

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/346395680>

# Accelerating Business Growth with Big Data and Artificial Intelligence

Conference Paper · November 2020

DOI: 10.1109/I-SMAC49090.2020.9243318

CITATIONS

52

READS

3,363

5 authors, including:



**Awishkar Ghimire**

Delhi Technological University

7 PUBLICATIONS 161 CITATIONS

[SEE PROFILE](#)



**Surendrabikram Thapa**

Virginia Tech (Virginia Polytechnic Institute and State University)

48 PUBLICATIONS 409 CITATIONS

[SEE PROFILE](#)



**Avinash Kumar Jha**

Delhi Technological University

8 PUBLICATIONS 188 CITATIONS

[SEE PROFILE](#)

# *Accelerating Business Growth with Big Data and Artificial Intelligence*

Awishkar Ghimire<sup>1, #</sup>, Surendrabikram Thapa<sup>1</sup>, Avinash Kumar Jha<sup>2</sup>, Surabhi Adhikari<sup>1</sup> and Ankit Kumar<sup>2</sup>

<sup>1</sup>Department of Computer Science and Engineering, Delhi Technological University, India

<sup>2</sup>Department of Civil Engineering, Delhi Technological University, India

<sup>#</sup>awishkar.ghimire@gmail.com

## ABSTRACT

Artificial Intelligence (AI) is considered to be the fourth industrial revolution. Artificial Intelligence with the help of big data has transformed all industries around the world. Artificial intelligence refers to the simulation of human or animal intelligence in computational systems so that they are programmed to think like intelligent beings and mimic the actions of intelligent entities. Computational systems which have programmed intelligence can solve different real-world problems far more accurately and efficiently than computational systems that are deterministic and hardcoded. Since many problems in business and business analytics cannot be solved by deterministic systems, AI plays a major role in tackling problems in the business world. Machine learning and deep learning which are subsets of the field of AI is widely used to solve and optimize many problems in business such as marketing, credit card fraud detection, algorithmic trading, customer service, portfolio management, product recommendation according to the needs of customers, insurance underwriting. AI and big data have revolutionized the business world and this paper discusses some AI and big data technologies that are currently being used to accelerate business growth.

**Keywords—**Artificial Intelligence, Big Data, Business Analytics, Decision Making

## 1. INTRODUCTION

A business can be defined as an enterprising entity or an organization consisting of people and assets, that is involved in professional, commercial or industrial activities to make a monetary profit. A business can be considered as the backbone of the modern economy. The size of a business can range from a small industry that offers its services in a small town to a very large group of industries that is located in many different countries. Businesses can be owned by a single person as well as many thousands of people [1]. There are many types and forms of businesses and all of

them have been affected by modern technology especially the larger corporations. In fact, many large companies like Google, Facebook, Amazon are at a war of technology.

Technology in today's modern world is rapidly improving and is making a huge impact in all sectors of the modern world [2]. It has impacted on medical diagnosis, business and many vital sectors [32]. Many businesses in today's world have started using modern cutting edge technology to accelerate their growth and to skyrocket their profits. Artificial Intelligence, Data Science, Big Data, Internet Of Things (IoT) have completely transformed business environments and the way people do business. In the present day, there is not a single field of work that has not explored the use cases of AI [27]. The uses of AI and different computational technologies being used in the manufacturing industries as well as technology industries can be seen. It has been well documented that machines can outperform or at least match human beings in a wide range of activities including emotion-sensing, tacit judgement and automation activities [31]. It has been estimated that computational technologies could take over as much as 47% of the current jobs in the world in as little as 10 years [3]. Technology has had a huge impact in the economic world and the rapid developments in technology in the upcoming years will have completely change the landscape of the current economy. So, it is paramount to have an understanding of how the current cutting edge technologies are impacting the business world. AI is not only being used to automate tedious manual work but it has also been successfully used to do jobs that require higher-order creative thinking such as the works of journalists, attorneys, lab technicians, paralegals etc. [3]. Due to AI and other computational technologies, many jobs are replaced by computational technologies, but this is only for low-skilled jobs such as clerical work. The demand for high skilled jobs and jobs that require the creation of such computational systems have increased and is speedily increasing. Soni et al. [4] in their paper analyze 100 AI startups in the world and describe a very interesting finding. The total investments in the 100 companies they investigated were \$25.88 million in 2011 which increased to \$1866.6 million

in 2016. In just 6 years the funding in these companies increased by a whopping 7112.52%. These figures give an idea of how artificial intelligence and big data is stirring the current business scenario.

