ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 12 , 2022

A REVIEW ON BIG DATA ANALYTICS FOR IOT: APPLICATION AND FUTURE

Shivendra Singh Chauhan

Research Scholar, Department of Computer Science, Faculty of Engineering & Technology, Rama University, Uttar Pradesh Kanpur

Shiveny2k@gmail.com

Dr. HariOm Sharan

Professor, CSE, FET, RAMA University, Uttar Pradesh, Kanpur,

drsharan.hariom@gmail.com

Abstract:

The era of Big Data has ushered in a paradigm shift in how we collect, process, and derive insights from vast and complex datasets. This abstract provides an overview of the key concepts, challenges, and opportunities associated with Big Data.Big Data refers to extremely large and diverse datasets that exceed the capabilities of traditional data processing methods. These datasets are characterized by the three Vs: Volume, Velocity, and Variety. Volume pertains to the massive scale of data generated from various sources, including social media, sensors, and transactions. Velocity refers to the rapid speed at which data is generated and must be processed to extract meaningful insights in real-time or near-real-time. Variety involves the diverse nature of data types, formats, and sources, such as structured, semi-structured, and unstructured data.The challenges posed by Big Data are multifaceted. Traditional data processing tools and techniques are inadequate to handle the scale and complexity of these datasets. Storage, processing power, and computational resources must be efficiently managed to derive value from Big Data. Additionally, issues of data quality, privacy, security, and ethical considerations come to the forefront, demanding robust strategies to ensure responsible data handling and usage.

Keywords: *Big data, Frameworks, Internet of Things (IoT), Architecture, Big Data Analytics*

INTRODUCTION:

In the modern digital landscape, the convergence of Big Data and the Internet of Things (IoT) has revolutionized the way we gather, process, and derive insights from data. This dynamic duo has transformed industries, enhanced decision-making, and opened new frontiers of innovation. This introduction provides an overview of the concepts of Big Data and IoT, highlighting their interplay and significance.

Big Data: Big Data refers to the exponential growth and complexity of data generated from various sources, ranging from social media and sensors to business transactions and scientific

experiments. The defining attributes of Big Data are commonly encapsulated in the "Three Vs": Volume, Velocity, and Variety. The volume of data generated has reached unprecedented levels, challenging traditional data storage and processing methods. The velocity of data creation and the need for real-time or near-real-time analysis have pushed conventional analytical approaches to their limits. Lastly, the variety of data types, including structured, semi-structured, and unstructured, demands adaptable tools and techniques for effective analysis.

IoT (Internet of Things): IoT refers to the vast network of interconnected physical devices, vehicles, appliances, and other items embedded with sensors, software, and network connectivity that enable them to collect and exchange data. These devices, often referred to as "smart" devices, communicate with each other and centralized systems, generating a continuous stream of data. IoT applications span diverse domains, from smart cities and healthcare to agriculture and manufacturing. The data generated by IoT devices provides valuable insights into real-world phenomena and enables informed decision-making for both individuals and organizations.

The Convergence: The synergy between Big Data and IoT arises from the fact that IoT devices are prolific generators of data that contribute to the Big Data ecosystem. As IoT devices become increasingly prevalent, they produce vast amounts of data related to user behaviors, environmental conditions, machine performance, and more. This influx of data presents both challenges and opportunities. The challenge lies in efficiently managing, storing, processing, and analyzing this data in a meaningful way. The opportunity arises from the potential to extract valuable insights, correlations, and patterns from this data, leading to improved efficiency, accuracy, and innovation across industries.

Significance: The amalgamation of Big Data and IoT has far-reaching implications. Organizations can harness the data generated by IoT devices to gain a deeper understanding of customer preferences, optimize supply chains, enhance product design, and enable predictive maintenance. Additionally, governments can leverage IoT data to create smarter and more efficient urban environments. However, with this vast data comes the responsibility to address data privacy, security, and ethical concerns.

