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Editorial

Big data, analytics and artificial intelligence for sustainability

Bolanle A. Ojokoh[a,*], Oluwarotimi W. Samuel[b], Olatunji M. Omisore[c], Oluwafemi A. Sarumi[d], Peter A. Idowu[e], Emile R. Chimusa[f], Ashraf Darwish[a,b,c,d,e,f], Adebayo F. Adekoya[a,b,c,d,e,f], Ferdinand A. Katsriku[a,b,c,d,e,f]

[a] Department of Information Systems, Federal University of Technology, Akure, Nigeria
[b] Center for Neural Engineering, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences (CAS), Shenzhen 518055, China
[c] Centre for Medical Robotics and Minimally Invasive Surgical Devices, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences, Shenzhen 518055, China
[d] Department of Computer Science, The Federal University of Technology, Akure, Nigeria
[e] Department of Computer Science and Engineering, Obafemi Awolowo University, Ile-Ife, Nigeria
[f] Department of Pathology, Institute of Infectious Disease and Molecular Medicine, University of Cape Town, Cape Town, South Africa

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ABSTRACT

Big data technologies, Analytics and Artificial Intelligence are great tools with capabilities to accomplish complex tasks at levels beyond human skills. The trio are becoming more and more prominent these days as they can be utilized to collect, organize, and analyze large varied data sets in order to reveal hidden patterns and trends that can help address several problems peculiar to sustainable development. Nevertheless, a number of challenges arise in the process of exploring these technologies for proffering solutions. This special issue presents novel research approaches adopted in Africa in relation to Big Data, Analytics and Artificial Intelligence in different domains. It also presents the challenges and issues that can be explored in the future.

Introduction

Big Data refers to a collection of data sources, technologies and methodologies that have emerged from the exponential growth in data creation over the past decades. They are complex and heterogeneous data with capacities that cannot be managed and processed within a tolerable computing time by commonly-used algorithms [1, 2]. In the past ten years, big data has become prominent in the field of Computer Science and Information Technology due to several technological advances and real-life application of high processing computing tools in diverse domains. In the global south, including Africa, the potentials of big data and analytics are great-leveraging the plethora of data everywhere around us. This serves like a gold mine, that has to be explored for meaningful knowledge discovery that can uplift the nations economically, socially, academically and in virtually all spheres. The 5Vs of Big Data has generally been used to describe its diverse characteristics including **value**–evaluating the efficacy of the collected data; **variety**–describing the heterogeneity of the data in terms of

* Corresponding author.
E-mail address: baojokoh@futa.edu.ng (B.A. Ojokoh).

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contents; **velocity**–expressing the momentum of data generation and collection; **veracity**–examining the degree of correctness, or trustworthiness of data; and **volume**–focusing on the magnitude or the quantity of the data [3], with several more emerging.

Data Analytics is an important concept involving the discovery, interpretation and communication of novel knowledge and meaningful patterns from big data in diverse application domains for fast, quality, and effective decision making. It is an emerging technology that combines methods and algorithms from diverse fields of study such as data mining, mathematics, statistics, machine learning, and high-performance computing to effectively handle big data problems [4]. Big data analytics has been found to improve Financial industries [5], Biomedicine [6, 7], Environmental studies [8], Computer networks [9], Agriculture [10], and Transportation [11] among others. In the developing economies, there are rich intellects and intellectuals to mine our existing big data; also there exists key technologies like Machine Learning, Data Mining and Management for our use. Artificial Intelligence (AI) also comes into play as one of these. Nevertheless, with the lots of benefits that can be gained with big data analytics, we are faced with the challenges of dealing with data growth, integrating disparate data sources, and security. Others are data validation, organizational resistance and governance issues with data.

AI is a branch of computer science that is geared towards the development and deployment of intelligent systems based on human knowledge reasoning, self-learning, and problem-solving for effective and efficient decision making [12, 13]. It is required to complement and better support decision making from big data analytics for sustainability. Sustainability is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs [14] The need for sustainability and its potential brought about the 17 Sustainable Development Goals (SDGs). Researchers in Africa can leverage the strength and opportunities of these three concepts to expedite the process of actualising the United Nations vision 2030 agenda for Africa through the SDGs–especially in the area of industry, innovation and infrastructure, quality education, good health and well being, affordable and clean energy, zero hunger, and climate change action.

