**ROLE OF DATA SCIENCE AND ARTIFICIAL INTELLIGENCE IN BUSINESSES**

**Table of Contents**

**Abstract**

[1. Introduction 3](#_Toc80231569)

[1.1 Introduction 3](#_Toc80231570)

[1.2 Research Context 3](#_Toc80231571)

[1.3 Research Problem 4](#_Toc80231572)

[1.4 Research Question 4](#_Toc80231573)

[1.5 Intervention 4](#_Toc80231574)

[2. Background 5](#_Toc80231575)

[2.1 State-of-the-art of Artificial Intelligence 6](#_Toc80231576)

[2.2 Reshaping the process of innovation with data science and AI 7](#_Toc80231577)

[2.3 Strategic Objectives of the organizations 9](#_Toc80231578)

[2.4 Business Intelligence 10](#_Toc80231579)

[2.5 AI-based data science 11](#_Toc80231580)

[3. Method 15](#_Toc80231581)

[4. References 18](#_Toc80231582)

**Abstract**

Artificial Intelligence (AI) and data science continue to dominate all non-business and busies environments amid several criticisms due to fear that the technology of AI and data science would endanger the role of all people in business operations and future management. AI and data science have several positive impacts upon whole business operations, and business and management investment in AI would enhance market leadership and sustainability. The algorithms of AI and data science provide machines the ability in making predictions and decisions in the future by using learned insights and patterns. The new applications continue in improving decision making and efficiency and whole business operations. Business operations and management are in the era of data that shapes daily processes within business operations. This research provides a basic understanding of the role of data science and AI to create value for businesses. This paper would provide an idea about how AI and data science could be used for making businesses more successful.

# 1. Introduction

## 1.1 Introduction

Innovation has been always the major engine of an improved standard of living throughout history. The innovation process could be quite disruptive as this makes the conventional technologies absolute obsolete. Data science helps to bring together all domain expertise from statistics, mathematics, and programming for creating insights and making sense of the data (Amirullah, Aulia and Arisandy 2020). The demand for data science is quite high and explains how digital data helps to transform businesses and help them in making crucial and sharper decisions. Hence, digital data is ubiquitous for people looking in working as data scientists.

All emerging technologies through data science and artificial intelligence are changing the way people work, live, and amuse themselves. More advancement of such technologies could contribute to develop hyper-connectivity and hyper-automation that would bring Industry 4.0. This incredible speed by which AI and data science are entering all sectors is forcing the organizations in getting into a race for making their organization more profitable. It is impelling businesses, investigators, entrepreneurs, pioneers, and strategists in using AI and data science in designing new strategies and creating new sources for the business value (Benaben et al. 2019). The quick pace of data science and AI is propelling the strategists in reshaping the business models. It is fostering the integration of data science and AI within business processes; however, the consequences of such adoption need attention and are underexplored.

## 1.2 Research Context

Data science has a vital role to play in an organization. Whereas, artificial intelligence needs more application-oriented skills to create value.

## 1.3 Research Problem

Analytics of data science powers business intelligence and marketing program efforts. However, the amount of value received from the data is a concern. Here, artificial intelligence is helpful. This is from a large set of data and creating predictions as per the data (Delacroix 2020). It comprises analytics data from various areas such as CRMS, content management systems, automation platforms, and Google Analytics. According to studies, business values are estimated to reach 3.9 trillion dollars by 2022 through AI.

## 1.4 Research Question

**RQ:** How does data science apply with artificial intelligence to create value in businesses?

## 1.5 Intervention

It has been essential to understand how the introduction of AI at the business level is making things simpler. Also, it is to be analyzed how it is helping them to expand and grow. Here, the key issue lies in the nature of the predictive model of the solution. For becoming actual AI, a productive model requires learning and development from its various predictions (Chergui, Kechadi and McDonnell 2020). Predictive analytics from data science indicates that machines predicted as per data and prescribed things to be done further.

**Interpretation 1:** The area of AI is yet to be explored, whereas data science has already begun to make a huge difference in the market. Through interpreting the growth of AI, new products are generated that are bringing autonomy through automatically performing various things.

**Interpretation 2:** Through interpreting data science, data can be analyzed as per business decisions as AI is implemented to provide value to companies.

