

The Impacts of Data Science in Everyday Life

ABSTRACT

The field of data science has brought about a significant transformation in decision-making processes and our interaction with the digital realm. This paper investigates the profound impact of data science on our everyday lives, delving into its core principles, diverse applications across various domains, technical obstacles encountered, and the emergence of novel fields of study and employment opportunities. The paper highlights the crucial stages of data science, which play a vital role in facilitating informed decision-making. Furthermore, it explores how data science has positively influenced sectors across the whole spectrum of industries while simultaneously addressing the challenges posed by it. Moreover, it sheds light on the birth of data analytics and artificial intelligence as exciting areas of study that are shaping the future job market. Lastly, ethical concerns pertaining to privacy and algorithmic bias are examined, considering their tangible impact on individuals' daily lives.

Index Terms: data science—big data—data center—data analytics;—artificial intelligence—data privacy—

1 INTRODUCTION

Data science has emerged as a revolutionizing field that harnesses the power of data to drive decision-making across multiple fields and industries, as well as transforming our interaction with the digital world. This paper seeks to explore its impact on our daily lives and address crucial issues. To begin the fundamentals of data science will be explained, exploring as well its process from collection to interpretation, and its importance in informed decision making. It will be then examined how it is being implemented in various fields, such as medicine, transportation and security, improving the quality of life and providing innovative solutions. Data science faces nonetheless significant technical challenges, such as handling large volumes of data and ensuring its quality and integrity. This paper will also inquire in some innovative approaches that are being developed to overcome these challenges and how data science has given rise to new branches of study and work, such as data analytics and artificial intelligence, which are shaping the employment landscape and fostering innovation. Finally, ethical concerns will be addressed, such as privacy and algorithmic bias, and how they affect people's daily lives.

2 UNDERSTANDING DATA SCIENCE

Data science encompasses the multidisciplinary field that combines statistical analysis, machine learning, and computational techniques and processes to unlock insights and knowledge from data. This involves several interconnected stages, each building upon the previous one to deliver meaningful outcomes. Data science is composed by the processes of data collection, cleaning, preparation, analysis, modeling, and interpretation. Let's explore each of the stages that compose the journey of data science:

- **Data collection:** It all begins with gathering data from various sources, such as databases, sensors, social media, or web scraping. This diverse collection allows for a comprehensive

understanding of the subject under study and ensures a holistic view.

- **Data cleaning and preparation:** Raw data is often messy, with inconsistencies, missing values, and errors. Data scientists employ techniques to clean and preprocess the data, ensuring its quality, accuracy, and reliability for subsequent analysis.
- **Data analysis:** This stage involves exploring the data using statistical methods, visualizations, and machine learning algorithms. Through data exploration, patterns, correlations, and insights are discovered, providing a deeper understanding of the data and potential relationships.
- **Modeling and interpretation:** In this stage, data scientists build models and algorithms that encapsulate the patterns and relationships identified during analysis. These models allow for predictions, classifications, or recommendations based on the data, enabling a deeper understanding of complex phenomena.
- **Iterative process:** Data science is an iterative process, meaning that each stage informs the next, and insights gained from one iteration can lead to refining the entire process. Feedback loops and continuous refinement are critical to enhancing the accuracy and effectiveness of data science outcomes.

3 LEVERAGING DATA SCIENCE

In today's data-driven world, organizations across various industries have recognized the immense value of data science techniques in making informed decisions and gaining competitive advantages. By harnessing the power of data, these organizations can gain valuable insights and drive strategic initiatives. Data science enables organizations to gain a deeper understanding of their customers. Via the analysis of vast amounts of customer data, including demographics, purchase history, and online behavior, businesses can identify patterns and preferences. This insight allows them to personalize products, services, and marketing campaigns, resulting in enhanced customer satisfaction and loyalty. By analyzing operational data, such as supply chain processes, manufacturing metrics, or logistics data, businesses can identify bottlenecks, streamline workflows, enhance productivity, and reduce costs. Through data science, organizations can leverage historical data to predict future trends and behaviors. Companies employing techniques like regression analysis, time series forecasting, and predictive modeling, businesses can anticipate market demands, customer preferences, and potential risks. This foresight enables proactive decision-making and strategic planning. Product development and quality improvement is another area in which through analysis of customer feedback, user behavior data, and product usage metrics, businesses can uncover insights to enhance product features, usability, and overall user experience. These data-driven improvements help organizations stay ahead of the competition but also benefits the customers who get better value for their money.

