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Applications of AI and Machine Learning in Banking Solutions

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***Abstract*—With the advent of recent advancement in technology, banking sector has entered into a new era of innovation. Big data and cloud computing has changed the face of business and banking solutions. The new technologies have opened diversified endeavors for the aspirants in the field of banking sector. Globally, approximately 59 Zettabytes of data is expected to be generated in the year 2020. Out of which major chunk of data comes from the banking sector wherein customer information, transactions, online purchasing, selling, etc. is being stored and analyzed. With this enormous data in banking sector; data processing, storing, analyzing has become a herculean task. Lately, Artificial Intelligence and Machine Learning have been recognized as the most beneficial in providing banking solutions by enabling decision making capabilities to provide competitive advantage. The recent development and enhancement in computational intelligence has catered to the rising demands of banking industry in various areas like customer retention, fraud detection, loan calculations, insurance, risk management, etc. The online markets and online platform has largely contributed to the databases of banking sector by enriching them with lots and lots of data. The data needs to be preprocessed and stored to maintain its quality for data analysis and processing. The data must provide improved and quick services to deal with the competitive market scenarios. In this paper, various banking sector applications have been explored where Artificial Intelligence, Machine Learning and Big Data Analytics are used for various banking solutions. The paper discusses and categorized various AI, ML and BDA models on the basis of business analytics methods.**

***Index Terms*— Banking, artificial intelligence, machine learning, big data analytics, descriptive analytics, predictive analytics, prescriptive analytics.**

I. INTRODUCTION

The banking industry has been the trend setting industry in terms of adapting new technology. It is the fastest growing industry from past few decades. The amalgamation of information technology with banking industry has proven to be the most successful so far. The way banking industry has shaped itself with the help of information technology is visible to all. Be it an online shopping, digital wallets, online payments, cashless transactions, online asset management, etc., everything has become handy with the help of information technology. The banking industry cannot afford to lag behind because of opportunities and challenges in its way. The banking sector invest heavily on information technology to be up to date with the latest challenges and to provide better customer services. The information technology was playing a pivotal role in giving best of the services to customers but with the advent of new innovations in information technology, banking sector has

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further improved. The new field of data science has given a new direction to the banking sector by integrating data, statistics and computer science. Artificial intelligence, machine learning, big data, cloud computing, IoT are the new technologies which have stepped into the banking sector to enhance customer services in almost every field. The self-learning approach of machine learning and neural network algorithms have opened up the new areas in banking sector wherein asset management, working capital management, risk management, fraud detection and prevention, etc. are seen as the potential areas for future research. Now the banks are looking for cloud computing to store big data and applying various machine learning algorithms to extract meaningful information about their customers. Due to competitive markets, banks are providing lot many services to their customers like chatbots, voice assistance for solving their small issues. Banks are using AI tools to detect fraud of money laundering and prevent them. The loan management, insurance managements, risk management, decision making, etc. are also taken care by AI tools and technologies. The banks were earlier used reporting and descriptive analytics but now they are incorporating predictive as well as prescriptive analytics for futuristic forecasting. The banks are providing customized solutions to their potential and prospective customers by analyzing their previous records of data and transactions. The customers and employees are getting highly benefitted through information technologies. The information technologies have improved the efficiency of the banks and gave them a competitive edge in the business.

II. MOTİVATİON OF THE STUDY

The motivation of this study is to find out the prospects of AI, Machine learning and Big data in the Baking industry. The specific objectives are:

- To find out applicability of AI and Machine learning in Banking
- To find out applicability of Big data in Banking
- To find out application areas for descriptive, predictive and prescriptive analytics in Banking
- To find out prospective application areas in Banking for future research directions

III. LİTERATURE REVİEW

The literature review is presented separately for the applicability of AI and Machine learning and Bid Data Analytics in Banking industry.