Brief of the special issue content

This special issue consists of invited papers from the 1st African Symposium on Big Data, Analytics and Machine Intelligence (BAM 2019), themed "Exploring Big Data, Analytics, and Machine Intelligence for Financial, Health and Environmental Inclusion in Developing Countries" organized by TWAS Young Affiliates Network (TYAN) with funding from TWAS, as well as some papers from the open call. In response to the call for papers, 43 manuscripts were submitted for the special issue. Only 24 of these manuscripts were qualified for review. These 24 manuscripts went through rigorous peer review in order to ensure that they met up with the standard and quality of the Scientific African Journal. They were evaluated in terms of the immediacy of interest for the wider research community, the degree of advancement provided, novelty of the research, new knowledge produced, solutions offered from the research in addressing challenges in Africa, and in terms of general scientific merit, before the final selection process. Eventually, 13 high-quality manuscripts, which focus on advancing research on Big Data, Analytics and Artificial Intelligence for Sustainability were selected. Hence, the acceptance rate is 30%. The results of the research will seamlessly aid adequate decision making and efficient service delivery across various fields, with different data-driven artificial intelligence based proposed solutions.

As electronic payment systems continue to impeccably aid global business transactions while credit cards emerged as a payment means, e-security has become a threat to financial institutions with worldwide focus being paid on realizing a unified platform for business transactions. As a result, [15] developed a framework that integrates the potentials of meta-learning ensemble techniques and cost-sensitive learning paradigm for detecting credit card fraud. The system is based on fitting traditional learning methods to allow base-classifiers while an ensemble learning process is incorporated to enforce cost-sensitive learning of meta-classifiers without the base-classifiers. Evaluation studies observed using the area under the receiver operating characteristic curve shows that the proposed method has acceptable predictive training accuracy.

Multi-Criteria Decision Making is an important technique that can enhance and support decision making processes wherein ideal choices are needed to be made in the sight of multiple and conflicting criteria. To address this research question, [16] proposed a feedback integrated fuzzy analytic hierarchy process and carried out performance analysis of several similar multi-criteria decision support models used for contractor and supplier selection process. Consolidating several fuzzy-based strategies with an analytic hierarchy process is adopted to take care of the entangled issues in the domain. Performance of the proposed model was validated with several existing models using three diverse datasets. It was found that the proposed model demonstrated a better accuracy when compared with the other models. Therefore, it can benefit decision-maker algorithmics while developing affective models in assessment and ranking criteria for choice selection systems.

In view of the constantly increasing number of chronic kidney disease patients in our society and lack of adequate diagnostic tools, [17] proposed the use of the Bagging and Random Subspace ensemble approaches for timely and accurate prediction of the disease. Meanwhile, the proposed Bagging and Random Subspace methods were implemented on three different base-learners including K-Nearest Neighbours (KNN), Naïve Bayes, and Decision Tree for improving the classification performance of the models. These models were further tested using chronic kidney disease dataset obtained from the UCI machine learning repository with experimental results indicating that the ensemble techniques could provide better performance than individual base learners while the Random Subspace recorded 100% accuracy on KNN classifier, showing

a better performance than Bagging approach. The result suggests that the proposed model could be a good potential for the efficient diagnosis of chronic kidney disease.

Considering the constantly increasing number of children with Autism Spectrum Disorder (ASD) particularly in African rural areas, [18] developed an easily accessible wearable emotional-based e-Healthcare system driven by fuzzy logic technique to adequately identify ASD and recommend suitable therapy to minimize its effect on the affected children. The proposed wearable emotional-based e-Healthcare controller utilizes electrodermal activity and speech recognizer sensors in classifying the emotional state of an individual, and it was able to record approximately 92.07% accuracy. In addition, the integrated recommender module was found to be effective in recommending music therapy that could effectively minimize the rate of meltdown in patients. Findings from the study showed that the developed system could help monitor the physiological state of children with autism regardless of their location.

Motivated by the need to develop an intelligent system that could address the limitations of the manual means of recognizing micro-expressions by humans, [19] proposed an automatic system based on an Extreme Learning Machine (ELM) that accurately recognizes micro-expressions using images extracted from recorded videos. The proposed method adopts a spatiotemporal based local binary pattern technique for extracting micro-expression frames from videos divided into image sequences. The proposed ELM model was compared with that of the support vector machine (SVM) model and the obtained results showed that the ELM model could automatically recognize micro-expressions at a faster rate with much better accuracy compared to the SVM model.