However, the advances in this field not only benefit large companies, but also ordinary people all around the world in a wide variety of areas. Many significant advancements in healthcare have been achieved by leveraging large datasets and developing algorithms that

help medical professionals make more accurate diagnoses, predict disease outcomes, and personalize treatment plans. Machine learning algorithms, which are another result of advances in data science, can analyze medical records, genetic data, and clinical research to improve patient care and outcomes. Dr. Najat Khan Chief Data Science Officer and Global Head at the Janssen Pharmaceutical Companies of Johnson & Johnson talked in an interview about how pharmaceuticals are helping patients with this new technologies: "Imagine that a patient has a specific mutation of cancer for which there is a targeted therapy. However, currently, these mutations are not picked up in a routine way because they are new and therefore are not sequenced on a regular basis. But every patient gets their tumor biopsied, so what we have done is used data science to digitize those biopsy slides, and then we use machine learning model to predict what mutation a patient might have just from those images. The impact of that is to find diseases earlier in patients who could benefit from a targeted therapy and may otherwise have been missed." [5] The financial industry has too been revolutionized, enabling faster and more accurate risk assessments, fraud detection, and personalized financial advice. Via the analysis of transaction data and patterns, banks can detect suspicious activities and protect customers' financial assets. Data science techniques are also vital in cybersecurity to detect and prevent threats. By assessing network logs, user behavior patterns, and anomaly detection algorithms, governments, companies and people can identify potential security breaches and fraud attempts. This proactive approach strengthens cybersecurity measures and safeguards sensitive data from unauthorized access.

4 TECHNICAL CHALLENGES OF DATA SCIENCE

Looking back to the processes of data science it is possible to realize that as the size of the data to be used increases, multiple challenges arise. Analyzing massive datasets, commonly known as big data, presents a unique set of challenges due to the volume, velocity, variety, and veracity of the data. While big data offers immense potential for generating valuable insights, it also requires specialized approaches and technologies to overcome these challenges. First of all to generate big amounts of data, multiple types of hardware are required such as sensors, microprocessors and computers. Incrementing the amount of collection devices requires some considerable commitment and big investments that can limit the ability of most people and small companies to obtain the desired or needed results. After collecting the information, it is necessary to ensure the quality of the data used for the analysis. Data sets may contain errors, outliers or incomplete information, which can affect the accuracy of the models and the results obtained. To address this problem, multiple specialists are needed to select the data to be used and to filter out what is not relevant or may have a negative effects and to further streamline processes and eliminate repetitive tasks, data cleaning and preprocessing techniques are also being developed, including error detection and correction, imputation of missing values and identification of outliers.

Big data often exceeds the storage and computational capabilities of traditional systems. Managing and storing massive volumes of data requires scalable infrastructure, such as distributed file systems and cloud-based solutions. Similarly, processing and analyzing such vast amounts of data necessitate distributed computing frameworks,¹ like Hadoop or Apache Spark that can parallelize computations across clusters of machines. In addition to all these hardware and trained personnel requirements, it is necessary to build infrastructure to house all these systems, also known as data centers. Construction requirements include choosing a suitable site that meets security standards, access to reliable electrical

power services, access to high-speed communication networks and scalability for future expansion. It is also necessary to design a robust physical infrastructure that includes redundant power supply systems, efficient cooling systems for the computers that run day and night, and security systems to protect the equipment and stored data. According to an analysis by the UK-founded commercial real estate services company Lang LaSalle Incorporated "the average-powered base building (defined here as foundation, four walls and roof along with a transformer and common areas for security, loading dock, restrooms, corridors, etc. . .) of a data center facility typically ranges from \$125 US-dollars per ft² to upwards of \$200 per ft²." [2] On top of these costs, getting a data center ready to function with all IT capabilities can cost between "\$280 and \$350 US-dollars per ft²." [2] These costs can, of course, be much higher depending on the location of construction as well as power and availability requirements. To provide an example, when Facebook started constructing the Prineville Data Center in Oregon USA back in 2009 the company invested more than a billion US-dollars to construct the 1.25 million-square-foot (116,128m²) facility.

Data science involves extracting meaningful information from large volumes of data. Nevertheless, proper interpretation of the results can be challenging. Machine learning models and analysis techniques can generate complex results that require deep and expert understanding for interpretation. This is why multiple companies and governments are constantly looking for educated and skilled workers to help them get the right results. Another way data scientists are addressing this challenge is through the development of visualization methods and model explainability techniques that help understand and communicate results more effectively.

5 THE EMERGENCE OF NEW BRANCHES OF STUDY AND WORK

The rapid rise of data science has led to the emergence of new fields of study and has created exciting opportunities in the job market. As companies increasingly recognize the value of data-driven decision making, the demand for qualified data science professionals continues to grow.

5.1 Studies on data science

Educational institutions have responded to the demand for data science skills by introducing specialized programs and courses. These programs equip students with the necessary skills in statistics, mathematics, programming, machine learning and data analysis allowing them to acquire the knowledge and proficiency needed to excel in this evolving domain. Within data science there are several prominent career paths, some of which were born alongside this field and represent its foundations are:

- **Data scientist:** The data scientist is one of the most prominent roles in the field of data science. These professionals are responsible for collecting, cleaning, analyzing, and visualizing data to gain meaningful insights and make decisions based on it.
- **Data engineer:** Data engineers are specialists in designing, building and maintaining data infrastructures. They focus on developing systems and architectures for data storage, extraction and transformation, and ensuring data availability and quality.
- **Data analyst:** Data analysts focus on interpreting and analyzing data to identify meaningful trends, patterns and relationships.