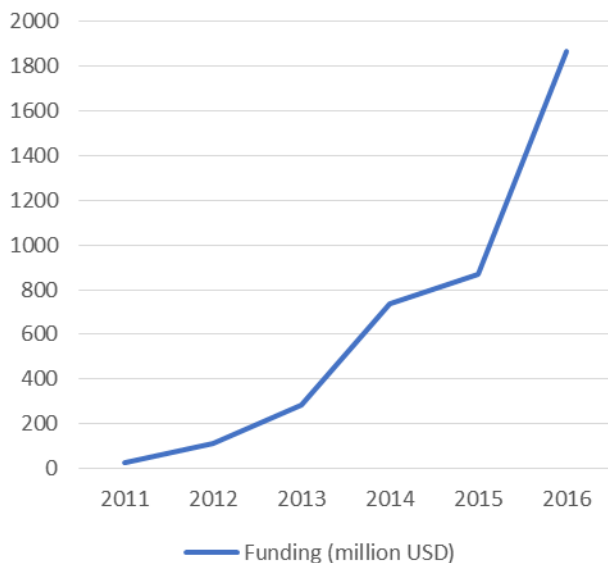


Fig.1. Bar graph of the total investment every year of the 100 AI startups as analysed by Soni et al. [4]

Artificial intelligence and big data are being used in various aspects of businesses to improve profits or to speed up laborious work and thus accelerate business growth. Many works that would have taken thousands of hours for a human to complete can be done in a matter of minutes by an automated system. Many companies like Cognizant develop artificially intelligent systems to improve business processes and revenue [5]. In one case the software company Cognizant developed a solution of optimum equipment utilization using data analysis for a global mining company that saved \$30 million in the capital due to higher availability of equipment. Thus can be seen that AI and data analysis is being heavily used in the modern industry to cut costs and optimize profits for the business thus accelerating growth.

## 2. RELATED WORKS

The major areas in finance and business where artificial intelligence and big data solutions are playing a role are loan/insurance underwriting, fraud detection, customer service, sentiment/news analysis, algorithmic trading, portfolio management, marketing, recommendation systems of financial products, advertisement recommendation etc. Some of the AI techniques and their uses in these areas of business are discussed below.

### A. Fraud Detection

Fraud is one of the most substantial crises in today's economic world. Businesses all around the world lose billions of dollars due to fraudulent activity. According to various sources, the total fraud losses reached \$27.85 billion in 2018 and this figure has been estimated to rise to \$40.63 billion in the coming ten year period [6]. This figure is more than the annual GDP of many third world countries. Therefore, computational systems that are capable of detecting and catching fraudulent activities is quintessential, because doing so would rapidly accelerate business and economic growth. Researchers have devised many systems that incorporate artificial intelligence and machine learning to create such systems. All fraud detection techniques can generally be classified into two categories, anomaly detection and misuse detection [7]. Anomaly detection learns the transaction behaviour of a certain customer and any new transaction made by the customer is classified as normal or anomalous according to past transactions made by that customer. Misuse detection creates the model using a labelled data set of all the customers, and fraudulent activity is determined according to the general fraudulent patterns.

Awoyemi et al. [8] compare traditional machine learning models for credit card fraud detection. A dataset consisting of 284,807 credit card transactions from European cardholders was used. Since fraud dataset is highly skewed, oversampling, undersampling techniques along with no sampling was also used for better and more accurate comparison. Their paper compared naive Bayes classifier, logistic regression classifier and k-nearest neighbour classifier [9]. All of these are misuse detection techniques. The naive Bayes classifier gave 97.92% accuracy, the logistic regression classifier gave 54.86% accuracy and the k - nearest neighbour classifier gave 97.69% accuracy. Logistic regression gives much lower accuracy and this is apparent because it cannot learn non - linear functions.