# 2. Background

AI and data science are the major technologies when this is about the products and processes with the automatic optimization and learning to be used within the industries in the future. AI and data science are the main technologies not in the daily lives of people and have several applications, like voice recognition and facial recognition. Innovation and adaptation are quite essential to organizations (Drobot 2020). The development must lead to sustainable development with the use of new technologies. AI and data science are all rising technologies that might create winners and losers all over the business world. However, in the last couple of years, this situation has dramatically changed, almost all fields employ these technologies. Several factors are responsible for it that includes advancement in computer technology, increase in transparency by code sharing, and a huge number of open-source software. Huge uses of such technologies in all fields that include healthcare, sports, security, agriculture, energy management, automobiles, environmental monitoring, gaming, and finance are changing the way people live, amuse themselves and work (Ebadi et al. 2019). The advancement of data science and AI is the center of this enhanced performance of other technologies. AI technology and data science offer several opportunities that could lead to a notable transformation within business and the whole economic system.

Behind every application of the real world, there is the intelligent agent (IA) that reacts with the environment in the repetitive cycle for sense think and act. This explores all input data for learning correlations, detect similarities, discover good depictions, and extract features at several levels. Earlier, the unavailability of efficient hardware and data was hindering the progress of data science and AI. Although, in the last couple of years, the accessibility of low-power and low-cost sensors has resulted in the production of a large volume of data (Earley 2017). The investigation of lists of the data providers is done for elucidating accessibility, diversity, and the number of datasets that are available on the web.

## 2.1 State-of-the-art of Artificial Intelligence

Despite some setbacks, there is AI due to the development of neural networks with several hidden layers. Such advancement of artificial intelligence is attributed to several major factors, such as tensor processing units and hardware accelerators, and the availability of a huge volume of data. An increase in the popularity of artificial intelligence has led to the expansion in investment in several sectors of artificial intelligence that include production, marketing, development, and research (Fatima et al. 2018). Several organizations are making this technology available commercially in form of application program interfaces (APIs), professional and personal agents, libraries of deep learning, robots, and chatbots. It is enhancing the business valuation that adds new resources and makes the services and products intelligent.

At the same time, the paradigm shift motivated by AI is enhancing the intuitive, analytical, and mechanical skills of all employees and shaping all other contexts of businesses. With the increased amount of funding, artificial intelligence could involve in many more sectors. Hence, this becomes necessary in investigating the functioning of AI systems in several possible sectors within existing businesses (Gibert, Andreu and Castell 2019). This is important also to inspect all market leaders and all start-ups adopting such AI systems. The adoption of AI by the organizations would lead in shaping of these business contexts. Prior knowledge about the domains would make society aware of the adoption and development of artificial intelligence in the future. It would aid also policymakers to identify the challenges and explore the ethical and legal corners in this field of artificial intelligence.

## 2.2 Reshaping the process of innovation with data science and AI

AI and data science have reached the place where this could take financial decisions of the real world, chat with the people, work with them, and play games against humans. Behind every application of the real world, there is the intelligent agent or AI system. This interacts with the environment in the repetitive cycle of the sense think and act. This takes in data from the environment, takes the informed decision based upon experience and input data, and performs the action that affects the environment. The IA could be a software agent or machine (Kandasamy, Raji and Arun 2018). This takes data in form of text, sound, images, and videos, and analyzes the data with the use of algorithms of AI. The unprecedented amount of data is fuel for the AI system. The major currency of the business would be the ability in converting the data into artificial intelligence that drives several competitive advantages.

Data unavailability was hindering the progress of artificial intelligence. Although, in the last couple of years, the accessibility of low-power and low-cost sensors has resulted in the generation of a huge volume of data. Data from all sensors such as camera, smoke sensor, a global positioning system (GPS), motion detection sensor, health monitoring sector, and chemical sensor could be processed continuously or could be stored for gaining useful insights by several mechanisms (Khan and Alla 2021). Data from several sensors could be combined using the technique of sensor fusion. Also, there exist several other sources through online directories, surveys, review sites, census databases, actual sales of retail, online communities, and commerce websites from where data could be extracted by using web scraping techniques. All raw data that is obtained from the sources could be used and processed for training the intelligent agent.