The interplay between Big Data and IoT has given rise to a new era of data-driven decision-making and innovation. As these technologies continue to evolve, their combined potential to transform industries and improve the quality of life is substantial. Harnessing the power of Big Data and IoT requires a multidisciplinary approach, blending technology, data science, ethics, and domain-specific knowledge to unlock their full potential.

However, the opportunities presented by Big Data are transformative. By harnessing advanced technologies like machine learning, artificial intelligence, and data analytics, organizations can uncover hidden patterns, correlations, and trends within these massive datasets. These insights can drive informed decision-making, predictive modeling, and the development of innovative products and services. In fields such as healthcare, finance, marketing, and scientific research, Big Data is revolutionizing how problems are approached and solved.

To fully leverage the potential of Big Data, a holistic approach is necessary. This includes adopting suitable data storage and processing architectures such as distributed computing frameworks and cloud platforms. Data preprocessing, integration, and cleaning are essential to ensure data accuracy and consistency. Moreover, effective data governance practices must be implemented to address regulatory requirements and safeguard privacy.

Big Data is reshaping the way we perceive and utilize information. It introduces new challenges related to data management, processing, and ethics, but also opens doors to unprecedented insights and opportunities. As technology continues to evolve, the potential for deriving value from Big Data will expand, making it a vital asset for organizations and researchers alike.

INTEGRATION OF BIG DATA AND IOT

In the current lifestyle, everything is merged with technology. IoT has been emerging rapidly in many industries. IoT consists of devices that collect the data, and with the help of this data, these devices connect with the real world. This data is useful to us as it can help in solving may research problem in one way or another. To analyze this data, various big data analytical tools and techniques can be beneficial. IoT and Big Data are considered as two sides of the same coin. Figure 5 shows the interrelation between IoT and Big data analytics.

IoT and Big Data Analytics relationship

IoT data vary much different from standard data because it includes various sensors and objects for during collection of data. IoT data is a heterogeneous data which involves noise, variety, and have rapid growth. It is assumed that by 2020 there will be 4.4 trillion data around us by IoT devices. Also, these devices will collect, gaze, transmit, analyze, share the real-time data, which changes with every millisecond.

Here comes the vital role of Big Data Analytics to handle such a redundant, heterogeneous, fluctuating data. Big data is used to store this vast amount of data with different storage techniques and then analyzing them for particular outcomes.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 12 , 2022

From various research its id generalized that big IoT data has three features that confirm it to get fit in the big data paradigm:

- It consists of an abundant amount of terminals, which generate massive raw-data.
- Raw-data generated by devices used in IoT can be in any form, but generally, it is unstructured.
- IoT devices generated raw-data are useless if not examined.

Steps for IoT Big Data Processing

To manage IoT Big data, the process is broadly classified into four steps, described below:

- The first step is to manage different data sources of IoT, i.e., IoT sensor devices, where sensors in a device interact with each other with the help of different applications and generate highly unstructured, semi-structured, or structured data.
- In the second step, data generated by different IoT devices called Big IoT data is collected and stored by the Big data storage system. This data is based on the 3V model given by Gartner.
- In Big data storage system, this IoT data is converted into shared and distributed Big data files.
- After that, it applies different analytical tools for analysis of data like Hadoop, Map-Reduce or Spark, and many more, which are further discussed in the next section.
- In the last step, the report corresponding to the injected data is generated and presented to the user.

USE OF BIG DATA AND IOT IN BUSINESS

The utilization of Big Data and the Internet of Things (IoT) in business has brought about transformative changes across various sectors. The integration of these technologies has enabled organizations to enhance operational efficiency, gain deeper customer insights, optimize decision-making processes, and create new revenue streams. Here are some key applications of Big Data and IoT in business:

Operational Efficiency and Process Optimization:

IoT devices embedded in machinery, equipment, and production lines collect real-time data on performance and maintenance needs. This data enables predictive maintenance, reducing downtime and increasing overall operational efficiency.Big Data analytics can identify bottlenecks, optimize workflows, and streamline processes across the supply chain, leading to cost savings and improved resource allocation.