Xuan et al. [7] in their paper mention a random forest algorithm for credit card fraud detection. The dataset used by them comes from a Chinese e-commerce company. Random forest is an ensemble learning method in which a set of decision trees is created, and every tree is made with an independent data set. The performance of the random forest depends on the strength of each tree and the correlation between the trees [28]. The higher the strength of each tree and the lower the correlation between the trees, the better the performance of the algorithm. Xuan et al use two different random forest models and compare their performance on the dataset. The two random forests differ in their base classifier i.e individual tree in the model. The first random forest uses a simple decision tree as the base classifier and the second random forest uses CART(classification and regression) trees as the base classifier. The accuracy of the first random forest comes out

to be 91.96% and the accuracy of the second model comes out to be 96.77%.

Randhawa et al. [10] compare the performance of about 12 machine learning algorithms on credit card fraud detection. They use a public credit card transaction dataset. They also use ensemble methods which use adaptive boosting and majority voting for classifying an instance. They experiment on 7 ensemble methods which use majority voting. The best accuracy was given by an ensemble of Neural Network and Naive Bayes classifier. This ensemble had an accuracy of 99.941% on the dataset they used. In the real world, companies generally use ensemble methods for fraud detection.

### B. Algorithmic Trading

Trading is one of the key concepts in economics and business. Trading can loosely be defined as the buying and selling of an economic entity such as goods, stocks, currency etc. Trading is undertaken by individuals and businesses to earn a profit. The trading process generally consists of 4 components, pre-trade analysis, trading signal generation, trade execution and post-trade analysis [11]. Algorithmic trading can be loosely defined as the automation of any of the combination of these steps or all of these steps. Artificial Intelligence has completely transformed this area of business by automating the trading process and many trading algorithms can create profit without any human intervention. Algorithmic trading using artificial intelligence has had a huge impact on business and growth.

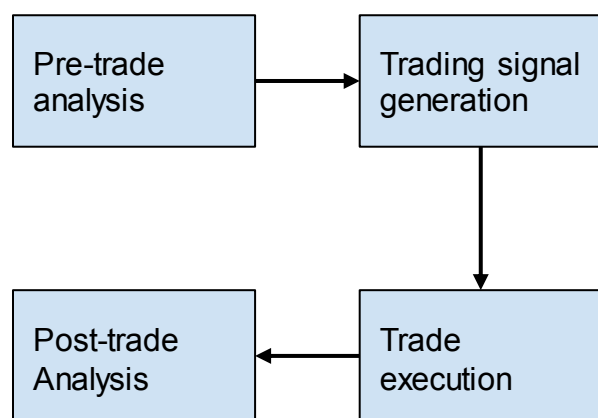


Fig. 2. Steps in a complete algorithmic trading system

Roondiwal et al. [12] propose a learning algorithm that can be used to predict stock prices. The dataset that they use is of New York stock exchange and the dataset consists of the data, the open price, the close price, the volume. The use LSTM (Long Short Term Memory) which is a type of recurrent neural network. LSTMs incorporates a memory cell which corresponds to neurons in traditional artificial

neural networks. These memory cells can associate memories in the input and grasp the structure of data and hence make the prediction accurate. The LSTM they used consisted of a sequential input layer after which comes the 2 LSTM layers and a dense layer which uses ReLU activation function and then finally the output layer which uses the linear activation function. Roondiwala et al conducted various experiments tweaking different parameters and the best performing LSTM displayed an RMSE(Root mean square error) of 0.00859 which is unbelievably low and hence proved that Artificial intelligence can be effectively used to predict stock prices.

Colianni et al. [13] use sentiment analysis to predict the prices of bitcoins. They use an open-source API to gather the tweets with the keyword bitcoin. Then the features are extracted from the tweet in the form of words and their counts. This feature then becomes an input to the classification algorithm which tells the bitcoin price will increase or decrease. The classification algorithms mentioned in their paper are naive bayes classifier and support vector machines. The SVM gives better accuracy according to their paper. Their algorithm is limited in the sense that it doesn't tell what the increasing percentage of the decrease percentage will be, however, bitcoin price prediction using sentiment analysis in twitter is an interesting application of artificial intelligence.