The conversion of raw data to the processed data is a time-consuming and expensive task. After training the intelligent agent, this could teach all other agents and also make them much smarter. Data is fuel for machine learning; however, the data might be expensive, rare, slow, or risky. In such cases, the machines could create synthetic experiences or could share experiences for one another for augmenting or replacing data (Lai et al. 2020). Machine teaching would same power and time as for all small changes it would eliminate the need for training the agent from scratch. Such knowledge transfer in agents could increase the deployment and development of intelligent agents at a much quicker rate.

The intelligent agents explore input data for learning correlations, extracting features, detecting similarities, and discovering good representation at several levels. It needs the use of tools of AI and data science such as decision trees, support vector machines, Bayesian algorithms, and deep learning networks (DLN). DLNs are the most used approach in the last couple of years. Few of these DLNs are reported surpassing the human-level accuracy in specific tasks. For the speech data, RNNs and CNNs are preferred (Latif et al. 2020). The hype and success that is generated by the DLNs in the last couple of years have propelled several organizations in launching a huge number of AI-based services and machines. Several organizations invest in AI, collect appropriate data about the customers, services, products, and acquisitions. The data is analyzed for gaining knowledge about the commercial availability of intelligent services and machines. Artificial intelligence and data science have attained efficient growth regarding deployment, innovation, and research. A notable achievement is to surpass human-level accuracy within several tasks through classification, recognition, and games. It offers several opportunities for product innovation and process innovation; however, the issues such as security, privacy, trust, and bias need attention still. These are a few of the issues that are compelling to think about all the negative impacts of AI.

## 2.3 Strategic Objectives of the organizations

The achievements in the field of innovation and research have propelled several existing organizations in becoming AI organizations and also have spawned AI-based start-ups. It has increased also the involvement of the actors in AI-related academic events and research. The actors are adopting several other strategies for business growth in the field of artificial intelligence and data science by recruiting AI talents, acquiring AI start-ups, and investing in more AI organizations (Lu et al. 2019). Such an increase indicates that the corporate organizations aim in growing quicker with the most advanced technologies of data science and AI. The investments made in AI should have played crucial roles in the financial growth of the organizations; however, this wasn't possible in conclusively finding the direct correspondence among the organizations as there could be several factors behind this growth.

As start-up is considered as growth and innovation drivers of the economy, this would help in detection of impact of AI and data science on the business models. The inclination of the start-ups towards such organizations indicates that such industries would create much more opportunities in the future and also provide improved services and products by enabling the automation of several tasks. AI is used maximally in these five industries, such as healthcare, core AI, cybersecurity, sales and marketing, and business intelligence (Manjunath and Hegadi 2018). The adoption of technology of data science and AI has led also to shape the business contexts. There are several business contexts identified that are influenced by data science and AI and this is called the third dimension of the three-dimensional analysis of the overall impact of data science and AI on businesses.

## 2.4 Business Intelligence

The systems of business intelligence (BI) provide predictive, current, and historical views of the business operations, by using data gathered into the data mart or data warehouse and working from the operational data. The software elements support pivot-table analyses, reporting, statistical data mining, and visualization (Mühlroth and Grottke 2020). The applications tackle financial, production, sales, and several other business data sources for purposes that involve business performance management. Data is gathered often about other organizations within the same industry that is known as benchmarking. They are the competitors in the same produced products or domains that are presented or manufactured in the same marketplace. Organizations are currently starting to view that content and data mustn't be considered as separate aspects of the information management; however, must be managed in the integrated approach of the organization. Enterprise information management provides enterprise content management and business intelligence together (Prayogo and Ikhsan 2020). The organizations are currently moving towards the operational business intelligence that is under-served by the vendors. The vendors of business intelligence are targeting the best. However, there is now the paradigm shift to move towards taking business intelligence to the bottom with the focus on self-service business intelligence.

For the crucial business processes, there might be one or many risk atoms; however, the risk atom should reflect the crucial business processes. The self-service business intelligence provides the end-users ability in doing more with the data without having the technical skills. Such solutions are created usually to be easy-to-use and flexible, such that the end-users could analyze the data, make plans and decisions, and forecast on their own. The organizations have taken the approach of making BI an easily integrated application for all other tools of end-users. BI comprises the technologies and strategies that are used by the organization for data analysis of the business information. The technologies of BI provide predictive, current, and historical views of the business operations (Rachmawati, Sihombing and Halim 2020). BI leverages the services and software for transforming data into actionable insights that help to inform the tactical and strategic business decisions of the organizations. Tools of BI analyze and access data sets and also present the analytical findings in the dashboards, graphs, reports, maps, and charts for providing the users with detailed intelligence about the state of that business.

