Technoarete Transactions on Advances in Data Science and Analytics
Vol-1, Issue-2, August 2022
e-ISSN: 2583-2956

To examine the application of data science to physics

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Abstract

Data science is an interdisciplinary field that uses statistical, mathematical, and computational techniques to analyse large datasets and draw meaningful insights. It has been applied to a wide range of topics in science and engineering, including physics. In physics, data science is used to analyse large datasets generated from experiments and simulations. This allows researchers to gain insight into physical phenomena, such as the behaviour of particles, forces, and fields. Data science techniques can also be used to develop models that can be used to predict future events and outcomes. In addition, data science can be used to visualize physical phenomena, such as the structure of the universe or the evolution of stars. Data science is an important tool for physicists, as it provides a powerful way to analyse and understand physical phenomena. By leveraging data science techniques, physicists can gain a deeper understanding of the laws of nature and make predictions about the future.

Keywords

Data Science, Physics, Application, data science techniques.

INTRODUCTION

Data science is the application of technology and data analysis to solve problems and uncover insights. It is a multidisciplinary field that combines methods from statistics, mathematics, computing and machine learning to study and analyse large datasets. In the field of physics, data science has been used to analyse and interpret data from experiments and simulations to gain new insights into the physical world. Additionally, data science has been used to develop new models and theories, as well as to identify patterns and correlations in physical phenomena. Data science can also be used to develop new methods for collecting, storing, and analysing data. Data science in physics has been used to study a wide range of topics, including particle physics, astrophysics, nuclear physics, quantum mechanics, and general relativity. It is also used in fields such as materials science, biophysics, and cosmology. Data science in physics can provide new insights into the behaviour of matter and energy, as well as new ways to study and understand the universe.

Data science is a rapidly growing field of study that combines aspects of computer science, mathematics, statistics, and other disciplines to analyse and interpret large amounts of data. This data can be used to make predictions and discover patterns in various areas. In physics, data science has become increasingly important as the field has become more data-driven. Data science is used to analyse data from experiments, simulations, and observations to better understand the physical world. By combining data from different sources, data science can provide insight into physical processes and phenomena that would otherwise be difficult or impossible to observe or understand [7]. Data science can also be used to create models to predict the behaviour of physical systems and identify trends. Additionally, data science can be used to optimize physical experiments and simulations, creating more efficient and accurate results. Data science can also be used to automate processes, allowing physicists to focus more on the theoretical aspects of their research. In summary, data science is an invaluable tool in modern physics and has been used to great effect in numerous areas of study.

DATA SCIENCE IN PHYSICS

Data science has become a powerful tool to analyse and interpret large amounts of data in the field of physics. In the past few decades, data science has been applied to a wide range of areas in physics, from cosmology and astrophysics to particle physics and condensed matter physics. In cosmology and astrophysics, data science has been used to study the structure and evolution of galaxies, dark matter and dark energy, and the large-scale structure of the universe [11]. In particle physics, data science is used to analyse and interpret data from particle accelerators such as the Large Hadron Collider. In condensed matter physics, data science is used to study the structure and properties of materials, as well as to model and simulate the behaviour of complex systems.

Data science has also been used to develop new tools and methods to analyse and interpret data in physics. For example, data mining techniques are used to uncover patterns and correlations in large datasets, while machine learning algorithms are used to build predictive models and simulations. In addition, data visualization techniques are used to explore and visually represent complex data sets. Overall, data science is a powerful tool that has revolutionized the way physicists analyse and interpret data. It has enabled physicists to uncover new insights and gain a better understanding of the universe.

e-ISSN: 2583-1127

Physicist	Data scientist
Collect data by doing experiments	Data collection from data sources
Analyze the data	Analyze the collected data
Build models to explain observed data	Build models to explain observed data

Table 1: difference between physicist and data scientist
(Source: made by the author)

Data science is increasingly being used in physics to analyse and interpret large amounts of data from experiments, simulations, or observational studies [12]. Data science techniques can be used to develop new models, identify patterns, and gain insights from the data. For example, data science can be used to identify relationships between different physical parameters and to determine the most important variables that affect the systems being studied. Additionally, data science can be used to develop algorithms and software to create simulations and visualizations that can help physicists better understand the underlying physical principles. Data science also has the potential to help physicists make predictions about the behaviour of systems and identify trends in data [13]. By applying data science approaches to physics, scientists are able to gain a better understanding of the physical world, enabling them to make more accurate predictions and discover new insights.

