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Unveiling Data Science Salary Trends (2021-2023) for Sustainability: A Comprehensive Analysis of Work Experience, Job Titles, and Company Location

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Abstract. *Sustainability refers to the ability to maintain balance and continuity over the long term, whether in the environment, in the economy, or society, so one of the highest-paid professions in the world is data science because this profession is concerned with providing companies with tools and systems with a machine learning system, such as the grade estimation system for universities and the system for extracting thousands of pieces of data to make decisions. Data science salaries vary across different fields and depend on factors such as skills, programming experience, and certifications held. In recent years, experts have considered the job of data scientists to be the most attractive. However, people with data science experience seem to be rare. This study aims to highlight data science salary trends for the years 2021–2023 for Sustainability. Focusing on various aspects of employment, including work experience, job titles, and company locations, this data set provides valuable insights into salary distributions within the industry. The research is based on a dataset taken from the open-source 'Kaggle' and an online survey of various sites. This study showed that the level of salaries for data analysts has increased significantly in 2023. People with the highest salaries are experienced professionals who make the most money. The study also showed that salaries in US dollars are the highest, with experienced contractors earning 416,000.*

Keywords: *Data Science, Salary, Job titles, Company locations, Visualization*

1. INTRODUCTION

Salary constitutes the most crucial component of labor remuneration and serves as an indispensable facet of an organization's strategic approach for humans to respond to incentives, such as salary, when offered the right incentives. With over one mil-lion job postings on employment websites, it's difficult to choose a job that offers significant pay for the talent one has. Many new employees are unaware of which jobs provide the best earnings and end up choosing less-paid jobs [1].

Nowadays, a primary factor in an employee's decision to change companies is their salary. Employees frequently switch companies in pursuit of their desired salary, resulting in a loss for the company. To address this issue, we have devised a solu-tion: What if companies or organizations could provide employees with their desired or expected salary? In today's competitive world, individuals have

increasingly high expectations and goals. However, it is not feasible to randomly grant each individual their desired salary. Instead, a system should be implemented to assess an employ-ee's competence about their expected salary [2].

Data science provides a multitude of exciting and profitable job opportunities. The indispensability of data scientists has grown significantly due to the exponential surge in data and its escalating significance in various industries. Data scientists employ their proficiency in statistical analysis, machine learning, and programming to gather, refine, and scrutinize extensive datasets, thereby uncovering compelling patterns and trends [3]. Models, algorithms, and predictive analytics are generated and utilized to enhance the pace of corporate expansion, streamline procedures, and enhance the process of reaching conclusions. Data analysts, data engineers, machine learning engineers, and data scientists are all occupational designations linked to the field of data science. These professionals address a variety of obstacles that encom-pass the examination of customer behaviour, the identification of fraudulent activi-ties, the evaluation of potential risks, and the provision of customised recommenda-tions. They operate in various sectors, including marketing, technology, finance and healthcare [4].

With the escalating need for proficient data science professionals, embarking on a career in this do-main presents substantial possibilities for advancement, novelty, and influence. In light of the copious amounts of data being generated in today's society, enterprises heavily rely on it to propel progress. The large amounts of un-structured data housed in cloud storage require processing and preparation before they can be used effectively by various industries. Over the past decade, data-driven technology has revolutionised our daily lives and commercial enterprises. Data sci-ence aims to extract concealed potential and value from data, making it an indispen-sable element across all levels of business. The unquenchable thirst for data analysis guarantees a place for data scientists within enterprises [5].

The objective of data visualisation is to construct a precise and reliable framework that possesses the ability to objectively discern the remunerations of data science. This mechanism seeks to provide valuable perceptions grounded in data scrutiny, thereby conferring advantages on both individuals seeking employment and employ-ers engaged in data science. Study contributions.

- Visualize data and provide explanations about the correlation between at-tributes.
- Data-Driven Observations: Offer individuals seeking employment valuable observations concerning the anticipated range of remuneration predicated on their credentials, expertise, and geographical situation. This data will be-stow on these individuals the ability to make judicious decisions about em-ployment propositions, engage effectively engage in salary negotiations, and strategize their occupational development.
- Employer Salary Benchmarking: involves aiding employers in assessing their salary offerings about prevailing industry norms. By scrutinizing mar-ket patterns and juxtaposing remuneration for analogous roles, employers can guarantee competitive compensation packages that entice and retain proficient data science.
- Know the average salary according to level of experience, and the top 10 job titles strong earning potential in the data science field.
- The highest and lowest average salary by currency, and the highest and lowest average salaries according to companies in the world.
- The most important job titles and highest salaries in data science. Know the average salary according to the company’s location and company size.