## 2.5 AI-based data science

The growing include of AI and data-driven technologies in industry and science is having a huge impact upon the rising discipline of data science. For reflecting such a new reality, a wider version of such discipline is proposed. Data science is a multi-disciplinary field using scientific methods, systems, algorithms, and processes for extracting insights and knowledge from unstructured and structured data (Saiki et al. 2018). This is a quite complex field incorporating programming, statistics, mathematics, database technologies, computer science, data analytics, and data visualization. AI-driven approaches are used by AI-based data science for turning data into actions and insights. AI-driven approaches add some crucial new capabilities for turning data into actions and insights. The AI methods offer many options for extracting knowledge from the available data with the use of swarm intelligence, simulated evolution, and machine learning. The algorithms of machine learning allow computers in discovering relationships and patterns in the historical data that might be used for decision-making. The simulated evolution generates knowledge automatically from the data based upon math models fighting with one another.

Many AI-driven methods, like intelligent agents and decision trees, allow data in being transformed into automatically generated decisions that are based on appropriate quantitative criteria. Such decisions could be used by humans or automatically execute in the process of decision-making. Many AI-driven approaches, like evolutionary computation, deep learning, and machine learning generate the solutions by executing automatically the major steps of the scientific process. For machine learning, the hypothesis could be defined by automatically discover patterns or by labeled data (Sukumar 2015). During the process of machine learning, the hypothesis would be tested on the validation data and a decision is taken about the correctness based upon model performance. Such capabilities are based upon new AI-driven technologies. As AI is the active area for research, this list is growing continuously.

The classical algorithms of machine learning are based upon artificial neural networks that are inspired by the capabilities of the brain for processing information. The neural networks include several nodes that are the mathematical model of the neurons. The learned knowledge within the artificial neural network could be represented by numerical weights of mathematical links. Deep learning is a new technology that is based on neural networks and has quite high complexity. The algorithms of deep learning are used for detecting the objects in the images, analyzing the sound waves for converting spoken speech to text, and for processing natural human language into the structured format to perform analysis (Tane and Fujigaki 2017). The technology still is in the early days to be used for business; however, this is expected in playing a major role in the primary application area of driverless vehicles. The evolutionary computation generates the solution automatically of the given issue with defined fitness through stimulating the natural evolution within the computer.

Due to all enhanced capabilities that are delivered by the wide set of the new technologies, data science-based on AI could be highly applicable to several fields that includes security, social media, healthcare, medicine, biological sciences, defense, social sciences, economics, medicine, marketing, and finance (TITU and STANCIU 2020). The new opportunities to improve that are offered by AI-based data science need extra knowledge about all major technologies of artificial intelligence. The required skillset involves basic knowledge about all principles of methods, awareness of the application potential, and training in proper software platforms of implementation.

Data science is turning to be a crucial factor for maintaining competitiveness in this data-rich business environment. As more disparate and complex data sets become available, this chasm between the groups would continue only to broaden. This is believed that these new and powerful technologies of this AI-based data science would further increase the competitive advantage of the first group. The most essential feature boosting AI-based data science is the objective nature of smart solutions derived. Objective intelligence is the same as the statistical models in that those are objective, as they are based upon the laws of numbers and nature (Tiwari et al. 2021). The major advantage is that all decisions suggested by objective intelligence could be supported by and derived from data. As the result, all defined rules are closer to reality, and influence on the individual preferences and subjective biases are reduced significantly. Another advantage of objective intelligence is the decisions aren't static; however, adapt to the changes within the environment.

AI-based data science could infer the solutions from the multidimensional spaces with several factors and numerous records. The feature is beyond capabilities of the human intelligence. There is another advantage where this has the ability in capturing unknown complicated patterns from the available data. This is quite difficult for human intelligence for detecting the patterns with several variables and on several different time scales (Yang et al. 2015). Many learning approaches, like reinforcement theory, statistical learning theory, and neural networks, are engines of the perpetual progress in the capabilities of objective intelligence. This competitive statistical method lacks a unique feature.