Data science has become increasingly important in physics. It is used to analyse large datasets and uncover new insights about physical phenomena. It can also be used to develop new theories and predictive models for physical systems. Data science can be used to analyse experiments in order to gain a better understanding of the underlying physical principles, as well as to identify patterns in data. It can also be used to develop simulations and models to predict and explain the behaviour of physical systems. Data science can also be used to inform the design of new experiments and the interpretation of results from existing experiments. Finally, data science can be used to develop new techniques for data analysis and visualization.

Data science can be applied to physics in a variety of ways. One of the primary uses of data science in physics is to analyse large sets of data in order to gain insights into the physical world. This can include analysing data from experiments or observations to uncover patterns in the data or to better understand the underlying physical processes at work [6]. Data science can also be used to develop and improve models of physical systems, such as simulating the behaviour of particles in a complex system. Additionally, data science can be used to create predictive models of physical systems, such as predicting the behaviour of the universe based on current data. Data science can also be used to develop tools to help physicists analyse data more efficiently, such as using machine learning algorithms to automate data analysis tasks. Finally, data science can be used to visualize data in order to gain insights into the physical world, such as plotting data points in a 3D space to better understand the relationships between different physical processes.

Data science is a rapidly growing field of study that involves the application of data analysis and machine learning techniques to gain insights from large datasets [15]. It can be applied to virtually any field of study, including physics. In physics, data science is used to analyse complex physical phenomena and to develop models to predict the behaviour of systems. Data science can also be used to make predictions about the physical world, such as the behaviour of particles and the behaviour of materials. Additionally, data science is used to develop simulations to test theories and to analyse large datasets collected from experiments. In conclusion, data science is becoming an increasingly important tool in physics, as it is used to gain a better understanding of the physical world and to make predictions about it.

Data Collection

Data science can be applied to physics in a variety of ways. One of the most common applications is in the collection and analysis of large amounts of data from experiments, simulations, and observations. This data can be used to gain insight into physical phenomena and to validate or refute theories [14]. For example, data collected from particle accelerators can be used to study the properties of subatomic particles and the interactions between them. Data from astronomical observations can be used to study the evolution of stars, galaxies, and the universe. Data from simulations can be used to study complex physical systems such as fluid flows and climate change. Data science can also be used to construct models that describe physical systems, such as equations of motion, and to develop algorithms for predicting future behaviour [3]. In addition, data science can be used to identify patterns in physical data, such as correlations between variables or clusters of similar observations.

Data science can be applied to physics in many ways. One way is by collecting data from experiments and simulations. Data can be collected from a variety of sources, including laboratory experiments, astronomical observations, particle accelerators, and computer simulations. Data collected from these sources can be used to construct models that explain physical phenomena, or to discover new phenomena [5]. Data collection is a critical step for any data science application to physics, as it allows for the generation of meaningful data sets that can be used for analysis and modelling.Data science can be applied to physics in a variety of ways. One way is through data collection. Data science can be used to collect and analyse data from physical experiments and observations, such as measuring the speed of a falling object or the volume of a container of liquid. This data can then be used to help better understand physical phenomena, such as the effects of gravity or the behaviour of fluids.