The rest of this paper is organized as follows: Section 2 presents the Literature Re-view; Section 3 discusses our research questions and Method and Section 4 presents the result and Discussion. Finally, Section 5 Conclusions.

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2. LITERATURE REVIEW

2.1. Data Science Field and Job Titles

Job Titles In the field of data science, the domain is broad, with various job titles related to data collection, man-agement, analytics, machine learning data, and more. This requires a wide variety of job titles or positions to perform each niche function. Building an analytics dashboard on salary will require a full picture of the domain of employment of data science and hence will need you to be aware of the job titles and specialized skill areas associated with it. Table 1 puts together the data from different reliable sources and provides the top 10 job titles in data science that are in demand.

Table 1. Top 10 most currently demanded data science jobs

NO.	Job Title	Description
1	Applied Scientist	A scientist, proficient in scientific knowledge and technical expertise, applies his skills to address practical issues. Their scope of work may encompass various subjects, including the creation of novel products or procedures as well as the advancement of innovative technologies. Using the scientific method, they formulate research inquiries and subsequently undertake studies that yield practical resolutions [6].
2	Data Quality Analyst	The data quality analyst (DQA) role emerged in organizations due to substandard data entering data warehouses. DQAs review data to ensure accuracy, recommend maintenance improvements, and provide recommendations to operational support teams. They also review the historical and referential integrity of data, contributing to overall quality assurance in the warehouse environment. This role ensures that data meet organizational informational requirements and meets the organisation's informational requirements [7].
3	Compliance Data Analyst	A compliance data analyst is a professional who uses data analysis to ensure a company adheres to industry laws and regulations. They work in various fields like finance, healthcare, insurance, and technology, conducting thorough research on regulations, assessing compliance, revising policies, communicating guidelines effectively, producing comprehensive reports, cultivating positive relationships with regulatory personnel, and ensuring high-quality service. They use various tools and software, often with a bachelor's degree and industry certifications. They also maintain positive relationships with regulatory personnel [8].
4	Machine Learning Engineer	The designation of this position is akin to that of a scientist specializing in machine learning, albeit with a decreased focus on technical proficiency. The primary duty entails the utilization of machine learning algorithms for predictive purposes, encompassing the evaluation of various models' performance as opposed to the creation of novel algorithms from scratch [9].
5	Data Engineer	The role is responsible for designing, building and maintain the data pipeline. As a telemetry service, its main role is to ensure the seamless and efficient flow of data across the system. In addition, the data engineer is responsible for monitoring the entire pipeline ecosystem to ensure its optimization and readiness for use by both data scientists and data analysts [9].
6	Data Analyst	The role of a data analyst bears similarities to that of a data scientist, although it diverges in the aspect that it predominantly concerns itself with employing pre-existing algorithms instead of actively participating in research endeavors. Broadly speaking, the responsibilities encompassed by this occupation encompass all aspects of data administration, which involve the collection, manipulation, and presentation of data in order to transform it into meaningful and advantageous insights for commercial purposes [10].
7	Autonomous	Systems test technicians engage in a variety of testing and inspection duties. They are

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	Vehicle Technician	employed in numerous environments, such as manufacturing, electronics, and scientific research. They conduct tests and validate equipment and equipment, as well as individual components and parts. In addition, their responsibilities encompass the testing and evaluation of the systems and programmes involved in these procedures. They bear the responsibility of inspecting, calibrating, and confirming the functionality of the testing tools and equipment employed for these purposes. They perform troubleshooting and supervise the process of requesting or executing any necessary modifications. They generate meticulous technical reports and other records pertaining to testing [11].
8	Applied Machine Learning Scientist	An Applied Machine Learning Scientist designs and develops machine learning systems, implements algorithms, conducts experiments, and monitors advancements. They work with data to generate models, conduct statistical analysis, and optimize performance. Their goal is to create efficient self-learning applications and contribute to artificial intelligence progress. They design and execute tests, select appropriate datasets, conduct statistical analysis, and address issues. To become an Applied Machine Learning Scientist, one needs a bachelor's degree, proficiency in statistics, programming, and data science [12].
9	AI Programmer	An AI programmer develops software specialised in artificial intelligence applications across various industries. They collaborate with professionals in machine learning, data engineering, and data science to create solutions, tailor programs to clients' needs, maintain existing programs, assess performance, and ensure quality standards. They also engage in research and stay updated on AI advancements [13].
10	AI Developer	An AI developer is a skilled professional who designs, develops, and implements AI solutions to improve organisational operations. They handle large data sets and use machine learning to create accurate models. They collaborate with data scientists and technical teams, possess strong communication, problem solving, and continuous learning skills [14].