A. Applicability of AI and Machine Learning in Banking

Genest J. proposed a Banking System using Machine Learning algorithms. Explanation Based Learning (EBL) technique of Machine Learning is being used for the system. It is named as Learning in Software Engineering (LISE) which is used to convert the user's requirements using EBL into operational module. The system is programmed in prolog which is a machine learning language [1]. Garavaglia used a model of Robert Hecht-Neilsen for Counter-Propagation Neural Network to simulate the standard and poor's corporate bond rating. For this work, 87 data elements were obtained from public company that had Standard & Poor's Corporate Bond. Almost 797 companies' data was available out of 7200 public companies having Standard & Poor's Corporate Bonds. The data was taken for three consecutive years to countercheck the recent forecasting. The data was divided into three classes on the basis of grades such as investment, speculative and poor quality [2].

The paper discussed various Business Intelligence methods for growth in profits, improving customer service, improving bank's operating performance, controlling financial risks, etc. The paper covered various supporting technologies for business intelligence such as data warehouses, Online analytical processing (OLAP) and data mining [3]. The authors proposed a framework of an intelligent system for bank based on data warehouse. The proposed model used bank's customer data as well as bank branch's data for analysis through an application of data warehouse. The model was simulated to experience the real-world applications and performed well for scalable banking solutions [4]. The author developed a back propagation neural network for a college student to evaluate the credit rating which can self-organize, self-learn, adaptive and dynamic. The proposed model was used on the data of various banks and proved to have performed well to evaluate the credit rating of a college student [5].

The authors evaluated the credit rating with quantitative as well as qualitative methods. For quantitative method, Adaptive Resonance Theory (ART) was used and for qualitative analysis Artificial Intelligence was used [6]. Alawneh et al. proposed a model for commercial banking sector in Jordan which could analyze factors influencing e-banking quality. The proposed model has a scale which is identified after a detailed literature review of the commercial banking sector considering many e-services quality. There are five dimensions for

evaluating e-banking service quality which includes reliability, efficiency, privacy/security, communication, and responsiveness. The paper suggested bank managers to use e-banking optimally to improve banking services and enhance performance by various marketing strategies through e-banking [7].

The authors focused on the problems of fraud detection and customer retention in Banking Sector. Various datasets were used from online libraries to test artificial neural network for classification purpose. The artificial algorithms used to classify the data have performed quite well for banking datasets [8]. Saleh & Hagras proposed a white box model for predictive analytics unlike various black box models such as support vector machine and neural networks being used in the banking sector. The authors believed that clear and transparent explanation is required to identify the reasoning of selecting particular rules and inferences. The proposed model uses evolutionary computing to reduce the number of rules generated with Genetic Type 2 fuzzy inference engine and summarize them into optimum rules which can provide clear and transparent reasoning. The proposed model can be used to minimize the financial defaults in banking sector [9]. Elisa et al. have explored the applications of AI and BDA for leveraging customer experience in Banking Sector in Indonesia. The paper discussed manager's viewpoints, customer's viewpoints, various challenges and opportunities in banking sector while implementing AI and BDA.

An enterprise system architecture has been proposed and digital innovation were recommended which enables banking institutions to leverage customer experiences. The paper conducted Qualitative research on primary as well as secondary data. The paper discussed the various AI methods like Chat-bots, AI enabled tools, mobile applications etc. being used in various banks in Indonesia for leveraging customer experience, fraud detection and process automation. The paper presented various BDA methods being used in various banks as well. The BDA methods were used to provide right content at the right time to the right people. It also enhanced the customer's satisfaction and market efficiency by providing numerous marketing strategies for online as well as offline channels [10]. The authors have suggested and explored the banks bankruptcy through computational intelligence methods like fuzzy neural networks, inductive modeling method. The computational intelligence methods were used for Ukrainian banks and found out that fuzzy neural networks methods for forecasting were better than traditional or conventional methods [11].