Data science can be applied to physics in a variety of ways. One of the most common applications is the collection of data related to physical phenomena [16]. This data can be collected through experiments, simulations, or observation.

e-ISSN: 2583-1127

Scientists can then use this data to create models and theories that explain physical phenomena. Additionally, data science can be used to analyse large datasets of physical data, allowing researchers to identify patterns and correlations that may not be seen by the naked eye. These patterns can then be used to make predictions about future physical phenomena or refine existing models. Finally, data science can be used to develop new technologies and algorithms that can improve the accuracy of physical measurements and simulations.

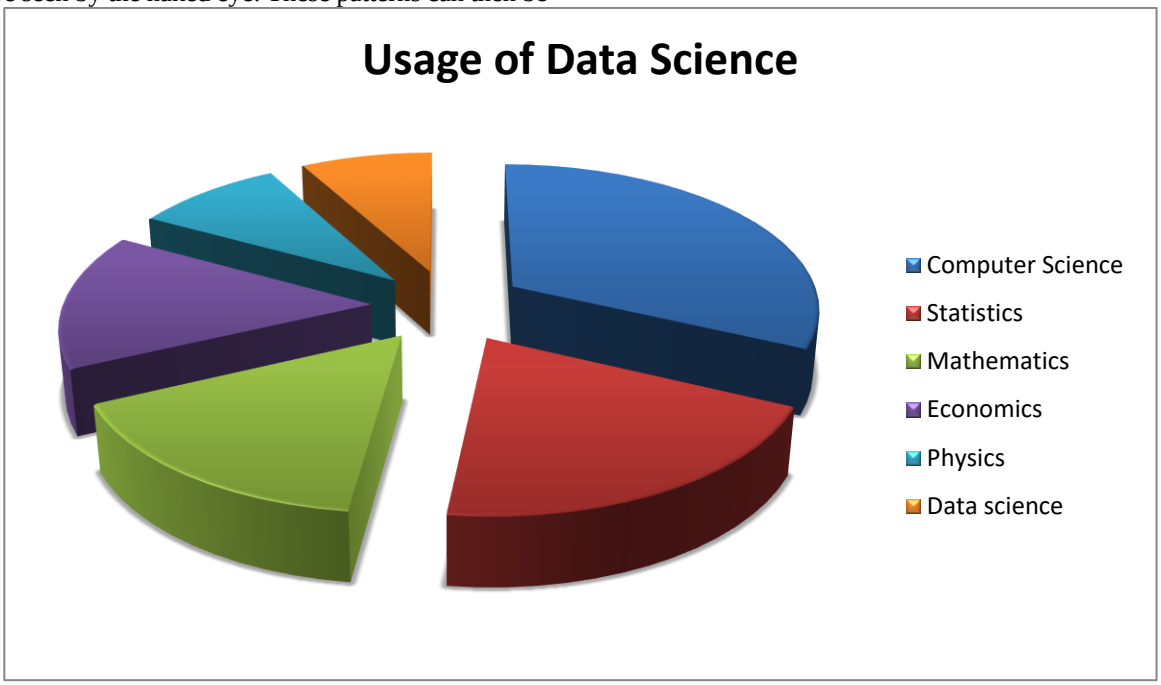

Figure 1: Usage of data science
(Source: made by the author)

Data Analysis

Data science is becoming increasingly important in the field of physics. It is used to analyse large datasets, identify patterns, and extract meaningful information from the data. Data science is also used to help physicists develop better models, simulate physical phenomena, and make predictions about the behaviour of systems [18]. Data science can be used to analyse experiments and simulations, such as those used in particle physics and cosmology. Data science techniques such as machine learning, clustering, and classification can be used to study the behaviour of subatomic particles, analyse the structure of the universe, and determine the properties of dark matter. Data science can also be used to identify correlations between different physical phenomena and help researchers better understand the laws of nature. In addition, data science can be used to optimize experiments and simulations, allowing physicists to obtain meaningful results more efficiently. Data science can also be used to develop new technologies, such as artificial intelligence (AI) algorithms that can assist physicists in their research [8]. Finally, data science can be used to develop applications that are used in the fields of astronomy, engineering, and medicine.