During previous decades, the Internet has progressively emerged as the primary source for job inquir-ies, consequently leading to an increase in the prevalence of job advertisements on the Web. These assemblages of job postings have become significant assets for investigating the specific qualifications and the overall indus-try perception of various job roles [15], [16]. As shown in Figure 1, three skills were applied: R, Python, and SQL.

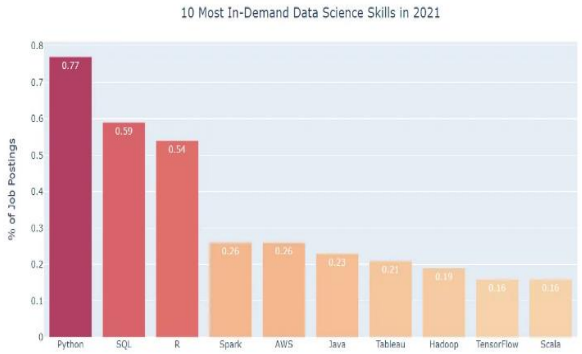

Fig. 1. The Most Essential Skills of Data Science in 2021 [6].

Looking at the fastest growing skills by%, from 2019–2021 (in Figure 2), gives further evidence for the dramatic growth in demand for cloud infrastructure. AWS showed the most explosive growth and has a commanding lead, while its closest competitor, Google Cloud Platform, also made the list, but at lower levels of growth. Additionally, there were some notable developments with respect to machine learning or deep learning frameworks like PyTorch, Scikit-learn, TensorFlow, which did not exist in the previous

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analysis. There are also noticeable trends in programming languages; Python has declined over the last 2 years in terms of lead. SQL surprisingly became the second most wanted language with a significant growth compared to Python the most wanted focused programming language. This means if one performs the same analysis in 2022 it is likely that SQL will outperform Python.

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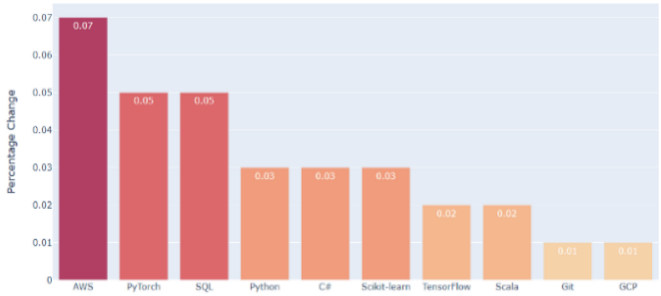

Fig. 2. Most Growing Data Science Skills from 2019 to 2021 [6].

A second study showed that for an individual working in the field of data science, it is noteworthy to observe that a shared expertise across all job categories is the Python programming language. This is in contrast to the language R, which appears less frequently, indicating that Python is more widely utilized for data-related positions in the industry.as soon as in Figure 3.

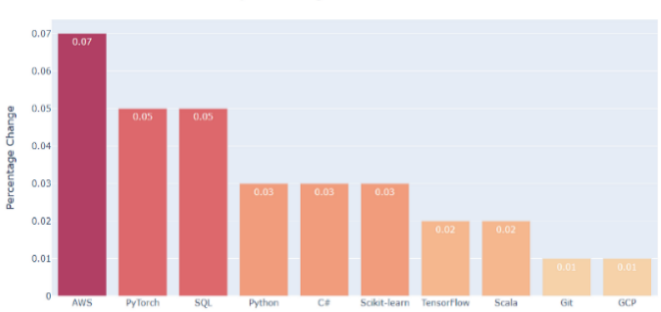

Fig. 3. Temporal insights of data science skills [17]

In Figure 3, we can observe a comparison that depicts the prominence of different programming languages during this specific time period. notably, Python is identi-fied as the most prevalent language, followed by r and java. This suggests that Py-thon not only holds a dominant position currently, but also indicates a growing de-mand for this language in the future, as evidenced by the trend and the noticeable gap between Python and other languages [17].

2.2. DATA SCIENCE AND MARKET ANALYSIS

The field of data science holds a distinctive position within the realm of information technology occupations because of its unique characteristics. Primarily, data scien-tists are expected to possess a broad array of skills, often stemming from diverse backgrounds and being sought after by various sectors. Additionally, this field is characterized by its rapid pace of advancement, with new tools and technologies being introduced on a daily basis. Consequently, it is logical for scholars to delve deep-er into this domain, as the resulting insights can contribute to a better under-standing of the field.