The author highlighted the importance of AI in financial industry by citing various application in functional areas of banking sector. Various applications which are discussed in this paper includes AI Models for Lending, AI powered virtual assistant to create exceptional customer experience, AI Applications for Insurance, AI adoption in financial industry for policy and compliance related issues, Use of AI for Fraud Detection. Finally, the author suggested some recent technologies like IoT which can be incorporated in this sector for improved performance [12].

Janet and Hani have proposed a framework for risk management with AI implementation in banking sector with a goal of explainability regarding customers. The focus of this proposed model is to serve customers and understand them better to achieve positive outcomes. They have applied three machine learning algorithms such as Neural Networks, Fuzzy Logic (Type 2) and Logistic Regression for nine banking use cases data. The paper also focuses on the ethical and safe usage of AI in banking sector worldwide and various explainability methods. Out of these three machine algorithms, Neural Networks performed better than its counterparts in terms of accuracy. For explainability, Type 2 Fuzzy Logic algorithm performed better than the other two [13].

The paper discussed various types of chatbots such as rule based and AI based chatbots. The paper showed that AI is always growing and improving. Till now there has not been much of chatbots AI implementation in banking sector. The paper tends to highlight futuristic approach of intelligent agents. The advent of AI as chatbots in banking sector has been the disruptive force which has changed the way customers can be helped and interacted. The chatbots are contributing to shed the workload of customer care executives for small issues and improving the overall customer's satisfaction and performance [14]. The paper aimed to re-skill the workforce of banking sector in South Africa with the help of Artificial Intelligence. The paper tends to find out the impact and relationship between the re-skilling of workforce with AI tools. This research is intended to allow the banking institution's workforces to develop their skills and competencies in the adaptation and integration of AI [15].

B. Applicability of Big Data Analytics in Banking

Munar et al. proposed and presented a Big Data architecture system design for banking standards which have resilient requirements. The proposed architecture is based on open distributed computing paradigms like Hadoop map-reduce, offering horizontal scalability and no-SQL flexibility. The proposed framework is able to consolidate data from different sources at the same time without losing any information in the financial markets [16]. Hafiz et al. proposed a framework to predict Bankruptcy in financial sector by using Big data analytics. The study caters to determine various data sources of construction firms that contains financial data, determine the

tools for analytics to develop failure prediction models, explore ways BPM tools can be used to predict with the help of Big Data Analytics. Ultimately, the work suggested that how Big Data Analytics can be a useful technique for bankruptcy prediction with the help of robust BPMs [17]. The authors proposed a Risk Forecast Model based on Meta MetaAnalytics (MMA-RFM) using Regression. The proposed model was evaluated using experimental data wherein it performed optimally. The research aimed to focus on the improvement of risk prediction modelling for big data financial domains. The proposed R-MMA model used regression using improved least squares statistical method regression analysis techniques [18].

The authors proposed a novel visualization method for creation and updation for scalable relationship-data graphs for prediction. The structured or semi-structured data from a Big Table (BT) of related data expressed as data-tuples with associated business keys. This table can be quite easily transformed using current Big Data (BD) technologies into a relationship data graph. The proposed method can then be applied to the graph for Predictive business models (e.g., from machine learning) which can further utilize a combination of data-parallel and graph-parallel computations. For any data update, there will be a corresponding change in the graph which can be easily identified and predict the change if any in future [19].

Makki et al. explained various approaches for fraud analytics in the financial and banking sector. The study identified many unresolved issues that includes skewed class distribution, real-time fraud detection dynamic patterns of fraud, and integrating large volume data with variety. The authors suggested that for better futuristic approach for fraud detection, these issues must be dealt with proper methodology [20]. The article articulated the relevance of big data approaches to the banking and financial sector. It summarized the challenges to adopt the big data technologies in this sector and future opportunities for technology development. The author focused on corporate banking because of its transaction and money volumes [21].

