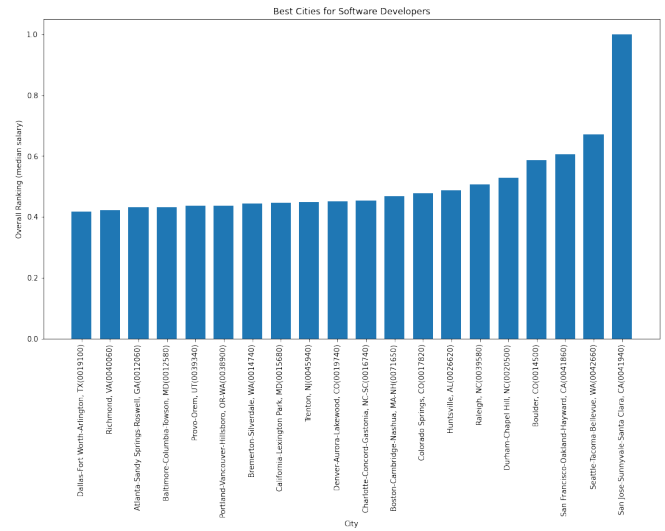

Fig. 3. Cities with most opportunity.

Fig. 4. Best cities for software developers.

V. MODELS & ALGORITHMS

The core functionality of our application revolves around providing users with valuable insights into the disposable income of software developers across different cities. While initially, we focused on rent as a percentage of total income, we later moved on to disposable income, finding it to be a better metric of value for a city in this application. To calculate disposable income, we employed a comprehensive approach that considered various factors beyond gross salaries. The formula used is as follows: Disposable income = Median Yearly Income - (Monthly Rent * 12)

We also measured a city's amount of opportunities through the rate of employment per 1,000 jobs. With these two measurements for each city, we normalized the values based on the max of each city as follows:

Disposable Income Score = Disposable Income / max(Disposable Income) Job Opportunity Score = Employ-

Fig. 5. Linear regression of Rent price vs. Annual median wage.

ment per 1,000 jobs / max(Employment per 1,000 jobs)

Then for each city we averaged these two scores for their overall ranking out of the 319 cities analyzed. A weighted average may be used to assign appropriate significance to each component based on user preferences. The resulting overall score offers a holistic measure of the overall desirability of a city for software developers from a financial standpoint.

Overall Score = (Disposable Income Score + Job Opportunity Score)/2

VI. RESULTS

As demonstrated by Figure 6, our map application successfully compared rent and software developer salaries across a diverse set of 319 cities in the United States, providing users with a comprehensive view of the financial landscape for professionals in the tech industry. The larger, brighter dots represent cities where users should expect to pay more for rent out of their income, while the smaller, darker dots are where rent is a smaller percentage of overall income. It is clear that the coastal cities have much higher rent-to-income ratios compared to areas like the Midwest. Users can click two cities to compare their values with more graphical visualizations. The app will track the two most recent cities the user has clicked by simply cycling the cities in and out of selection, akin to a queue (FIFO). With the data integrations listed in section IV (also seen in Figure 1), we provide some financial context for the user. The wage percentiles show the user what most software developers make in the area, along with the upper and lower fence of what a beginner software developer is likely to make and what a more experienced software developer is likely to make. In our data integration that has a time series graph of rent prices (Figure 7) for both selected cities and the average across the United States, we give the user some broader context on both the historical trend for rent prices and how those trends compare to other cities. For example, you can see in Figure 7 that rent had dropped During COVID in New York City because the city became less desirable to live in due to remote work. You can also see that Knoxville rent prices have surged much more quickly than the average rent across the United States, which may encourage the user to investigate why rent prices are rising so quickly before moving to the area. The visual

representation of rent value along with our data integrations provide holistic information on cities a user may want to move to.
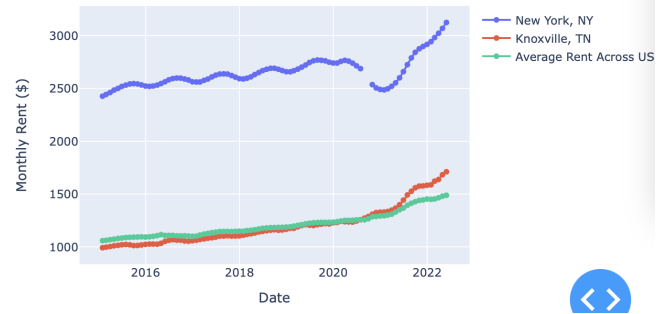

Fig. 6. Time Series Graph of New York City and Knoxville

Utilizing the methods described in section five, we also gave each city an overall rank for value. We have identified the top 20 cities that represent the best value for software developers based on disposable income and rent pricing. These cities not only boast competitive software developer salaries but also provide a cost of living that allows software developers to walk away with higher disposable incomes. The top 20 cities, listed below, reflect a diverse range of locations across the United States:

1	San Jose, CA
2	Seattle, WA
3	San Francisco, CA
4	Boulder, CO
5	Durham, NC
6	Raleigh, NC
7	Huntsville, AL
8	Colorado Springs, CO
9	Boston, MA
10	Charlotte, NC
11	Denver, CO
12	Trenton, NJ
13	California, MD
14	Bremerton, WA
15	Portland, OR
16	Provo, UT
17	Baltimore, MD
18	Atlanta, GA
19	Richmond, VA
20	Dallas, TX