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In a scholarly article published in 2017, authored by IBM researcher Steven Miller, the authors ex-pounded on the disruptive nature of data science within the labour market. Through an analysis of job market advertisements encompassing all catego-ries of data science positions in 2015, the authors scrutinised both the required skill-sets and the sectors involved in recruiting for such positions [18]. The growth rate of skills was also subjected to analysis, and consequently, the projected number of jobs for the forthcoming years was determined. As previously stated, this information possesses the potential to provide guidance to educational institutions in the en-hancement of their data science curriculum. Manieri et al. adopted a similar ap-proach when they conducted an ex-amination of the necessary skills based on a cor-pus of 2500 job advertisements in the field of data science in 2015. To reduce the dimensions of their data, principal component analysis was employed, leading to the identification of programming skills, big data skills, database knowledge, and ma-chine learning as the primary components derived from the data science job market. Additionally, research-ers endeavored to create a semi-automatic service that would analyze and identify the gaps in the demand and supply of skills by combining the available courses and job advertisements in the field of data science [19].

3. METHOD

The goal of the data set is to explain the trend in salary in the field of data science between 2020 and 2023. This data set focusses on various aspects of employment, including employment experience, occupations, and location, and provides useful information on wage distribution in the industry. To achieve the desired objectives, we define a set of research questions as follows:

- RQ1: What changes occurred in salaries from 2020 to 2023?
- RQ2: What is the trend in salaries over time depending on the size of the company?
- RQ3: What is the average salary by Experience Level?
- RQ4: What is the Average Salary by Employment Type?
- RQ5: What is the Average Salary by Job Title (Top 10)?
- RQ6: What is the average salary by Currency?
- RQ7: What are the average data science salaries by Location?
- RQ8: What is the average salary by Company Size?
- RQ9: What is the Salary Distribution for Data Science Professionals?
- RQ10: What is the job title recommendation?
- RQ11: What is the Average Salary by Experience Level and Employment Type?
- RQ12: What is the average salary by Company Location and Company Size?
- RQ13: What is the Count Plot for Experience Level, Employment Type, Salary currency, and Company size

4. RESULTS

In this section, we explain the results of the Data Science Salary Trends (2021-2023) for the Sustainability study and provide answers to the research questions based on the results we obtained by visualizing and analysing the data using Python libraries. Before starting to answer the research questions, we will explain how data visualization works and its importance in analysis. The following steps show the answers.

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4.1. WORK ON DATA

Data Collection, we got a dataset comprising pertinent details encompassing Data Science profiles, their credentials, professional background, expertise, educational history, geographical location, and salary figures. This data set should include additional variables that could potentially affect salary levels, encompassing factors such as organisational magnitude, industry, and prevailing market tendencies. Data Preprocessing: The first step in the data analysis process involves purifying and prepping the gathered data to ensure precision and uniformity. This task can include the elimination of dupli-cates, the management of absent values, the establishment of standardised data formats, and the conversion of categorical variables into numerical representations. Visualize data and provide explanations about the correlation between attributes. Language used: Python, Framework: Jupiter Notebook (platform: Anaconda), Visualization tools:) Matplotlib, warnings, and seaborn.

4.2. EXPLORATORY DATA ANALYSIS (EDA)

EDA is generally employed to examine the extent to which information can be revealed beyond the formal modeling or speculation verification process, thereby providing a more comprehensive perspective on variables within the dataset and their interrelationships. In addition, it can help determine the suitability of the statistical techniques used for data science. EDA techniques are widely employed in the contemporary data discovery process.

The primary objective of exploratory data science (EDA) is to facilitate the examination of information before reaching any conclusions. It aids in the identification of evident errors and enhances the understanding of patterns within the data. Furthermore, it enables the detection of anomalies and the discovery of intriguing relationships among the data variables. data scientists employ exploratory analysis to ensure the accuracy and relevance of the outcomes they generate with their desired objectives.

Answer research questions.

RQ1: What changes occurred in salaries from 2020 to 2023?

We found an answer in Figure 4 by visualising the data..