The authors explained the methodologies of centralizing data by linking all the bank transactions with AADHAR card number, to track Passport details, to tracking Driving Licenses, to centralize data with PAN card number, to check datasets from RBI & Banks, to track Land Records, to link the GST registration with the PAN card number. The paper described the approach of BDA in demonetization which includes recording of currency details in real time, equipping the cash counting machines with sensors, finding the recurring patterns and correlations in transactions, implementing the analytical tools in the current infrastructure, calibrating the analytical tools in geographical parameters. Two cases were also discussed in this paper; Case 1 includes Tracking of Tax evasion by tracing different accounts linked to one person and Case 2- Tracing discrepancies in transactions between two parties [22].

The authors aimed to suggest a machine learning and big data analytics technique to for the detection and early prevention of any fraudulent online transactions. The proposed model used principle component method for the basic analysis of preprocessed data. These features extracted from PCA method are used to train the machine learning model for pattern recognition for every user for any types of online transactions. Hence, for testing any further online transaction, the user is authenticated by using the testing data. Therefore, the proposed model can be useful to detect and prevent any online fraudulent transactions [23]. Srivastava et al. presented various BDA methods and application areas where these technologies can be used to prevent different types of frauds and improve the performance and efficiency of the Indian banking industries. The paper also presented open research issues and future directions which can be incorporated in banking sector to make it more secure and reliable [24].

Stockinger et al. harnessed Big Data technology for large scale financial risk analytics of a real-world use case and presented a novel implementation. The idea presented in this paper has shown linear scalability with competitive performance. The paper has shown the practical implementation of up to 96 million financial contracts on 512 vCPUs cores to perform data analytics. With such an abundant data, the proposed framework can be promising in future analytics wherein it could evaluate core risk analytics of about 10 large banks in only about 16 minutes [25]. The authors described various analytical methods, outputs, and problems which are encountered while developing the unstructured text-based prediction system which is used to detect the possibility of corporate insolvency.

The real use case was discussed which was ordered by a national government bank. The authors suggested to implement an automatic tagger program for the process of labeling largely unlabeled articles. The proposed scheme achieved the accuracy of 92% (AUC 0.96) in terms of performance and throughput of 50% in 26 predicted candidates having the possibility of insolvency [26]. The paper described and determined essential areas in banking and financial industries which can be benefitted from the BDA topologies. It may also predict the possibilities of employing BDA technologies in Indian banking industries. It further identified the architectural frame works that could be helpful to identify possible frauds during the period of online transactions [27].

IV. Applications of AI and Big Data Analytics in Banking

AI and Big data analytics has a huge contribution towards the growth of Banking industry. There are various areas of banking industry which are directly or indirectly benefitted through AI and Big Data analytics. The applications areas are further classified into three types of Business analytics i.e. Reporting & Descriptive analytics, Predictive analytics and Prescriptive analytics. Businesses use data analytics to explore, collect and transform new dimensions of data for business objectives. The three types of analytics such as descriptive analytics describes the data considering the historical aspects, predictive analytics presents the futuristic predictions based on the historical as well as the current data whereas prescriptive analytics states that what should have happened. Predictive and Prescriptive analytics works best on huge amount of data; that's why big data is used for both of these types of analytics.

A. Reporting and Descriptive Analytics

Descriptive analytics is the most basic type of analytics to present the data. For descriptive analytics, data is collected, organized, completed and transformed in the desired way for analyses. It works on the principle of previous historical data and presents what has happened in the past. Hence, it cannot predict what is going to be happened in present and future. It is the best and easiest way to understand this type of data. Many statistical and mathematical functions are used to present the relevance and output of this data. Hence, reporting and visualizing tools are also used to present the descriptive analytics.

B. Predictive Analytics

Predictive analytics is dependent on the descriptive data. It focusses on what is going to happen in future by studying the historical as well as the current data. It looks for the patterns in the data and accordingly anticipate the subsequent future trends. It uses various machine learning tools to apply various AI and machine learning algorithms to envisage the future prospects of businesses. Machine learning and Deep learning algorithms have revolutionized the businesses by empowering executives and managers to act proactively in the field of business management.