### C. Customer Service

Artificial Intelligence and data science solutions have also been used to automate customer service [14]. With AI technology businesses no longer need to hire dedicated customer service officials. A 24/7 chatbot can answer the different queries of customers and this practice is seen widely successful in the last few years in different businesses. AI can handle questions of the customers from a huge knowledge database it has learnt from. This substantially decreases the hiring cost of a company, and the same work can be done with much less money, thus empowering the growth of the business.

Cui et al. [15] developed a chatbot called superagent that acts as a customer service provider for e-commerce websites like amazon. It is an add on and it can work on any e-commerce website. The system first crawls the page of the product that the user searches for and gathers the information from the page. The system uses state of the art NLP techniques to interpret the question that the user asks it. To find information regarding the subject matter asked the system uses deep learning models and recurrent neural networks and further uses NLP to answer the questions in English. Super agent system has 3 engines that are effectively used to answer the questions of the customers. The first engine is FACT QA that is used to answer questions related to the product information like "what is the specification of the CPU". The second engine is FAQ search

for customer QA pairs. This engine is used to answer questions like “does it come with ink” etc. The third engine is Opinion-Oriented Text QA used for reviews. This engine is used to answer questions like “what do you think of the design of the cup”. The system is also capable of answering small talk questions such as hello etc. Systems like these can potentially save millions of dollars for a company.

#### D. Marketing and Product Recommendation

Artificial Intelligence and big data have had a considerable impact on marketing as well. Data-driven marketing strategies are much more effective than using human-based marketing strategies. These days youtube, Facebook, Instagram and almost all social media uses artificial intelligence and machine learning systems to display individualized and personalized advertisements. A person that is interested in guitar is much more likely to be shown an advertisement related to guitar in such platforms. Marketing is arguably the most heavily affected area in business due to artificial intelligence. The centrepiece in marketing today is customer analytics using big data and the interpretation of this data using various machine learning models that produce amazing and profitable insights [16].

Sundsoy et al. [17] experimented on an MNO (mobile network operator) in Asia comparing big data-driven marketing strategies to traditional human-based marketing strategies. The company often used to send marketing SMS to selected customers regarding some data packs and hope that the customer would buy it. The customers were selected by marketing officials. In their experiment sundsoy et al divides customers into a control group and treatment group. The control group was selected by the marketing officials of the company whereas the treatment group was selected by using some data-driven machine learning models. After the experiment, they found that the conversion rate i.e the customers who were willing to buy the marketed data pack was 13 times higher in the treatment group (group selected using data-driven models) than the control group (group selected by marketing officials). They tested using different machine learning models such as artificial neural networks, support vector machines, and the final model was a bootstrapped decision tree. This experiment clearly shows the power of data-driven analytics and how it can impact and accelerate business growth. Product Recommendation in websites is also another form of marketing that is widely being used in today's world.

Paradarami et al. [18] propose a hybrid recommender system for recommending business products. Their recommendation system consists of a deep artificial neural network that uses reviews along with content-based features and collaborative features to create accurate recommendations. This paper demonstrates that ANN trained for a specific class of business can generalize into other classes of business as well and recommend products for other classes very effectively as well. It also generalizes

into different types of users as well and hence the scalability of the recommendation system is drastically improved. This approach only requires model parameters to be saved in the memory unlike memory-based recommendation systems, this significantly decreasing digital memory footprint and greatly increasing scalability. Their approach can also be used to implement real-time recommendation systems which work in an instant due to the speed of their system.