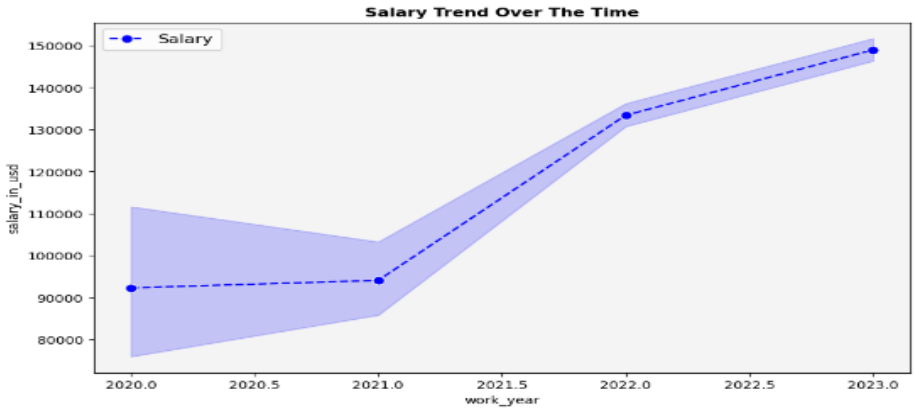

Fig. 4. Data Science Salary Trends (2020-2023).

When you see the chart, there was not much change in salary from 2020 to 2021, while continuous changes occurred in salary from 2021 to 2022, Follow this progress in salary from 2022 to 2023 followed a similar pattern.

RQ2: What is the trend in salaries over time depending on the size of the company?

We found an answer in Figure 5 by visualizing the data.

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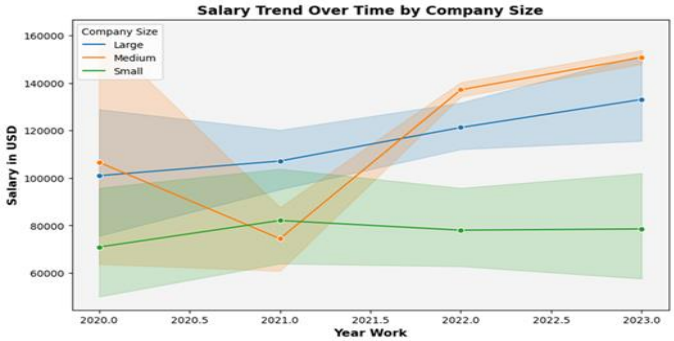

Fig. 5. Salaries over time depending on the size of the company.

The graph shows the Salary Trend Over Time by Company Size. The salary trend in medium-sized companies is increasing compared to small and large companies. The salary line in large companies does not fluctuate as much as in medium-sized companies.

RQ3: What is the Average Salary by Experience Level?

We found an answer in Figure 6 by visualizing the data.

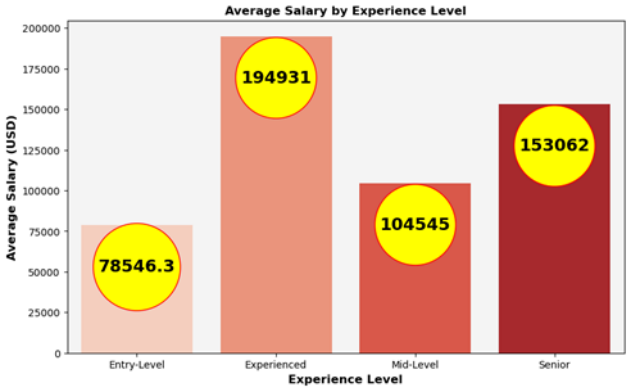

Fig. 6. Average Salary by Experience Level.

The graph shows the average salary by experience level. The salary Experienced professionals earn the highest average salary at approximately 194,931 USD. Seniors also receive a competitive average salary of about 153,062 USD. Mid-level employees have an average salary of around 104,545 USD. Entry-level positions offer a lower average salary, at approximately 78,546 USD.

RQ4: What is the Average Salary by Employment Type?

We found an answer in Figure 7 by visualising the data.

Fig. 7. Average Salary by Employment Type.

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The graph shows the average Salary by Employment Type. Full-time employees have the highest average salary at approximately 138,298 USD. while contractors also earn a competitive average salary of about 113,447 USD. Freelancers and part-time workers have lower average salaries, around 51,808 USD and 39,534 USD.

RQ5: What is the Average Salary by Job Title (Top 10)?

We found an answer in Figure 8 by visualising the data.