Data science can be applied to physics in a variety of ways. It can be used to analyse and interpret data collected from experiments and simulations. This can help to identify patterns, trends, and correlations within the data, which can then be used to better understand physical phenomena. Data science can also be used to develop models and simulations that can help to predict and explain physical phenomena. Additionally, data science can be used to construct algorithms that can be used to optimize physical systems, such as controlling the trajectory of a spacecraft [20]. By applying data science to physics, researchers can gain a better understanding of physical systems, improving the accuracy and precision of their predictions.

Data science can be applied to physics in many ways, from analysing data from experiments to creating simulations and simulations of physical phenomena. Data science can help physicists to identify patterns and relationships in data, to build models and simulations, and to draw conclusions about physical phenomena. It can also be used to develop better methods of collecting and analysing data, as well as to improve the accuracy and reliability of data. Data science can also be used to develop new physical theories, to analyse and visualize data, and to uncover trends and patterns in data in order to draw conclusions. Finally, data science can be used to develop and apply machine learning algorithms to physical systems in order to gain novel insights into the underlying physics.

Data science is a powerful tool that can be applied to a wide range of disciplines, including physics. In physics, data science can be used to analyse and interpret large amounts of data from experiments and simulations [19]. This data can then be used to aid in the discovery of new theories and insights about the physical world. Data science techniques

e-ISSN: 2583-1127

can also be used to develop predictive models and simulations, which can be used to understand the behaviour of complex physical systems. Data science can also be used to visualize and interpret physical phenomena, such as the behaviour of particles in a fluid. Finally, data science can be used to develop new methods of data analysis, such as machine learning algorithms. All of these techniques can be used to gain a better understanding of the physical world and can lead to new and exciting discoveries.

Visualization

Data science can be applied to physics in many ways, including visualization. Visualization tools such as graphs, charts, and diagrams can be used to represent physical phenomena in a more engaging and interpretable way [1]. Data science can also be used to analyse and interpret experimental data, allowing for deeper insights into physical systems. Furthermore, machine learning techniques can be used to aid in the discovery of new phenomena, or to make predictions from existing data. Finally, data science can help to automate and optimize the process of conducting experiments, leading to more effective use of resources.

Data analyst	Data Scientist
Less pay, Less experience	More pay, More experience
Static modelling	Predictive modelling
Basic programming	Advanced programming
Historical analysis of data	Future predictions

Table 2: difference between data analyst and data scientist (Source: made by the author)

Data science can be applied to physics in a variety of ways. One of the most powerful and widely used tools is visualization. By using data visualization techniques, such as graphs, charts, and diagrams, researchers can quickly and easily understand the relationships between different variables, as well as how they interact with each other [30]. This type of analysis can be used to identify patterns and correlations in physical phenomena, allowing researchers to make more informed decisions about the experiments they conduct. Additionally, data visualizations can be used to present complex information in an accessible and understandable manner, making it easier to explain the results of experiments to a wider audience.

Data science techniques can be used to visualize physical phenomena in a variety of ways. For example, data can be visualized in 3D models, graphs, or animations to show the relationships between different physical variables [29]. Data science can also be used to analyse large datasets from experiments and simulations, allowing researchers to identify patterns and correlations that can provide insights into the behaviour of physical systems. Additionally, data science can be used to develop predictive models that can be used to forecast future physical conditions or events.

Data science can be applied to physics in a variety of ways. One of the key ways is through visualization. By using data science methods and tools, researchers can create visuals that allow them to better understand the physical world. Visuals can provide insights and allow for analysis of complex systems and processes [9]. For example, data science can be used to visualize the behaviour of particles in a system, the interactions between molecules, and the effects of external forces on matter. Visualizations can also be used to simulate the behaviour of physical systems. By using data science in this way, physicists can gain a deeper understanding of the physical world and better inform their research.