C. Prescriptive Analytics

Prescriptive analytics is the most advanced field after descriptive and predictive analytics. It needs deep understanding of the data and associated parameters which influence each other. It works on the prescription like what should be done by executive, managers and people involved in the business for the benefits of the business. Prescriptive analytics provides multiple decisions and implications of each decision. It even recommends the best decision to be taken for future growth. Prescriptive analytics combines data, statistics, AI and machine learning to deeply understand the intricacies of data. It works on the minutest details of each aspect of the data and prescribes accordingly.

Most of the applications of banking industry fall into the categories of Reporting & Descriptive and Predictive analytics. Therefore, there is good scope for prescriptive analytics in banking industry through AI and Big data analytics. Table 1 showcases various AI and BDA models for Reporting & descriptive, predictive analytics though most of the areas are open for research for prescriptive analytics.

V. Open Research Issues and Challenges

There are many research issues in banking industry which could not have been taken up so far. There is no standard solution for Asset Management and Working Capital Management which can prescribe the solutions and implications associated with each solution. The Loan Management such as Business Loans, Personal Loans and Credit Rating is being managed very well for predictive analytics but it needs further research for prescriptive analytics. Integrated Payment Processing Management such as NFC Payment Solutions, Contactless Payments are handled beyond a doubt but there are lot of security issues pertaining to this area which needs attention and further exploration. There are many companies which provides Contract Solutions like Vehicle Insurance and General Insurance, etc. based on the person's credit score but there is no prescriptive analytics associated with it. There is a lot of scope for Risk Assessment and Management in the banking solutions because there is no fool proof system so far to prescribe the risk assessment and management. Recently many systems have been introduced to enhance customer experience with voice assistant systems, chatbots and consumer engagement platforms but there is scope of improvement in this area as well. The predictive and prescriptive analytics can genuinely benefit the cost assessment, decision making management and fraud detection and prevention because of severity of such problems in the banking industry.

TABLE 1. CLASSIFICATION OF BANKING SOLUTIONS W.R.T. AI AND BIG DATA ANALYTICS

Banking Solutions	**Reporting and Descriptive Analytics**	**Predictive Analytics**	**Prescriptive Analytics**
Asset Management	Counter-Propagation Neural Network Model [2]	Counter-Propagation Neural Network Model [2]	Under research
Working Capital Management	Model for commercial banking [7]	Model for commercial banking [7]	Under research
Loan Management • Business Loans • Personal Loans • Credit Rating	Banking solutions [4], Back Propagation neural network [5], ART and AI [6]	Banking solutions [4], Back Propagation neural network [5], ART and AI [6]	ART and AI [6]
Integrated Payment Processing Management • NFC Payment Solutions • Contactless Payment	Banking solutions [4]	Banking solutions [4]	Under research
Contract Solutions • Vehicle Insurance • General Insurance	AI Models [12]	AI Models [12]	Under research
Mobile and Digital Banking • Digital Wallets	Model for commercial banking [7], Enterprise System Architecture [10]	Model for commercial banking [7], Enterprise System Architecture [10]	Business Intelligence models [3]
Risk Assessment and Management	Business Intelligence models [3], Computational intelligence methods [11], Type 2 Fuzzy Logic algorithm [13], Failure prediction model [17], Risk Forecast Model [18], BDA [25]	Business Intelligence models [3], Computational intelligence methods [11], Type 2 Fuzzy Logic algorithm [13], Failure prediction model [17], Risk Forecast Model [18], BDA [25]	
Enhanced Customer experience • Voice assistant systems • Chatbots • Consumer engagement platforms • Painless onboarding	Learning in Software Engineering (LISE) [1] Business Intelligence models [3], Enterprise System Architecture [10], AI Models [12], Rule Based AI models [14]	Learning in Software Engineering (LISE) [1], Business Intelligence models [3], Enterprise System Architecture [10], AI Models [12], Rule Based AI models [14]	AI Models [12]
Integrated Platforms for eCommerce • B2C sales management • B2B sales management	AI Models [12], Integration of AI [15], BDA [26]	AI Models [12], Integration of AI [15], BDA [26]	Under research
Cost Assessment	Big Data architecture System [16]	Big Data architecture System [16]	Under research
Decision making Management	Novel visualization method [19]	Novel visualization method [19]	Under research
Fraud Detection and Prevention	ANN [8], Genetic Type 2 fuzzy inference engine [9], Enterprise System Architecture [10], BDA in demonetization [22], [23], BDA [27]	ANN [8], Genetic Type 2 fuzzy inference engine [9], Enterprise System Architecture [10], BDA in demonetization [22], [23], BDA [27]	Genetic Type 2 fuzzy inference engine [9]