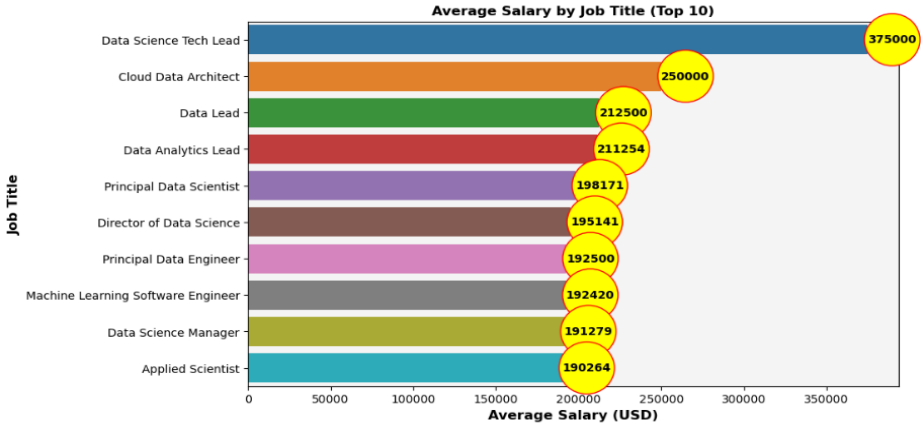

Fig. 8. Average Salary by Job Title (Top 10).

The graph shows Average Salary by Job Title (Top 10). Data Science Tech Lead has the highest average salary at 375,000 USD. while Cloud Data Architects and Data Leads also have notably high salaries. The top 10 job titles exhibit strong earning potential in the data science field.

RQ6: What is the Average Salary by Currency?

We found an answer in Figure 9 by visualising the data.

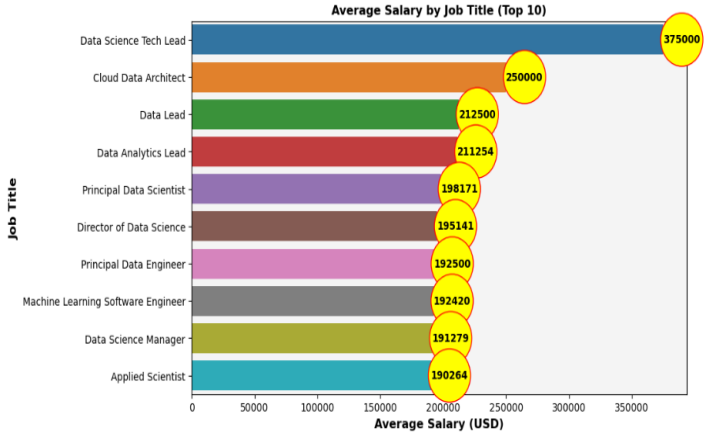

Fig. 9. Average Salary by Currency.

The graph shows Average Salary by Currency. Employees receiving salaries in USD have the highest average salary at approximately 149,351 USD. Salaries in ILS (Israeli Shekel) are notably high, with an average of 423,834 USD. while GBP (British Pound) and CHF (Swiss Franc) also offer competitive average salaries. Other currencies vary in average salaries, with AUD (Australian Dollar) and BRL (Brazilian Real) being among the lowest.

RQ7: What are the Average Data Science Salaries by Location?

We found an answer in Figure 10 by visualising the data.

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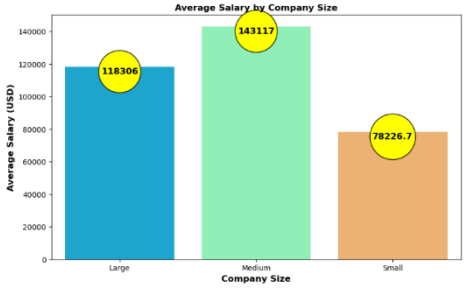

Fig.10. Data Science Average Salaries by Location.

The graph shows average data science salaries by location. In Illinois (IL), the average data science salary is notably high, at approximately 271,447 USD. Puerto Rico (PR) and the United States (US) also offer competitive average salaries, with approximately 167,500 USD and 151,801 USD, respectively. Russia (RU) and Canada (CA) have average data science salaries of around 140,333 USD and 131,918 USD, respectively. New Zealand (NZ), Bosnia and Herzegovina (BA), Ireland (IE), Japan (JP), and Sweden (SE) round out the top locations with varying average salaries.

RQ8: What is the Average Salary by Company Size?

We found an answer in Figure 11 by visualising the data.

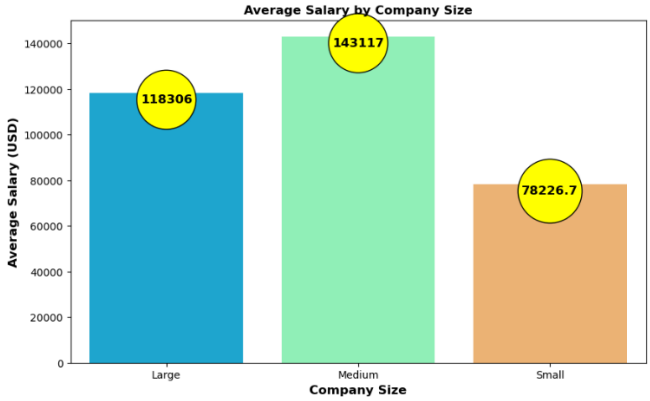

Fig. 11. Average Salary by Company Size.