Customer Insights and Personalization:

IoT-enabled devices, such as wearables and smart home devices, gather data on user behaviors, preferences, and usage patterns. This data can be analyzed to create personalized customer experiences and tailored marketing strategies.Big Data analytics can process vast amounts of customer data from multiple sources, providing businesses with a comprehensive view of customer interactions and helping them identify trends and preferences.

Product Development and Innovation:

IoT sensors embedded in products enable manufacturers to collect data on how products are used in real-world scenarios. This information informs product design improvements and innovations.Big Data analytics can analyze customer feedback, usage patterns, and market trends to guide product development strategies and identify opportunities for new offerings.

Supply Chain Optimization:

IoT devices and sensors track the movement, temperature, and condition of goods in transit. This data helps optimize supply chain routes, monitor the quality of perishable goods, and ensure timely deliveries.Big Data analytics can optimize inventory management by analyzing historical data, demand patterns, and external factors, minimizing excess inventory and stockouts.

Risk Management and Fraud Detection:

IoT sensors can monitor physical security measures and detect anomalies in real-time, reducing the risk of theft and unauthorized access.Big Data analytics can detect patterns of fraudulent activities by analyzing large datasets, helping businesses prevent financial losses and protect sensitive information.

Retail and Marketing Insights:

IoT devices in retail environments can track foot traffic, dwell times, and customer interactions, providing insights for store layout optimization and targeted marketing strategies.

Big Data analytics can analyze online and offline customer behaviors to refine marketing campaigns, optimize pricing strategies, and improve customer engagement.

Energy Management and Sustainability:

IoT sensors monitor energy usage in buildings and industrial settings, enabling businesses to identify opportunities for energy efficiency improvements.

Big Data analytics can analyze energy consumption patterns and suggest strategies for reducing carbon footprint, leading to cost savings and environmental benefits.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 12 , 2022

In essence, the integration of Big Data and IoT in business has redefined how organizations operate, innovate, and interact with customers. By leveraging the power of data from interconnected devices, businesses can make informed decisions, optimize processes, enhance customer experiences, and stay competitive in rapidly evolving markets. However, it's important for organizations to consider data privacy, security, and ethical considerations while implementing these technologies to ensure responsible and beneficial outcomes.

MODEL OF BIG DATA

A common model used to describe the characteristics and components of Big Data is the "3Vs + 1" model. This model captures the essential attributes of Big Data and provides a framework for understanding its complexity and challenges. Additionally, some variations include additional Vs to address evolving aspects of Big Data. Here's an overview of the 3Vs + 1 model:

Volume: Volume refers to the massive scale of data generated and collected. With the proliferation of digital devices, sensors, and online activities, data is being produced at an unprecedented rate. Traditional data storage and processing methods are often insufficient to handle the sheer volume of data generated, necessitating scalable and distributed computing architectures.

Velocity: Velocity represents the speed at which data is generated, processed, and transferred. Real-time or near-real-time processing is becoming increasingly important as certain applications require immediate insights. Social media interactions, financial transactions, sensor data, and IoT devices contribute to the rapid influx of data that must be analyzed promptly to extract value.

Variety: Variety highlights the diversity of data types and sources. Big Data encompasses structured data (like traditional databases), semi-structured data (like JSON or XML), and unstructured data (like text, images, videos, and audio). This variety poses challenges in terms of integration, storage, and analysis. Effective tools and techniques are needed to handle this diverse range of data.

Variability (Optional): Some variations of the model include the concept of variability. Variability refers to the inconsistency or volatility of data flows. This can include seasonal variations, spikes in data generation, or the dynamic nature of social media trends. Handling data with varying patterns requires adaptable processing and storage solutions.