A major strength of this AI-based data science is to handle technical uncertainty. The economic benefit of such a competitive advantage is substantial. Any reduced technical uncertainty results in tighter control over process quality, less frequent incidents, and quicker design of new products. Such benefits translate the technical advantages explicitly into value. The fundamental modeling helps to deal with the uncertainty in strictly defined assumptions. Uncertainty is handled by statistics by calculating the confidence boundaries in ranges of the available data. These options narrow down all assumption space of all potential solutions significantly and make this quite sensitive in changing the operating conditions (Zhou et al. 2020). As the result, the performance lacks robustness and also leads to evaporating the credibility of the application outside assumption space. AI-based data science possesses a quite open assumption space and could operate with the starting date.

AI-based data science could cluster data by automatically learning how this is related. Its condensed form of data reduces overall entities representing the system significantly. The evolutionary computation helps to deliver the distilled solutions having low complexity. A side effect of this simulated evolution is that unimportant variables are removed gradually from final solutions that lead to the automatic dimensionality reduction and variable selection. The swarm intelligence and evolutionary computation might converge and also find the optimal solutions in more complex and noisier search spaces. AI-based data science could reduce whole effort within innovation discovery and increase chances of success. As generating intellectual property is a major component of the economic competitive advantage, such unique strength of this AI-based data science might have a huge economic impact.

The complex and self-organized adaptive system mimics the discovery process through means of property of emergence. The property is the result of the coupled interactions among parts of the system. A specific method within genetic programming and evolutionary computation could generate any type of new structure based upon several building blocks. The most use of AI-based data science is to capture the unknown relationships among variables (Lee et al. 2018). The time of development to find the relationships is shorter than to build statistical models. For the simulated evolution, the dependencies could be automatically derived and the role of the expert is also reduced to the selection of the most ideal solutions based upon interpretability and performance. The models that are derived by AI-based data science have optimal complexity and accuracy. AI-based data science provides more technical opportunities for operating with minimum cost.

# 4. References

1. Amirullah, A., Aulia, I. and Arisandy, D., 2020, July. Implementing Cosine Similarity Algorithm to Increase the Flexibility of Hematology Text Report Generation. In *2020 International Conference on Data Science, Artificial Intelligence, and Business Analytics (DATABIA)* (pp. 76-82). IEEE. Retrieved from <https://doi.org/10.1109/DATABIA50434.2020.9190549>

2. Ampatzoglou, A., Bibi, S., Avgeriou, P., Verbeek, M. and Chatzigeorgiou, A., 2019. Identifying, categorizing and mitigating threats to validity in software engineering secondary studies. *Information and Software Technology*, *106*, pp.201-230. Retrieved from <https://doi.org/10.1016/j.infsof.2018.10.006>

3. Benaben, F., Lauras, M., Montreuil, B., Faugère, L., Juanqiong, G.O.U. and Mu, W., 2019, September. Physics of Organization Dynamics: An AI Framework for opportunity and risk management. In *2019 International Conference on Industrial Engineering and Systems Management (IESM)* (pp. 1-6). IEEE. Retrieved from <https://doi.org/10.1109/IESM45758.2019.8948167>

4. Chergui, N., Kechadi, M.T. and McDonnell, M., 2020, February. The Impact of Data Analytics in Digital Agriculture: A Review. In *2020 International Multi-Conference on:“Organization of Knowledge and Advanced Technologies”(OCTA)* (pp. 1-13). IEEE. Retrieved from <https://doi.org/10.1109/OCTA49274.2020.9151851>

5. Delacroix, E., 2020. It Takes More Than Technologies. *IEEE Potentials*, *39*(6), pp.11-14. Retrieved from <https://doi.org/10.1109/MPOT.2020.3014452>

6. Drobot, A.T., 2020, December. Industrial Transformation and the Digital Revolution: A Focus on Artificial Intelligence, Data Science and Data Engineering. In *2020 ITU Kaleidoscope: Industry-Driven Digital Transformation (ITU K)* (pp. 1-11). IEEE. Retrieved from <https://doi.org/10.23919/ITUK50268.2020.9303221>

7. Earley, S., 2017. The Problem With AI. *IT Professional*, *19*(4), pp.63-67. Retrieved from <https://doi.org/10.1109/MITP.2017.3051331>