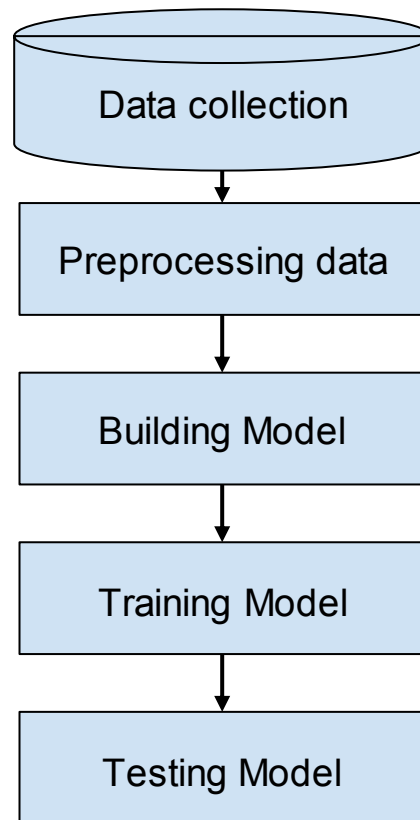


Fig. 3. General scheme of an AI model

#### E. Cyber Security

Cybercrime is one of the greatest threats to mankind in the modern world. It is the most prominent threat to any modern business in the current day. It has been estimated that the loss due to cybercrimes is projected to reach \$6 trillion by 2021, which is staggeringly huge. Technologies and strategies to fight cybercrime are paramount in business. Many businesses have gone bankrupt due to cybercrimes. Effective cybersecurity technology against cybercrimes will invariably help the growth and sustenance of a business [19]. Artificial intelligence and machine learning have been successfully used to fight against cybercrimes. Application of machine learning in cyber crimes is generally categorized into three categories, intrusion detection, malware analysis and phishing detection [20].

Kim et al. [21] used Long short term memory (LSTMs) which is a type of Recurrent neural network for intrusion detection in cybersecurity systems. The data set they used to conduct their experiments was KDD Cup 1999 dataset. 4,898,431 network traffics were present in the data set and each traffic consisted of 41 features like IP address etc and 22 attacks are differentiated according to their characteristics. In their experiment, they compared many different machine learning algorithms and LSTM-RNN has

the highest accuracy of 96.93%. Another application of machine learning in cybersecurity is phishing detection.

Gupta et al. [22] propose an artificial neural network with particle swarm optimization(PSO) to detect phishing URLs. The PSO techniques are used widely because of its robustness and short computational time [29]. Moreover, they also have an easy implementation [30]. In their paper, they compare back propagation neural network and part PSO neural network and they find that in their dataset, PSO

TABLE I. PAST WORK IS DONE IN THE FIELD OF BUSINESS ANALYTICS

Name of Author	Year of Publication	Methods used	Dataset used	Use case
Paradarami et al. [18]	2017	Deep ANN + content-based features + collaborative features	Yelp academic dataset	Product Recommendation
Awoyemi et al. [8]	2017	K-nearest neighbour/ naive bayes/ logistic regression	Credit card transaction of european cardholders dataset	Fraud detection
Xuan et al. [7]	2018	Random forest	Credit card transaction dataset of chinese e-commerce company	Fraud detection
Randhawa et al. [10]	2018	Adaboost + majority voting , ANN + NB	Public credit card transaction dataset	Fraud detection
Roondiwala et al. [12]	2017	LSTM	New York stock exchange dataset	Stock prices prediction using time series data
Colianni et al. [13]	2015	NLP + SVM/NB	Twitter data	Bitcoin price prediction using sentiment analysis
Cui et al. [15]	2018	NLP + Deep ANN	E-commerce data	Customer service
Kim et al. [21]	2016	LSTM	KDD cup 1999 dataset	Intrusion detection in cyber security
Gupta et al. [22]	2017	ANN with PSO	UCI repository archive	Phishing detection in cyber security

neural network gave an accuracy of 93.93% accuracy when the number of hidden neurons was 67 and the activation function used was tansig. The highest accuracy that the Backpropagation algorithm gave was 96.81% when the number of hidden neurons was 21 and the activation function was logsig. Machine learning is heavily influencing the field of cybersecurity and many companies are using it to fight cybercrimes and save billions of dollars.