Veracity (Optional): Another optional addition is veracity, which addresses the accuracy, reliability, and trustworthiness of the data. In a Big Data environment, the quality of data can

vary significantly, leading to potential issues in analysis and decision-making. Ensuring data quality and reliability is crucial to derive meaningful insights.

Value (Optional): In some discussions, "value" is added as an additional V. This emphasizes that the ultimate goal of dealing with Big Data is to extract valuable insights and actionable information. The value of Big Data lies in its ability to provide organizations with a competitive edge, improved decision-making, and new revenue opportunities.

The 3Vs + 1 (or more) model illustrates that Big Data is more than just a large amount of information; it's about managing diverse data types, processing data at high speeds, and extracting meaningful insights that can drive positive business outcomes. This model serves as a foundation for understanding the challenges and opportunities associated with Big Data, guiding organizations in their efforts to leverage data effectively.

FUTURE OF BIG DATA AND IOT

The future of Big Data and the Internet of Things (IoT) holds immense potential for reshaping industries, improving decision-making processes, and enhancing the quality of life. As technology continues to advance, several trends and developments are likely to shape the trajectory of Big Data and IoT:

Edge Computing and Real-time Analytics: Edge computing, which involves processing data closer to the source (IoT devices), will become increasingly important. This approach minimizes latency, reduces data transfer costs, and enables real-time analytics, making it especially valuable for time-sensitive applications like autonomous vehicles and industrial automation.

5G Connectivity: The rollout of 5G networks will greatly enhance the capabilities of IoT devices. With significantly faster speeds and lower latency, 5G will enable seamless communication between devices, unlocking new applications in fields like remote surgery, augmented reality, and smart cities.

AI and Machine Learning Integration: The integration of artificial intelligence (AI) and machine learning (ML) with Big Data and IoT will lead to more intelligent and autonomous systems. IoT-generated data will fuel AI models, enabling predictive analytics, anomaly detection, and personalized recommendations across various domains.

Data Privacy and Security: As the volume of data collected grows, ensuring data privacy and security will remain paramount. Stricter regulations and standards will shape how organizations handle and protect sensitive information, necessitating robust encryption, access controls, and ethical data practices.

Industry-specific Applications: Different industries will leverage Big Data and IoT in unique ways. In healthcare, wearable devices and medical sensors will facilitate remote patient monitoring. In agriculture, IoT-enabled sensors will enhance precision farming practices. Industry-specific solutions will continue to evolve, leading to more tailored and effective applications.

Environmental Monitoring and Sustainability: IoT devices will play a critical role in monitoring environmental conditions and promoting sustainability efforts. These devices can track air quality, water usage, energy consumption, and more, contributing to a greener and more efficient world.

Blockchain Integration: Blockchain technology may find integration with IoT to enhance data security and transparency. It could provide tamper-proof records of IoT device interactions, ensuring the integrity of data generated and exchanged.

Data Monetization and Sharing: Organizations will explore ways to monetize the data they collect while respecting privacy regulations. Secure data marketplaces might emerge, allowing individuals to share their data in exchange for compensation, giving them more control over their personal information.

Smart Cities and Urban Planning: IoT-driven smart city initiatives will continue to grow, improving urban services and infrastructure. Smart traffic management, waste disposal, energy distribution, and public safety systems will make cities more efficient and livable.

Ethical Considerations: As the use of Big Data and IoT expands, ethical concerns surrounding data ownership, consent, and algorithm bias will become more prominent. Striking a balance between innovation and responsible use of technology will be crucial.

In essence, the future of Big Data and IoT is one of continuous evolution and innovation. As technologies mature and intertwine, they will create new opportunities and challenges that impact industries, society, and individuals alike. Balancing technological advancements with ethical considerations will be key to realizing the full potential of these transformative forces.