The graph shows the Average Salary by Company Size Medium-sized companies offer the highest average salary at approximately 143,117 USD. The large companies followed with an average of about 118,306 USD. Small companies offer a lower average salary of around 78,227 USD.

RQ9: What is the Salary Distribution for Data Science Professionals?

We found an answer in Figure 12 by visualizing the data.

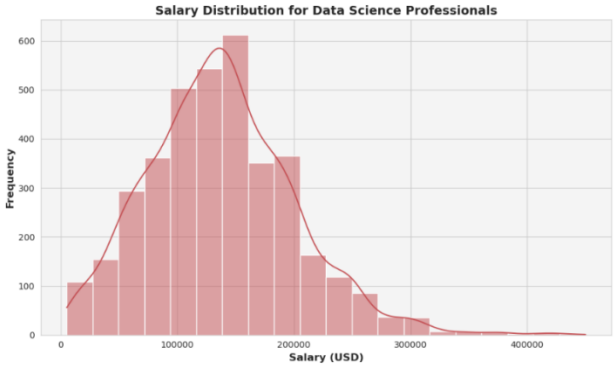

Fig. 12. Salary Distribution for Data Science Professionals.

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The graph shows the Salary Distribution for Data Science Professionals. The salary distribution for data science professionals is right-skewed, with a majority of professionals earning lower to mid-range salaries. A noticeable peak in the distribution suggests a concentration of professionals within a specific salary range. The KDE (Kernel Density Estimate) curve provides a smooth estimate of the distribution, showing a prominent peak.

RQ10: What is the Job Title Recommendation?

We found an answer in Figure 13 by visualizing the data.

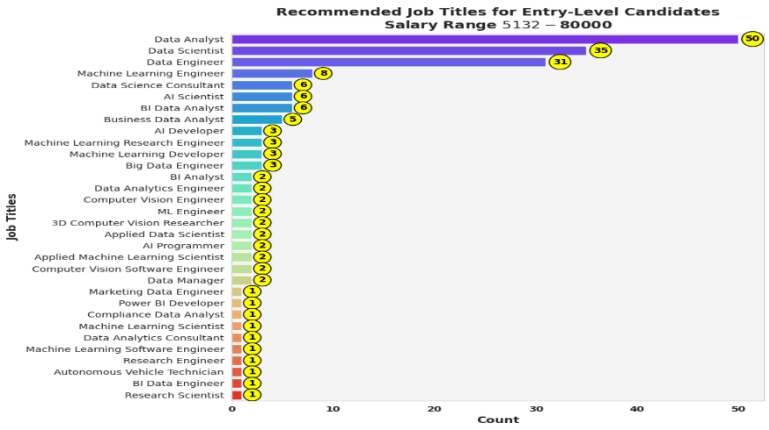

Fig. 13. Job Title Recommendation.

The graph shows The Job Title Recommendation: For Entry-Level candidates seeking a salary range between 5,132 USD and 80,000 USD, the top recommended job titles are Data analyst (50 job openings), data scientist (35 job openings), and data engineer (31 job openings).

RQ11: What is the Average Salary by Experience Level and Employment Type?

We found an answer in Figure 14 by visualizing the data.

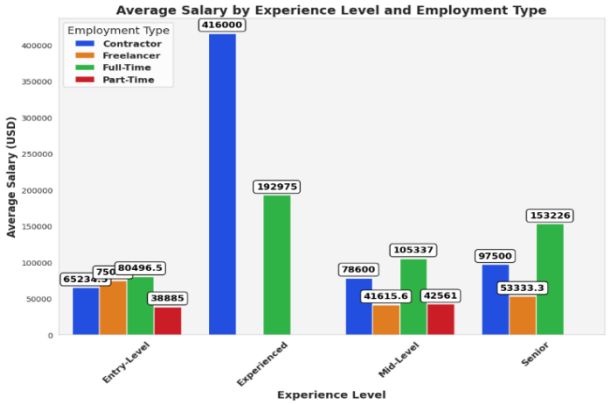

Fig. 14. Average Salary by Experience Level and Employment Type.

The graph shows The Average Salary by Experience Level and Employment Type. The Best Employment Type and Experience Level for Maximum Cost-Effectiveness Are Experienced Contractors, with an Average Salary of 416,000 USD.

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RQ12: What is the Average Salary by Company Location and Company Size?
We found an answer in Figure 15 by visualizing the data.