8. Ebadi, A., Gauthier, Y., Tremblay, S. and Paul, P., 2019, December. How can automated machine learning help business data science teams?. In *2019 18th IEEE International Conference On Machine Learning And Applications (ICMLA)* (pp. 1186-1191). IEEE. Retrieved from <https://doi.org/10.1109/ICMLA.2019.00196>

9. Fatima, A., Khan, F.A., Raza, A. and Kamran, A.B., 2018, December. Automated feature synthesis from relational database for data science related problems. In *2018 International Conference on Frontiers of Information Technology (FIT)* (pp. 71-75). IEEE. Retrieved from <https://doi.org/10.1109/FIT.2018.00020>

10. Gibert, K., Andreu, C.P. and Castell, N., 2019, September. Deployment of territorial structures to reduce gender gap in technology and some real cases in Catalonia. In *2019 24th IEEE International Conference on Emerging Technologies and Factory Automation (ETFA)* (pp. 1823-1830). IEEE. Retrieved from <https://doi.org/10.1109/ETFA.2019.8869108>

11. Johnston, M.P., 2017. Secondary data analysis: A method of which the time has come. *Qualitative and quantitative methods in libraries*, *3*(3), pp.619-626. Retrieved from <http://www.qqml-journal.net/index.php/qqml/article/view/169>

12. Kandasamy, P., Raji, D. and Arun, S., 2018, December. Data Science Techniques to Improve Accuracy of Provider Network Directory. In *2018 IEEE 25th International Conference on High Performance Computing Workshops (HiPCW)* (pp. 119-128). IEEE. Retrieved from <https://doi.org/10.1109/HiPCW.2018.8634423>

13. Khan, S. and Alla, R.R., 2021, January. Big Data and Customer Relationship Management: Impact on General Insurance Companies in UAE. In *2021 11th International Conference on Cloud Computing, Data Science & Engineering (Confluence)* (pp. 273-279). IEEE. Retrieved from <https://doi.org/10.1109/Confluence51648.2021.9377184>

14. Lai, Y.H., Wu, T.C., Lai, C.F., Yang, L.T. and Zhou, X., 2020. Cognitive optimal-setting control of AIoT industrial applications with deep reinforcement learning. *IEEE Transactions on Industrial Informatics*, *17*(3), pp.2116-2123. Retrieved from <https://doi.org/10.1109/TII.2020.2986501>

15. Latif, S., Usman, M., Manzoor, S., Iqbal, W., Qadir, J., Tyson, G., Castro, I., Razi, A., Boulos, M.N.K., Weller, A. and Crowcroft, J., 2020. Leveraging data science to combat covid-19: A comprehensive review. *IEEE Transactions on Artificial Intelligence*, *1*(1), pp.85-103. Retrieved from <https://doi.org/10.1109/TAI.2020.3020521>

16. Lee, E., Jang, Y., Yoon, D., Jeon, J., Yang, S.I., Lee, S.K., Kim, D.W., Chen, P.P., Guitart, A., Bertens, P. and Perianez, A., 2018. Game data mining competition on churn prediction and survival analysis using commercial game log data. *arXiv preprint arXiv:1802.02301*. Retrieved from <https://doi.org/10.1109/TG.2018.2888863>

17. Lu, Y., 2019. Artificial intelligence: a survey on evolution, models, applications and future trends. *Journal of Management Analytics*, *6*(1), pp.1-29. Retrieved from <https://doi.org/10.1080/23270012.2019.1570365>

18. Manjunath, T.N. and Hegadi, R.S., 2018, December. Literature Review on Big Data Analytics and Demand Modeling in Supply Chain. In *2018 International Conference on Electrical, Electronics, Communication, Computer, and Optimization Techniques (ICEECCOT)* (pp. 1246-1252). IEEE. Retrieved from <https://doi.org/10.1109/ICEECCOT43722.2018.9001513>

19. Moore, E.F., Thomas, K. and Gephart, S.M., 2021. Fresh Perspectives on an Old Method: Secondary Analysis in a Big Data Era. *CIN: Computers, Informatics, Nursing*, *39*(8), pp.393-399. Retrieved from <http://doi:10.1097/CIN.0000000000000796>

20. Mühlroth, C. and Grottke, M., 2020. Artificial intelligence in innovation: how to spot emerging trends and technologies. *IEEE Transactions on Engineering Management*. Retrieved from <https://doi.org/10.1109/TEM.2020.2989214>