BENEFITS OF DATA SCIENCE IN PHYSICS

Improved Modelling: Data science can help to provide a more accurate picture of the physical world by helping to develop better models for physical phenomena. By applying data science techniques, researchers can gain insight into the underlying structure of physical systems and improve the accuracy of their models.

Improved Understanding: By applying data science techniques, researchers can gain a better understanding of the underlying physical processes behind physical phenomena [20]. This can help to improve predictions and ultimately lead to improved designs, applications, and other technologies.

Enhanced Experiments: Data science can be used to analyse large amounts of data obtained from experiments to gain a better understanding of the physical world. This can help to improve the accuracy of experimental results and reduce the amount of time needed to conduct experiments.

Improved Analysis: Data science can be used to analyse large amounts of data obtained from experiments to gain a better understanding of the physical world. This can help to improve the accuracy of results and reduce the amount of time needed to analyse data.

Uncovering Patterns: Data science techniques can be used to uncover patterns in data that may otherwise be hidden [21]. This can help researchers to gain a better understanding of the underlying physical processes behind physical phenomena and improve the accuracy of their models.

e-ISSN: 2583-1127

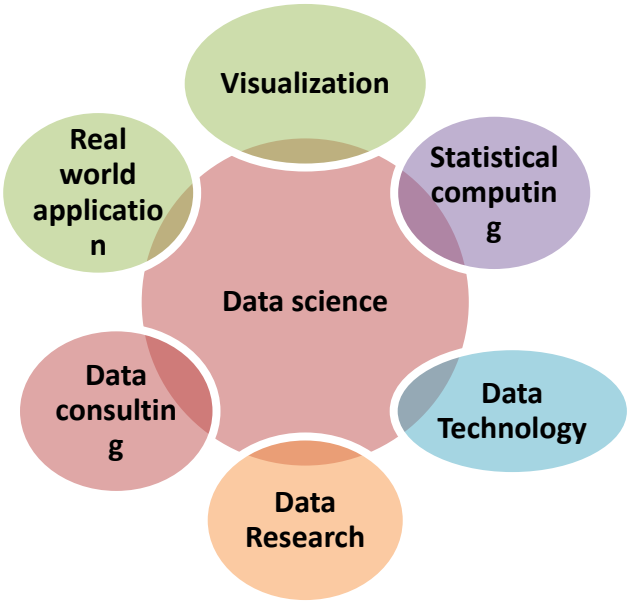

Figure 2: Different usage of Data science
(Source: made by the author)

Data science has become an integral part of modern physics, providing a powerful tool for the analysis and interpretation of data. It has enabled physicists to uncover new phenomena, develop new theories, and gain a better understanding of the universe. Data science has enabled physicists to analyse large datasets more efficiently and accurately, uncover patterns and correlations, and develop models to explain observations [10]. Data science has also been used to develop better instruments, such as particle accelerators and telescopes, that can be used to collect more data and make more accurate predictions.

Data science has also enabled physicists to better understand the properties of particles and the behaviour of matter on a quantum level. Furthermore, data science has allowed physicists to explore phenomena such as dark matter, dark energy, and the Big Bang. Data science has enabled physicists to better understand the structure and evolution of the universe and the physical laws that govern it. In short, data science has enabled physicists to gain a deeper understanding of the physical universe.

Data science has become increasingly important in the field of physics, as it allows for a more efficient and accurate analysis of data. Data science can be applied to a variety of physics problems to improve accuracy and reduce computational time. Data science can be used to analyse and interpret complex data sets, such as those in particle physics, astrophysics, and cosmology. Data science can also be used to develop new theories and models, and to search for patterns and correlations in existing data [28]. Additionally, data science can be used to predict the behaviour of particles and celestial bodies, as well as to uncover new phenomena. By applying data science to physics, researchers can gain a better understanding of the laws of nature and develop new ways of applying them to solve problems.