CONCLUSION:

In conclusion, the symbiotic relationship between Big Data and Artificial Intelligence (AI) has ushered in an era of unprecedented possibilities and transformative impact across various domains. The convergence of these two technological giants has redefined how we approach data, make decisions, and address complex challenges. This conclusion encapsulates the significance and implications of this synergy.The synergy between Big Data and AI has fundamentally altered the landscape of data-driven insights. Big Data's three-dimensional challenge of Volume, Velocity, and Variety has been met head-on by AI's ability to process,

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 11, Iss 12 , 2022

analyze, and extract patterns from vast datasets with unparalleled efficiency. AI algorithms, fueled by the immense amounts of data, have ushered in a new level of predictive accuracy, enabling organizations to anticipate trends, understand customer behavior, and optimize operations like never before.Crucially, AI's iterative learning and adaptability have elevated the value of Big Data from static information to actionable intelligence. Through machine learning and deep learning techniques, AI systems continuously refine their understanding of data, leading to refined predictions and insights that traditional approaches would struggle to achieve. As AI models mature, they are capable of understanding nuances, context, and even emotions hidden within the data, enhancing the quality of decision-making.

Industries across the spectrum have been revolutionized by this union. Healthcare benefits from personalized treatments and predictive diagnoses, finance embraces algorithmic trading and fraud detection, manufacturing optimizes production lines, and marketing tailors strategies to individual preferences. Moreover, AI-powered recommendation systems have altered consumer behaviours and preferences, influencing purchasing decisions in the digital age.Yet, this partnership is not without its challenges. The ethical use of AI-driven insights gleaned from Big Data remains a critical concern. Ensuring that these insights are used responsibly, protecting individual privacy and avoiding algorithmic biases, becomes an ethical imperative. Striking a balance between innovations and safeguarding human values must remain at the forefront of AI and Big Data endeavours.

In conclusion, the convergence of Big Data and AI has unleashed a paradigm shift, democratizing access to actionable insights and transforming how organizations, governments, and individuals navigate the complexities of our data-rich world. The future holds boundless potential as we continue to harness the power of data and AI to drive innovation, uncover hidden patterns, and make informed decisions that have a lasting impact on our society and well-being.

Reference:

1. M. Beyer, ``Gartner says solving `Big Data' challenge involves more than just managing volumes of data," Tech. Rep., AaltoDoc, Aalto Univ., 2011.

2. R. Mital, J. Coughlin, and M. Canaday, ``Using big data technologies and analytics to predict sensor anomalies," in *Proc. Adv. Maui Opt. Space Surveill. Technol. Conf.*, Sep. 2014, p. 84.

3. N. Golchha, ``Big data-the information revolution," *Int. J. Adv. Res.*, vol. 1, no. 12, pp. 791_794, 2015.

4. Y. Wang, L. Kung, W. Y. C. Wang, and C. G. Cegielski, "An integrated big data analytics-enabled transformation model: Application to health care," *Inf. Manage.*, vol. 55, no. 1, pp. 64–79, Jan. 2018.

5. R. Khan, S. Khan, R. Zaheer & S. Khan, "Future Internet: The internet of things architecture, possible applications, and key challenges," In *Proceedings of international conference on frontiers of information technology*, pp. 275-260, 2012.

6. Ilapakurti, J. S. Vuppalapati, S. Kedari, S. Kedari, C. Chauhan, and C. Vuppalapati, "iDispenser #x2014; Big Data Enabled Intelligent Dispenser," in *2017 IEEE Third International Conference on Big Data Computing Service and Applications (BigDataService)*, pp. 124–130, 2017.

7. Y. Wang, L. Kung, and T. A. Byrd, "Big data analytics: Understanding its capabilities and potential benefits for healthcare organizations," *Technol. Forecast. Soc. Change*, vol. 126, pp. 3–13, Jan. 2018.

8. M. Marjani, F. Nasaruddin, A. Gani, A. Karim, I.A.T. Hashem, A. Siddiqa, I. Yaqoob "Big IoT Data Analytics: Architecture, Opportunities, and Open Research Challenges," *IEEE Access*, vol. 5, pp. 5247–5261, 2017.