21. Nuhoğlu Kibar, P. and Akkoyunlu, B., 2018. Modeling of Infographic Generation Process as a Learning Strategy at the Secondary School Level Based on the Educational Design Research Method. Retrieved from <http://earsiv.cankaya.edu.tr:8080/handle/20.500.12416/2287>

22. Prayogo, R.D. and Ikhsan, N., 2020, July. Attribute selection effect on tree-based classifiers for letter recognition. In *2020 International Conference on Data Science, Artificial Intelligence, and Business Analytics (DATABIA)* (pp. 13-18). IEEE. Retrieved from <https://doi.org/10.1109/DATABIA50434.2020.9190393>

23. Rachmawati, D., Sihombing, P. and Halim, B., 2020, July. Implementation of Best First Search Algorithm in Determining Best Route Based on Traffic Jam Level in Medan City. In *2020 International Conference on Data Science, Artificial Intelligence, and Business Analytics (DATABIA)* (pp. 5-12). IEEE. Retrieved from <https://doi.org/10.1109/DATABIA50434.2020.9190626>

24. Saiki, S., Fukuyasu, N., Ichikawa, K., Kanda, T., Nakamura, M., Matsumoto, S., Yoshida, S. and Kusumoto, S., 2018, July. A Study of Practical Education Program on AI, Big Data, and Cloud Computing through Development of Automatic Ordering System. In *2018 IEEE International Conference on Big Data, Cloud Computing, Data Science & Engineering (BCD)* (pp. 31-36). IEEE. Retrieved from <https://doi.org/10.1109/BCD2018.2018.00013>

25. Sherif, V., 2018, May. Evaluating preexisting qualitative research data for secondary analysis. In *Forum: qualitative social research* (Vol. 19, No. 2, pp. 26-42). Freie Universität Berlin. Retrieved from <https://www.qualitative-research.net/index.php/fqs/article/download/2821/4211?inline=1>

26. Sukumar, S.R., 2015, October. Open research challenges with Big Data—A data-scientist's perspective. In *2015 IEEE International Conference on Big Data (Big Data)* (pp. 1272-1278). IEEE. Retrieved from <https://doi.org/10.1109/BigData.2015.7363882>

27. Tane, E. and Fujigaki, Y., 2017, July. Cross-Disciplinary Survey on" Data Science" Field Development: Historical Analysis from 1600s-2000s. In *2017 Portland International Conference on Management of Engineering and Technology (PICMET)* (pp. 1-10). IEEE. Retrieved from <https://doi.org/10.23919/PICMET.2017.8125428>

28. TITU, A.M. and STANCIU, A., 2020, June. Acquiring businesss intelligence through data science: A practical approach. In *2020 12th International Conference on Electronics, Computers and Artificial Intelligence (ECAI)* (pp. 1-6). IEEE. Retrieved from <https://doi.org/10.1109/ECAI50035.2020.9223190>

29. Tiwari, P., Pandey, R., Garg, V. and Singhal, A., 2021, January. Application of Artificial Intelligence in Human Resource Management Practices. In *2021 11th International Conference on Cloud Computing, Data Science & Engineering (Confluence)* (pp. 159-163). IEEE. Retrieved from <https://doi.org/10.1109/Confluence51648.2021.9377160>

30. Trinh, Q.D., 2018, April. Understanding the impact and challenges of secondary data analysis. In *Urologic Oncology: Seminars and original investigations* (Vol. 36, No. 4, pp. 163-164). Elsevier. Retrieved from <https://doi.org/10.1016/j.urolonc.2017.11.003>

31. Yang, B., Yamazaki, J., Saito, N., Kokai, Y. and Xie, D., 2015, May. Big data analytic empowered grid applications—Is PMU a big data issue?. In *2015 12th International Conference on the European Energy Market (EEM)* (pp. 1-4). IEEE. Retrieved from <https://doi.org/10.1109/EEM.2015.7216718>

32. Zhou, J., Chen, F., Berry, A., Reed, M., Zhang, S. and Savage, S., 2020, December. A Survey on Ethical Principles of AI and Implementations. In *2020 IEEE Symposium Series on Computational Intelligence (SSCI)* (pp. 3010-3017). IEEE. Retrieved from <https://doi.org/10.1109/SSCI47803.2020.9308437>