### 3. FURTHER APPLICATIONS AND DISCUSSION

Table I shows the past works that have been done in the last five years or so. The works show that there are ample areas where artificial intelligence can be used to grow business in a lot of ways ranging from fraud detections to product recommendation. The recent use of chatbots in customer service experience was a hugely celebrated success and it shows that there is a great scope of AI in business analytics. Similarly, small stock traders and bitcoin traders also use Business analytics to build predictive models.

In the above section, various papers on artificial intelligence and data science pertaining to the use cases in business and finance have been discussed. However, AI is not just limited to the above-mentioned areas of finance. There are a lot more areas of finance and business in which artificial intelligence and data science have been successfully used to make huge progress in a particular field. AI is increasing the efficiency and productivity across the entire value chain in a business process, right-front the moment the business model is developed to the moment the business product goes to the hands of the customer. AI is revolutionizing the business process.

One interesting application of AI in business technology is automatic retail transactions in supermarkets. Amazon with its Amazon Go retail stores are using this technology. There are recognition sensors of various kinds throughout the store that sense what the customer is picking up in the store and they automatically charge the customer without the customer having to checkout through the traditional process [23]. Another area in which data science and AI has had immense value is credit scoring. AI and ML algorithms have been successfully used to give a credit score to customers given the customer data.

Artificial intelligence has also been successfully used in portfolio management. Portfolio management is the robust decision-making process in which funds are allocated in different types of investment products to reduce the risk of losing too much money. Jiang et al. [24] propose a deterministic deep reinforcement learning method for solving the portfolio management problem when investing in cryptocurrencies. Their approach doesn't rely on any financial theory hence, it is robust and can be extended to any other financial markets as well. Liu et al. [25] propose a

one-layer recurrent artificial neural network for solving linear pseudoconvex optimization problems with constraints for dynamic portfolio optimizations to improve profits and reduce the loss of investment opportunities.

A lot of Quantitative Finance is another field of business in which machine learning has played a huge role. Spiegel et al. [26] propose various machine learning models for solving traditional quantitative finance problems like hedging, curve fitting, derivative pricing. They have also given a novel idea which used a Bayesian non-parametric technique called the GPR. They use ML models to fit sophisticated greek profiles and summarise different implied volatility surfaces.

According to an article published in the Harvard business review [33], three kinds of artificial intelligence are taking over the business industry. The first kind is process automation. This included reading contractual and legal documents using state of the art NLP techniques and extracting and interpreting it using different intelligent models, transferring relevant data and information from call centre systems and emails to the databases of the company. The second kind is cognitive insights. This kind of system solves problems like what the customer is more likely to buy, analyze different warranty data to correctly identify quality problems or safety in different manufactured problems. provide insurance companies with detailed and more accurate modelling. The third kind mentioned in the article is cognitive engagement. This includes systems like recommendation systems for health treatment that help users get a customized care plan that takes into account each user's health history and different data. In that article, the author's reviewed 152 different use cases of artificial intelligence in business systems, among which 47% fell into the process automation category, 38% fell into the cognitive insights category and 16% fell into the cognitive engagement category.

### 4. CONCLUSION AND FUTURE WORKS

In this paper, several applications of machine learning, deep learning and data science in the context of business and their growth have been reviewed. AI has utterly transformed the business world, and many people in today's world have been working side by side with artificial intelligence systems to solve complex problems in the world and make a profit out of the solution. AI has been seen used in various areas of the business to accelerate its growth. Some fields which have been discussed in this paper are marketing, customer service, algorithmic trading, fraud detection, cybersecurity, portfolio management, sentiment analysis, credit scoring.

AI has been used successfully to drive the modern economic world and it will be a key player in shaping the

future. Today's AI is not even as intelligent as human beings yet it has had a massive impact in the world. The AI of tomorrow will undoubtedly change the way the business and how businesses function is seen. Once AI reaches a certain level, might be able to see systems that can hire people into a company. Artificial Intelligent systems might someday take over the work of a CEO and might overlook businesses and how they function. In the future, AI systems might do every job from building a business model to supplying it into the market rendering human intervention obsolete.