9. E. Ahmed, Ibrar Yaqoob, Ibrahim Abaker Targio Hashem, Imran Khan, Abdelmuttlib Ibrahim Abdalla Ahmed, Muhammad Imran, Athanasios V. Vasilakos, "The role of big data analytics in Internet of Things," *Computer Networks*, vol. 129, pp. 459–471, Dec. 2017.

10. Acharjya, D.P., Ahmed, K., "A survey on Big Data analytics: challenges, open research issues, and tools." in *Int. J. Adv. Comput. Sci. Appl.* Vol.7, issue 2, pp. No.- 511–518, 2016.

11. F. Constante Nicolalde, F. Silva, B. Herrera, and A. Pereira, "Big Data Analytics in IoT: Challenges, Open Research Issues and Tools," in *Trends and Advances in Information Systems and Technologies*, Cham, 2018, pp. 775–788.

12. S. Foundation: Spark 0.8.0: This document gives a short overview of how Spark runs on clusters, to make it easier to understand the components involved, 2014, https://spark. apache.org/docs/0.8.0/cluster-overview.html

13. V. Morabito, "Managing change for big data driven innovation," in *Big Data and Analytics*. Springer, 2015, pp. 125–153.

14. Bhardwaj, S. Bhattacherjee, A. Chavan, A. Deshpande, A. J. Elmore, S. Madden, and A. G. Parameswaran, "Datahub: Collaborative data science & dataset version management at scale," *arXiv preprint arXiv:1409.0798*, 2014.

15. F. Farber, S. K. Cha, J. Primsch, C. Bornh¨ovd, S. Sigg, and W. Lehner, "Sap hana database: data management for modern business applications," *ACM Sigmod Record*, vol. 40, no. 4, pp. 45–51, 2012.

16. Y. Zhuang, Y.Wang, J. Shao, L. Chen, W. Lu, J. Sun, B.Wei, and J. Wu, "D-ocean: an unstructured data management system for data ocean environment," *Frontiers of Computer Science*, vol. 10, no. 2, pp. 353–369, 2016. [Online]. Available: http://dx.doi.org/10.1007/s11704-015-5045-6

17. Isard, M., Budiu, M., Yu, Y., Birrell, A., Fetterly, D. Dryad, "distributed data-parallel programs from sequential building blocks" in ACM SIGOPS Oper. Syst. Rev. 41, pp. No.- 59–72, 2007.

18. Kelly, J.: Apache Drill Brings SQL-Like, Ad Hoc Query Capabilities to Big Data (2013). http://wikibon.org/wiki/v/Apache_Drill_Brings_SQL-Like,_Ad_Hoc_Query_Capabilities_to_Big_Data

19. C.L.P., Chen, C.Y. Zhang, "Data-intensive applications, challenges, techniques, and technologies: a survey on Big Data." In *Inf. Sci.* 275, pp. no. -314–347, 2014.

20. G. Ingersoll, "Introducing apache mahout: Scalable, commercial-friendly machine learning for building intelligent applications," White Paper, IBM Developer Works, pp. no. - 1- 8, 2009.

21. C.-W. Tsai, C.-F. Lai and A. V. Vasilakos, "Future Internet of Things: open issues and challenges," *Wireless Netw*, vol. 20, no. 8, pp. 2201–2217, Nov. 2014, DOI: 10.1007/s11276-014-0731-0.

22. M. Chen, S. Mao, and Y. Liu, "Big Data: A Survey," *Mobile Netw Appl*, vol. 19, no. 2, pp. 171–209, Apr. 2014, DOI: 10.1007/s11036-013-0489-0.

23. G. Manogaran, D. Lopez, C. Thota, K. M. Abbas, S. Pyne, and R. Sundarasekar, "Big Data Analytics in Healthcare Internet of Things," in *Innovative Healthcare Systems for the 21st Century*, H. Qudrat-Ullah and P. Tsasis, Eds. Cham: Springer International Publishing, 2017, pp. 263–284.