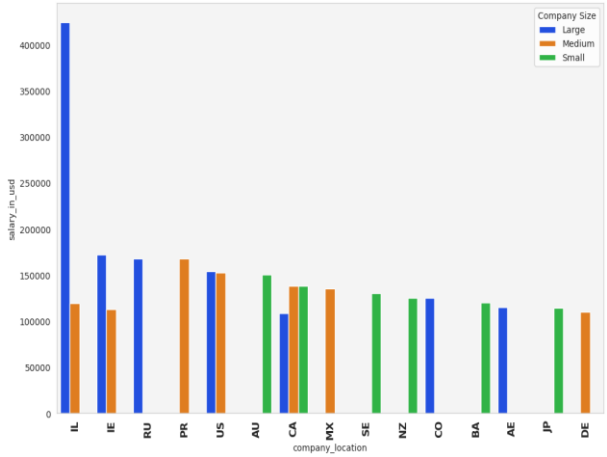

Fig. 15. Average Salary by Company Location and Company Size.

In Illinois (IL), large companies tend to offer an average salary of USD 423,834, meeting cost-effectiveness criteria.

RQ13: What is the Count Plot for Experience Level, Employment Type, Salary currency, and Company size?
We found an answer in Figure 16 by visualizing the data.

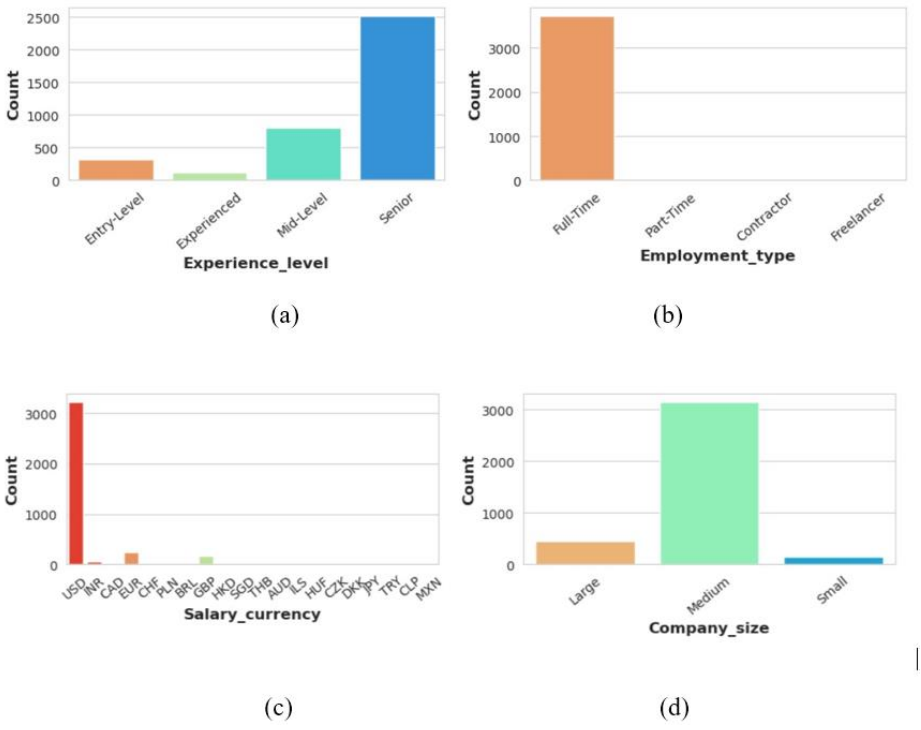

Fig. 16. Count Plot for Experience Level, Employment Type, Salary currency, and Company size.

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The graph shows the most common type of employment: ‘full time’ (3,724 counts). The majority of salaries are in USD (3229 counts). Most prevalent company size: "Medium" (3157 counts)."Medium" (3157 counts).

5. CONCLUSION

This study undertook a comprehensive examination through the review of thirteen research inquiries and the utilization of data visualization methods in Python. The investigation employed a dataset obtained from 'Kaggle,' along with data gathered via an online survey from different websites. The findings of the study yielded valuable insights, as detailed below. The current study can help direct the business sector, advance scientific understanding in the area, and offer useful cues to the government so that it can formulate wise legislation. These findings can help the industrial sector by enhancing recruiting and human resource management techniques, establishing market competitiveness and pay scales, directing hiring and training practices, and enhancing performance and sustainability. Furthermore, by providing fresh data and a more thorough examination of the variables affecting earnings and employment in the industrial sector, the current study can further scientifically understand in the domain.

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