¹ A distributed computing framework refers to a software framework that allows the coordination and utilization of multiple computers (also known as nodes) connected over a network to work collectively.

² 10.7ft² \approx 1m²

- **Data architect:** Data architects are responsible for designing and overseeing the technology infrastructure needed to manage large volumes of data. They work on the planning and design of databases, storage systems and data flows.

As the field evolves new opportunities and specialized roles emerge that adapt to the specific needs of certain domains and technological advances. These domain-specific roles require a deep understanding of both the data science techniques and the unique challenges and nuances of the respective fields. Some examples of these study branches are:

- **Machine learning engineer:** With the recent rise of artificial intelligence, machine learning has become a popular field of study all over the world. These engineers play a crucial role in developing and implementing models that can learn from data and make accurate predictions or automate processes.
- **Business analyst:** A business analyst the processes in a company and analyses industry trends and markets. Business analysts process enormous amounts of data in order to find opportunities to improve business revenue and growth.
- **Clinical data scientist:** These scientists unite healthcare training with computer science and statistics to actively collect, assimilate, analyze and predict patient diagnoses as well as medical industry trends.

5.2 labor demand in data science

After all the previous insights of how data science its being leveraged for a wide variety of purposes, it is easy to acknowledge that the demand for professionals in this area has witnessed significant growth and is expected to continue its upward trajectory in the coming years. According to Mckinsey & Company and the Synergy Research Group the global spending on the construction of data centers is forecast to reach \$49 billion US-dollars by 2030. [1]

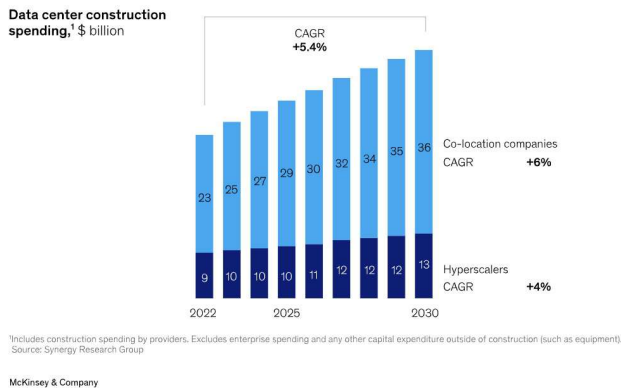


Figure 1: A visualization of the 2022–2030 forecast data of global spending on data centers. The image is from [1] and is in the public domain.

The increase of investments directly translates to an increase in the projected number of jobs not only for data science specialists, but also for construction workers, maintenance and IT support personnel who play a crucial role in building, upkeeping and upgrading data centers, ensuring the physical infrastructure is in optimal condition to house and protect data. Additionally, the US Bureau of Labor Statistics predicts that "data scientist jobs will experience an impressive 36 percent growth between 2021 and 2031 in the United

States, making it one of the fastest-growing occupations." [4] This growth can be attributed to the expanding adoption of data-driven strategies across industries and the need for professionals who can derive actionable insights from complex data sets, and since the demand for specialists keeps increasing workers can expect a median annual salary of a \$100 thousand US-dollars or even close to \$200 thousand at some senior positions with big companies. Furthermore, in the ranking of the 100 best jobs of the digital media company U.S. News & World Report, data scientist ranks 22nd, with other occupations related in some way to data science like software developer, information security analyst and market research analyst ranking 1st, 5th and 15th respectively. [3]

6 ARTIFICIAL INTELLIGENCE

7 ETHICAL ISSUES

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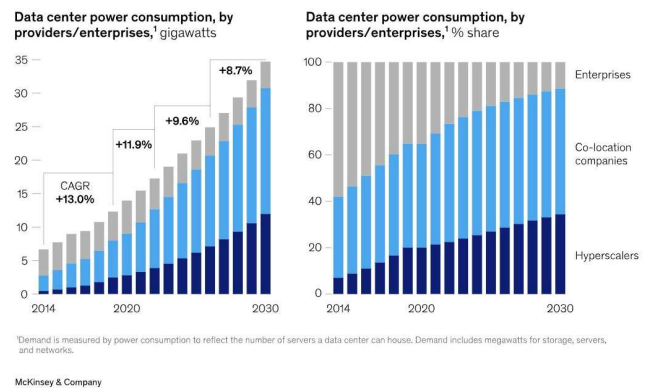


Figure 2: A visualization of the 2014–2030 forecast data of US data center demand. The image is from [1] and is in the public domain.

8 CONCLUSION

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³Footnotes appear at the bottom of the column.

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