24. S. Tanwar, S. Tyagi, and N. Kumar, Eds., *Multimedia Big Data Computing for IoT Applications: Concepts, Paradigms, and Solutions*. Springer Singapore, 2020.

25. Dhankhar, K. Solanki, A. Rathee and Ashish, "Predicting Student's Performance by using Classification Methods," International Journal of advanced trends in computer science and engineering, Volume 8 No. 4, 2019.

26. Dhankhar and K. Solanki, State of the Art of Learning Analytics in Higher Education, International journal of emerging trends in engineering research, Vol. 8 No. 3, pp. 868-877, 2020.

27. M. Hooda and C. Rana, Learning Analytics Lens: Improving Quality of Higher Education, International journal of emerging trends in engineering research, Vol. 8 No. 5, pp. 1626-1646, 2020.

28. Dhankhar and K. Solanki, A Comprehensive Review of Tools & Techniques for Big Data Analytics, International journal of emerging trends in engineering research, Vol. 7 No. 11, pp. 556-562, 2019.

29. O. Dahiya and K. Solanki, S. Dalal, A. Dhankhar, Regression Testing: Analysis of its Techniques for Test Effectiveness, International Journal of advanced trends in computer science and engineering, Vol. 9, No. 1, pp. 737-744, 2020.

30. O. Dahiya and K. Solanki, Comprehensive cognizance of Regression Test Case Prioritization Techniques, International journal of emerging trends in engineering research, Vol. 7 No. 11, pp. 638-646, 2019.

31. K. Solanki, Y. Singh, and S. Dalal, "Experimental analysis of m-ACO technique for regression testing," Indian Journal of Science and Technology, 9(30), pp.1-7.

32. K. Solanki, and S. Kumari, "Comparative study of software clone detection techniques." In *2016 Management and Innovation Technology International Conference (MITicon)*, pp. MIT-152, *IEEE*, 2016.

33. Shivani Yadav and Bal Kishan, "Assessment of software quality models to measure the effectiveness of software quality parameters for Component Based Software (CBS)", Journal of Applied Science and Computations, vol. 6, no. 4, pp. 2751-2756, 2019.

34. S. Yadav and B. Kishan, "Analysis and Assessment of Existing Software Quality Models to Predict the Reliability of Component-Based Software", International journal of emerging trends in engineering research, vol. 8, no. 6, 2020. *[In Press]*

35. P. Gulia and Palak, "Nature-inspired soft computing-based software testing techniques for reusable software components" Journal of Theoretical & Applied Information Technology, 95(24), 2017.

36. P. Gulia, and Palak, "Hybrid swarm and GA based approach for software test case selection." International Journal of Electrical & Computer Engineering, pp. 2088-8708, Issue-9, 2019.

37. R. Ratra, and P. Gulia, "Big Data Tools and Techniques: A Roadmap for Predictive Analytics.", International Journal of Engineering and Advanced Technology (IJEAT), Vol. 9, Issue-2, pp. 4986-4992, 2019.

38. K. Vikram, Ch.Aparna, Harshitha.B and Ishpreet Kaur, A Secure and Certifiable Access Mechanism System Designed For Big Data Storage In Clouds. International Journal of Computer Engineering & Technology, 9(2), 2018, pp. 86–90.

39. Azhagammal Alagarsamy and Dr. K. Ruba Soundar, A Survey Paper on Deep Belief Network for Big Data. International Journal of Computer Engineering and Technology, 9(5), 2018, pp. 161-166.

40. Dr. Nirmal Kumar Gupta, Addressing Big Data Security Issues and Challenges. International Journal of Computer Engineering & Technology, 9(4), 2018, pp. 229-237.

41. Kodimalar Palanivel and Chellammal Surianarayanan, An Approach for Prediction of Crop Yield Using Machine Learning and Big Data Techniques, International Journal of Computer Engineering and Technology 10(3), 2019, pp. 110-118

***