1 San Jose, CA; 2 Seattle, WA; 3 San Francisco, CA; 4 Boulder, CO; 5 Durham, NC; 6 Raleigh, NC; 7 Huntsville, AL; 8 Colorado Springs, CO; 9 Boston, MA; 10 Charlotte, NC; 11 Denver, CO; 12 Trenton, NJ; 13 California, MD; 14 Bremerton, WA; 15 Portland, OR; 16 Provo, UT; 17 Baltimore, MD; 18 Atlanta, GA; 19 Richmond, VA; 20 Dallas, TX

The West Coast comfortably dominates the top spots despite their incredibly high rent prices. The salaries offered
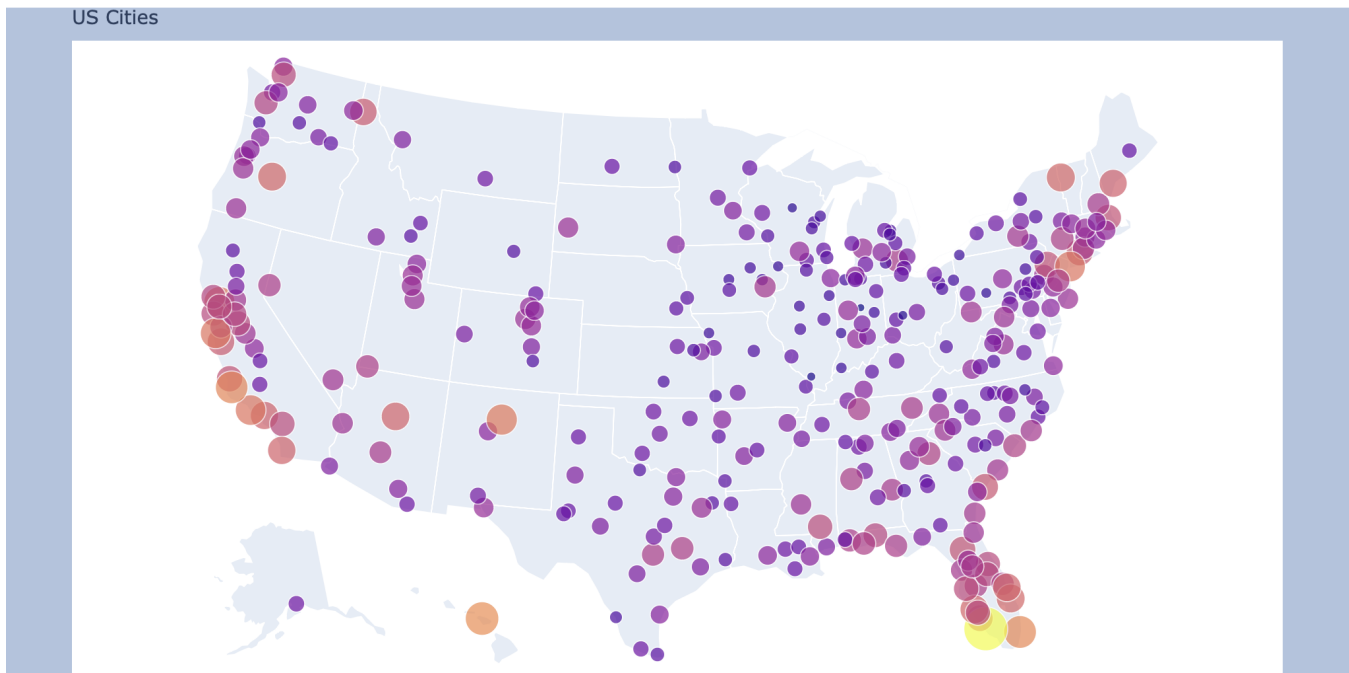
Fig. 7. Map

here for software developers is so high that the disposable income calculated is still the highest in the US. Some emerging, southeast tech cities like Huntsville, Raleigh, and Durham are also attractive destinations for their relatively high salaries and lower cost of living. They could make great locations for those seeking strong career opportunities and affordability. This list covers a multitude of regions across the US, which highlights the diverse opportunities available to software developers. This diversity allows professionals in the field to consider factors such as climate, lifestyle, and cultural amenities comfortably when making relocation decisions.

VII. Future Work

While our application successfully provided users with valuable insights into the value a software developer can expect when compared to rent in various cities, there are several areas where future work could expand the utility and accuracy of this application. One critical aspect for future development is the use of more timely and robust data sources. Our wage data was limited to one month, and our rent data was sourced exclusively from Zillow, which caused some cities to have spotty data. Regularly updating these sources would keep data current and reflective of the dynamic nature of the job and housing markets. The tool could also be expanded to be more reflective of the true value of a city by including more aspects of the cost of living, including, but not limited to, food, transportation, and taxes. Future development could also include wages beyond the median in both directions. By limiting the application to the median salary, our analysis could potentially exclude both newcomers to the industry and highly experienced developers alike, making it a less useful application for them. Lastly, the

tool could be expanded to include users who are not software developers at all. By adding data regarding a multitude of occupations, users across many industries could make use of this application or even those deciding on which industry to enter. Overall, the future development of our application should focus on refining existing features and incorporating additional data points to create a more comprehensive and accurate tool for users seeking insights into the cost of living compared to their occupation's compensation.

VIII. Org Chart

1) Jacob Armiger – Created the Dash Map Application utilizing the cleaned data.
2) Zac Perry – Retrieving data from BLS & Zillow. Implemented additional analysis features on the Dash Map Application.
3) Justin Bower – Statistically analyzed the value of Salary vs Rent between locations.
4) Dong Jun Woun – Cleaned the data collected from BLS & Zillow utilizing regular expressions and Panda functions. Collaboratively wrote the final report.

References

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[2] "Occupational Employment Statistics," data.bls.gov. https://data.bls.gov/oes/#/occGeo/One%20occupation%20for %20multiple%20geographical%20areas