## REFERENCES

- [1] S. Prakash et al., "Characteristic of enterprise collaboration system and its implementation issues in business management," *International Journal of Business Intelligence and Data Mining*, vol. 16, no. 1, pp. 49-65, 2020.
- [2] S. Adhikari, S. Thapa, and B. K. Shah, "Oversampling based Classifiers for Categorization of Radar Returns from the Ionosphere," in *2020 International Conference on Electronics and Sustainable Communication Systems (ICESC)*, 2020: IEEE, pp. 975-978.
- [3] S. A. Wright and A. E. Schultz, "The rising tide of artificial intelligence and business automation: Developing an ethical framework," *Business Horizons*, vol. 61, no. 6, pp. 823-832, 2018.
- [4] N. Soni, E. Shama, N. Singh, and A. Kapoor, "Impact of Artificial Intelligence on Business," in *Digital Innovations, Transformation, and Society Conference 2018 (Digits 2018)*, pp. 2018, vol. 10.
- [5] A. Kumar and M. Janakiraman, "Cognizant Technology Solutions: Growth and transformation of its data warehousing and business intelligence division," *Journal of Information Technology Case and Application Research*, vol. 10, no. 3, pp. 56-83, 2008.
- [6] S. Rajora et al., "A comparative study of machine learning techniques for credit card fraud detection based on time variance," in *2018 IEEE Symposium Series on Computational Intelligence (SSCI)*, 2018: IEEE, pp. 1958-1963.
- [7] S. Xuan, G. Liu, Z. Li, L. Zheng, S. Wang, and C. Jiang, "Random forest for credit card fraud detection," in *2018 IEEE 15th International Conference on Networking, Sensing and Control (ICNSC)*, 2018: IEEE, pp. 1-6.
- [8] J. O. Awoyemi, A. O. Adetunmbi, and S. A. Oluwadare, "Credit card fraud detection using machine learning techniques: A comparative analysis," in *2017 International Conference on Computing Networking and Informatics (ICCN)*, 2017: IEEE, pp. 1-9.
- [9] A. Saxena et al., "A review of clustering techniques and developments," *Neurocomputing*, vol. 267, pp. 664-681, 2017.
- [10] K. Randhawa, C. K. Loo, M. Seera, C. P. Lim, and A. K. Nandi, "Credit card fraud detection using AdaBoost and majority voting," *IEEE access*, vol. 6, pp. 14277-14284, 2018.
- [11] G. Nuti, M. Mirghaemi, P. Treleven, and C. Yingsaeree, "Algorithmic trading," *Computer*, vol. 44, no. 11, pp. 61-69, 2011.
- [12] M. Roondiwala, H. Patel, and S. Varna, "Predicting stock prices using LSTM," *International Journal of Science and Research (IJSR)*, vol. 6, no. 4, pp. 1754-1756, 2017.
- [13] S. Colianni, S. Rosales, and M. Signorotti, "Algorithmic trading of cryptocurrency based on Twitter sentiment analysis," *CS229 Project*, pp. 1-5, 2015.
- [14] S. Thapa, S. Adhikari, and S. Mishra, "Review of Text Summarization in Indian Regional Languages," in *2020 International Conference on Computing Informatics & Networks (ICCN)*, 2020: Springer.
- [15] L. Cui, S. Huang, F. Wei, C. Tan, C. Duan, and M. Zhou, "Superagent: A customer service chatbot for e-commerce websites," in *Proceedings of ACL 2017, System Demonstrations*, 2017, pp. 97-102.
- [16] S. Erevelles, N. Fukawa, and L. Swayne, "Big Data consumer analytics and the transformation of marketing," *Journal of business research*, vol. 69, no. 2, pp. 897-904, 2016.
- [17] P. Sundsøy, J. Bjelland, A. M. Iqbal, and Y.-A. de Montjoye, "Big data-driven marketing: how machine learning outperforms marketers' gut-feeling," in *International Conference on Social Computing, Behavioral-Cultural Modeling, and Prediction*, 2014: Springer, pp. 367-374.