VI. CONCLUSİONS

The banking industry has always been the booming sector in the last few decades and it has ample scope of expansion. Now with AI, machine learning, cloud computing, IoT, Big data analytics lot more avenues are coming up. Data science is also expanding and rising in the current scenario with latest IT innovations. Therefore, the field of data science can explore new types of business and possibilities in the near future. Lot many companies are providing business solutions using predictive and prescriptive analytics but there is huge possibilities and prospects in this area because of gap between IT and banking expertise. In past few decades, new IT innovation has always been successfully implemented in the banking sector to provide quality of service to customers. The challenging times like covid-19 pandemic has opened the wide arena of possibilities and challenges in this field. Therefore, to overcome all the challenges in this particular industry analytics can play a major role. The paper summarized few predictive and prescriptive models of AI and BDA. There is quite a lot scope of addition of more and more analytical models for the study but with the advent of technology there is no end of innovations in this particular industry.

REFERENCES

[1] Genest J., “Building a Banking System Specification using Machine Learning”, IEEE, 1991, pp. 263-268.

[2] Garavaglia S., “An Application of a Counter-Propagation Neural Network: Simulating the Standard & Poor’s Corporate Bond Rating System”, IEEE, 1991, pp. 278-287.

[3] Qihai Z., Tao H. & Tao W., “Analysis of Business Intelligence and Its Derivative -- Financial Intelligence”, IEEE Computer Society, International Symposium on Electronic Commerce and Security, 2008, pp. 997-1000.
[4] Lin Z., Zhu M., Yin W. & Dong J., “Banking Intelligence: Application of Data Warehouse in Bank Operations”, IEEE, 2008, pp. 143-146.
[5] HU J., “Personal Credit Rating Using Artificial Intelligence Technology for the National Student Loans”, IEEE, Proceedings of 2009 4th International Conference on Computer Science & Education, 2009, pp. 103-106.
[6] Ma H. & Guo Y., “Credit risk evaluation based on artificial intelligence technology”, IEEE Computer Society, International Conference on Artificial Intelligence and Computational Intelligence, 2010, pp. 200-203.
[7] Alawneh A.A., Al-Taan F., Al-Azzam A. & Al-Radaideh R., “A Proposed Measurement Scale for E-Banking Services Quality in Jordan”, IEEE, 2013, pp. 1-14.
[8] Patil P.S. & Dharwadkar N.V., “Analysis of Banking Data Using Machine Learning”, IEEE, International conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC 2017), 2017, pp. 876-881.
[9] Salih A. & Hagres H., “Towards a Type-2 Fuzzy Logic Based System for Decision Support to Minimize Financial Default in Banking Sector”, IEEE, 2018, pp. 46-49.
[10] Elisa I., Ford L.G., Tokuro M., “Digital Banking Transformation: Application of Artificial Intelligence and Big Data Analytics for Leveraging Customer Experience in the Indonesia Banking Sector”, IEEE 8th International Congress on Advanced Applied Informatics (IIAI-AAI), 2019, pp. 863-868.
[11] Zaychenko Y. & Zgurovsky M., “Banks Bankruptcy Risk Forecasting with Application of Computational Intelligence Methods”, CSIT 2019, 17-20 September, 2019, pp. 38-41.
[12] Agarwal P., “Redefining Banking and Financial Industry through the application of Computational Intelligence”, IEEE, Advances in Science and Engineering Technology International Conferences (ASET), 2019, pp. 1-5.