Improved understanding of physical phenomena: Data science can help physicists better understand physical phenomena by analysing large datasets. This can help them make more accurate predictions and develop new theories.

Increased efficiency: Data science can help physicists automate processes, allowing them to work more efficiently and quickly [27]. It can also help them identify patterns in data that would otherwise be difficult to detect.

Improved accuracy: By using data science, physicists can reduce errors in their calculations or simulations. This can result in more accurate results and predictions.

Better visualization: Data science can help physicists visualize complex physical phenomena in 3D or other formats. This can help them better understand their results and make more informed decisions.

Increased collaboration: Data science can facilitate collaboration between physicists by allowing them to share data and results more easily. This can lead to faster progress and more discoveries.

Data science has become an increasingly important tool for physicists, providing them with powerful methods to analyse and interpret data from experiments and simulations. Data science is used to discover patterns in large datasets and to make predictions about future events. Data science can also be used to optimize experiments, allowing for the most efficient use of resources. Data science can also help physicists to better understand the behaviour of complex systems, and to develop models of physical systems which are more accurate and reliable than traditional methods [22]. By utilizing data science, physicists are able to gain a deeper understanding of the natural world, which can lead to new discoveries and advances in the field of physics.

Technoarete Transactions on Advances in Data Science and Analytics
Vol-1, Issue-2, August 2022
e-ISSN: 2583-1127

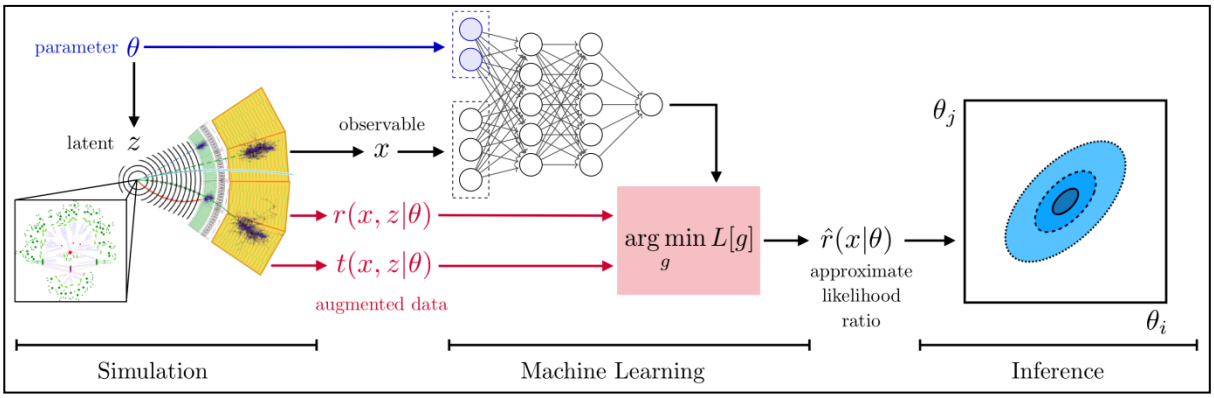

Figure 3: Internal algorithm of the data science
(Source: Sun, Luning, et al.2020 [25])

CHALLENGES AND LIMITATIONS

Data science has become increasingly important for physics research, as it allows physicists to process and analyse large amounts of data to gain insights into complex physical systems. Data science techniques have been used to study particle physics, cosmology, and general relativity, among other areas of research [25]. However, there are several challenges and limitations to the application of data science to physics.

- ✓ First, the data sets used in physics often contain a large amount of noise, making it difficult to identify meaningful patterns or trends.
- ✓ Second, the data used in physics studies often requires a high level of pre-processing before it can be analysed, such as removing outliers or transforming the data into a more useful form.
- ✓ Third, there are often specific physics models that must be used to interpret the data, which can be difficult to implement in data science tools.

Finally, the results of data science experiments in physics may not always be reliable, as the results may not be valid for all physical systems.