- [18] T. K. Paradarami, N. D. Bastian, and J. L. Wightman, "A hybrid recommender system using artificial neural networks," *Expert Systems with Applications*, vol. 83, pp. 300-313, 2017.
- [19] A. Saini, M. S. Gaur, V. Laxmi, and M. Conti, "Colluding browser extension attack on user privacy and its implication for web browsers," *Computers & Security*, vol. 63, pp. 14-28, 2016.
- [20] G. Apruzzese, M. Colajanni, L. Ferretti, A. Guido, and M. Marchetti, "On the effectiveness of machine and deep learning for cyber security," in *2018 10th International Conference on Cyber Conflict (CyCon)*, 2018: IEEE, pp. 371-390.
- [21] J. Kim, J. Kim, H. L. T. Thu, and H. Kim, "Long short term memory recurrent neural network classifier for intrusion detection," in *2016 International Conference on Platform Technology and Service (PlatCon)*, 2016: IEEE, pp. 1-5.
- [22] S. Gupta and A. Singhal, "Phishing URL detection by using artificial neural network with PSO," in *2017 2nd International Conference on Telecommunication and Networks (TEL-NET)*, 2017: IEEE, pp. 1-6.
- [23] C. Campbell, S. Sands, C. Ferraro, H.-Y. J. Tsao, and A. Mavrommatis, "From data to action: How marketers can leverage AI," *Business Horizons*, vol. 63, no. 2, pp. 227-243, 2020.
- [24] Z. Jiang and J. Liang, "Cryptocurrency portfolio management with deep reinforcement learning," in *2017 Intelligent Systems Conference (IntelliSys)*, 2017: IEEE, pp. 905-913.
- [25] Q. Liu, Z. Guo, and J. Wang, "A one-layer recurrent neural network for constrained pseudoconvex optimization and its application for dynamic portfolio optimization," *Neural Networks*, vol. 26, pp. 99-109, 2012.
- [26] J. De Spiegeleer, D. B. Madan, S. Reyners, and W. Schoutens, "Machine learning for quantitative finance: fast derivative pricing hedging and fitting," *Quantitative Finance*, vol. 18, no. 10, pp. 1635-1643, 2018.
- [27] S. Thapa, P. Singh, D. K. Jain, N. Bharill, A. Gupta, and M. Prasad, "Data-Driven Approach based on Feature Selection Technique for Early Diagnosis of Alzheimer's Disease," in *2020 International Joint Conference on Neural Networks (IJCNN)*, 2020: IEEE.
- [28] A. K. Jha, S. Adhikari, S. Thapa, A. Kumar, A. Kumar, and S. Mishra, "Evaluation of Factors Affecting Compressive Strength of Concrete using Machine Learning" in *2020 Advanced Computing and Communication Technologies for High Performance Applications (ACCTHPA)*, 2020: IEEE.
- [29] N. Bansal, R. Gautam, R. Tiwari, S. Thapa, and A. Singh, "Economic Load Dispatch Using Intelligent Particle Swarm Optimization", in *2020 2nd International Conference on Intelligent Computing Information and Control Systems (ICICCS 2020)*, 2020: Springer.
- [30] N. Bansal, S. Thapa, S. Adhikari, A. K. Jha, A. Gaba, and A. Jha, "Novel Exponential Particle Swarm Optimization Technique for Economic Load Dispatch", *2nd International Conference on Inventive Computation and Information Technologies*, 2020: Springer.
- [31] S. Thapa, S. Adhikari, U. Naseem, P. Singh, G. Bharathy, and M. Prasad, "Detecting Alzheimer's Disease by Exploiting Linguistic Information from Nepali Transcript", in *2020 27th International Conference on Neural Information Processing*, 2020: Springer.



- [32] S. Thapa, S. Adhikari, A. Ghimire, and A. Aditya, "Feature Selection Based Twin-Support Vector Machine for the diagnosis of Parkinson's Disease", in 2020 IEEE 8th R10 Humanitarian Technology Conference (R10-HTC), 2020: IEEE
- [33] T. H. Davenport and D. D. D. Ronanki, "Artificial intelligence for the real world," Harvard business review, vol. 96, no. 1, pp. 108-116, 2018