[13] Janet A. & Hani H., “A Type-2 Fuzzy Logic Approach to Explainable AI for regulatory compliance, fair customer outcomes and market stability in the Global Financial Sector”, IEEE International Conference on Fuzzy Systems (FUZZ-IEEE), July 2020.
[14] Suhel S.F., Shukla V.K., Vyas S. & Mishra V.P., “Conversation to Automation in Banking Through Chatbot Using Artificial Machine Intelligence Language”, IEEE, 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions) (ICRITO) Amity University, Noida, India. June 4-5, 2020, pp. 611-618.
[15] Mamela T.L., Sukdeo N. & Mukwakungu S.C., “Adapting to Artificial Intelligence through Workforce Re-skilling within the Banking Sector in South Africa”, IEEE, 2020, pp. 1-9.
[16] Munar A., Chiner E., & Sales I., “A Big Data Financial Information Management Architecture for Global Banking”, IEEE, International Conference on Future Internet of Things and Cloud, 2014, pp. 385-388.
[17] Hafiz A., Lukumon O., Muhammad B., Olugbenga A., Hakeem O. & Saheed A., “Bankruptcy Prediction of Construction Businesses: Towards A Big Data Analytics Approach”, IEEE First International Conference on Big Data Computing Service and Applications, 2015, pp. 347-352.
[18] Baptiste H.J., Qiu M., Gai K. &Tao L., “Meta Meta-Analytics for Risk Forecast Using Big Data Meta-Regression in Financial Industry”, IEEE 2nd International Conference on Cyber Security and Cloud Computing, 2015, pp. 272-277.
[19] Ragavan H. & Shanmugam S., “A Novel Approach to Predictive Graphs using Big Data”, IEEE Computer Society, 2nd International Conference on Big Data Security on Cloud, IEEE International Conference on High Performance and Smart Computing, IEEE International Conference on Intelligent Data and Security, 2016, pp. 123-128.
[20] Makki S., Haque R., Taher Y., Assaghir Z., Ditzler G., Hacid M.S. & Zeineddine H., “Fraud Data Analytics Tools and Techniques in Big Data Era”, IEEE Computer Society, 2017, pp. 186-187.
[21] Trelewicz J.Q., “Big Data and Big Money The Role of Data in the Financial Sector”, IEEE Computer Society, IT Pro, 2017, pp. 8-10.
[22] Sagar R.K. & Gupta Y., “Demonetization: How Big Data Analytics can Unearth the Black Money of India”, IEEE, International Conference on Intelligent Computing and Control Systems (ICICCS), 2017, pp. 67-70.
[23] Balasupramanian N., Ephrem B.G. & Al-Barwani I.S., “User Pattern Based Online Fraud Detection and Prevention using Big Data Analytics and Self Organizing Maps”, IEEE, International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICICT), 2017, pp. 691-694.
[24] Srivastava A., Singh S.K., Tanwar S. & Tyagi S., “Suitability of Big Data Analytics in Indian Banking Sector to Increase Revenue and Profitability”, IEEE, 2017, pp. 1-5.
[25] Stockinger K., Heitz J., Bundi N. & Breymann W., “Large-Scale Data-Driven Financial Risk Modeling using Big Data Technology”, IEEE Computer Society, IEEE/ACM 5th International Conference on Big Data Computing Applications and Technologies (BDCAT), 2018, pp. 206-207.
[26] JIN H., Hong J.P., Lee K.H. & Joo D.W., “Diagnosis of Corporate Insolvency using Massive News Articles for Credit Management”, IEEE, 2019, pp. 1-6.
[27] Gupta T., Gupta N., Ankit Agrawal A., Agrawal A. &Kansal K., “Role of Big Data Analytics in Banking”, IEEE, International Conference on contemporary Computing and Informatics (IC3I), 2019, pp. 222-227.