Data science is quickly becoming an essential tool for physicists as they seek to understand the complex systems they study [26]. By leveraging the power of machine learning, data science offers physicists the ability to analyse large datasets and uncover new insights and correlations. However, there are a variety of challenges and limitations that come along with applying data science to physics. One of the biggest challenges is finding a way to apply data science to the physical models that physicists use to explain the behaviour of matter.

Additionally, the sheer complexity of physical systems makes it difficult to develop data-driven models that accurately capture the behaviour of the system. Furthermore, many physical systems are difficult to observe, which can limit the amount of data available for analysis. Finally, data science models can be difficult to interpret and may not be able to accurately explain the phenomena being studied. Despite these challenges, data science is becoming an increasingly important tool for physicists, and with further development, it will be possible to use data science to uncover new insights in physics.

Data science has been used to great effect in the field of physics, allowing for the analysis and interpretation of large amounts of data and providing insights that would have been impossible to obtain using traditional methods [3]. However, while the application of data science to physics has been extremely beneficial, there are a number of challenges and limitations that must be addressed in order to maximize its potential. One of the primary challenges is the sheer complexity of the data that must be analysed. Physics data can contain hundreds or even thousands of variables, making it difficult to accurately interpret, and the sheer amount of data can overwhelm even the most experienced data scientists [23]. Additionally, the data in physics often comes from multiple sources, with different data formats and resolution, making it difficult to combine and analyse.

Another challenge is the need to accurately represent the physical processes being modelled. Data scientists must have a deep understanding of the physics in order to use the data effectively, and the models they create must be able to accurately represent the physical world. This often requires the use of advanced machine learning techniques, which can be difficult to implement and may require extensive training and expertise [24]. Finally, data science tools are still relatively immature when compared to traditional physics tools. This can limit the speed and accuracy of the results and may require additional resources and expertise to achieve the desired results. Overall, the application of data science to physics has the potential to revolutionize the field, but there are a number of challenges and limitations that must be addressed in order to maximize its potential [2]. By addressing these challenges and limitations, data scientists will be able to use the power of data science to unlock the mysteries of the physical world and make breakthroughs that would otherwise be impossible.

CONCLUSION

Data science has become an increasingly important tool for physicists to explore and analyse complex systems. By combining data analysis techniques with their own physical understanding of a system, physicists are able to uncover

e-ISSN: 2583-1127

patterns and insights that might otherwise remain hidden. Data science can be used to develop more accurate models of physical phenomena, better understand the behaviour of different materials, and more accurately predict outcomes of experiments. As data science continues to develop, its application to physics will only become more powerful and useful.

Data science has proven to be an invaluable tool for physicists, allowing them to analyse complex physical phenomena and uncover new knowledge. Data science techniques such as machine learning, artificial intelligence, and big data analytics have enabled researchers to gain insights from large datasets and uncover previously unknown correlations. Furthermore, data science has led to the development of new technologies such as autonomous vehicles, facial recognition, and smart cities. As data science continues to evolve, its applications to physics will continue to expand, enabling researchers to make more accurate predictions, solve complex problems, and discover new physical phenomena.

Data science has become an increasingly important tool for physicists studying a wide variety of topics. With the increasing availability of data and computing power, data science techniques can be used to explore and analyse data more quickly and effectively than ever before. Data science techniques can be used to uncover new insights and relationships in data, identify patterns, and develop models that can be used to make predictions and decisions. In addition, data science can be used to automate tasks and process large datasets, allowing for faster and more accurate analysis. Data science is an invaluable tool for physicists to explore the mysteries of the physical world.

Data science has been applied to physics in a number of ways. There are applications in areas such as machine learning, data visualization, and analysis of large datasets. These techniques are used to better understand and predict physical phenomena, and can even be used to develop new technologies and materials. Data science has also been used to develop models and simulations of complex physical systems, and to analyse experimental data. As data science continues to advance, its applications in physics are likely to expand.

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