Looking at the current role of the Internet in merging celestial and terrestrial boundaries, positive changes are being observed in the social, political and economic structures previously obviated by geographical boundaries. Nevertheless, the mobile telecommunication technology, a major player in the paradigm shift, is still embattled with inaccessible, unreliable, and unsatisfactory quality of voice service. To address this issue, [20] developed a hybrid fuzzy-based intelligent model that could assess the quality of service for voice calls. Quality of service metrics were modeled by combining the conventional fuzzy logic approach with Takagi-Sugeno-Kang inference mechanism in a Neuro-Fuzzy model. Experimental study was carried out on crowd-sourced network data, and the results obtained showed high assessment accuracy with significantly high sensitivity and specificity values. This study shows that quality of service for voice calls for different network providers can be effectively assessed.

Towards resolving the limitation of the conventional methods for exploring hidden patterns in dataset and analyzing them, [21] proposed an improved Adaptive neuro-fuzzy inference system (ANFIS)–using an agglomerative-based clustering ensemble of fuzzy c-means in predicting outcomes of events, processes or systems from their numerical representations. Their ensemble algorithm uses probability trajectories of random walk processes based on clustering partitions of the dataset so as to refine direct co-association relationships or links among data objects of the base partitions thereby improving on these relationships that later metamorphosed to fuzzy rules. Comparative analysis of the proposed improved ANFIS with the conventional ANFIS was carried out using two standard petrophysical datasets for lithology prediction and their results show that the proposed ANFIS is better than the conventional ANFIS in terms of accuracy and stability.

The need for adequate data visualization and analysis tools is becoming increasingly important particularly in the field of data science. Although different tools have been adopted for analyzing interesting patterns generated from models to aid fast decision-making, most of the existing tools are limited particularly when it comes to handling big data. To address this issue, [22] proposed a Tree-plot model that employs an In-memory node mechanism implemented based on Gradient Boosted Model learning algorithm. The proposed method's performance was assessed using a number of metrics with experimental results indicating that it could provide a basis for evaluating a given dataset and also as means for visualizing a modeled tree. Furthermore, the method also integrates a feature that shows how a learner algorithm could work with a plotting method with less computational costs. Hence, the proposed method could potentially enhance the visualization and analyses of the dataset.

In view of the huge number of optimization methods that have been developed to improve scientific and engineering applications, [23] was motivated by the need for a systematic diagnostic evaluation to show the strengths and weaknesses of each technique. Thus, the authors assessed the impact of certain factors *viz.* number of iteration and search agents in flower pollination algorithms. Critical analysis was performed on some popular and unpopular optimization functions, with case studies of benchmark sphere and shekel foxhole functions. It was observed that the flower pollination algorithm is a faster technique that also obtained better results than the African buffalo optimization under similar settings. This suggests that the flower pollination algorithm can be considered as a benchmark optimization method that can improve both scientific procedures and engineering applications.

In view of the constantly increasing need to safeguard computer resources over the Internet, [24] proposed a light-weight driven intrusion detection system (IDS) that integrates gain ratio concept and neural network algorithm for identification of potential network treats. The proposed IDS adopts the concept of Gain ratio in selecting relevant features associated with network attack and normal traffic prior which served as inputs to the neural network classifier that eventually classifies the features. The proposed IDS's performance was validated by using UNSW-NB15 intrusion detection dataset from which thirty selected highly ranked attributes were considered. The experimental results indicated that the light weight IDS would be a suitable potential for real time intrusion detection, thus aiding a fast and secured transmission of computing resources over a network.

Similarly, [25] carried out a comparison between two intrusion detection systems based on Apriori association rule mining and machine learning technique respectively. While support vector machine (SVM) was the choice of the latter, Apriori

association mining was considered for the former. Performances of both systems were evaluated using two datasets namely, the Network Security Laboratory Knowledge Discovery and Data Mining, and the University of New South Wales-NB 2015 datasets. The comparison study shows that SVM performs better than Apriori association rules mining in terms of accuracy, and the latter gives a better speed performance. In general, both methods could address specific challenges such as information theft, privacy, and confidentiality facing information communication over the internet.

In an attempt to address the drawbacks of the conventional scaled-distance approach for estimating the magnitude of the blast-induced ground vibration, [26] proposed the use of an artificial neural network-based (ANN) model whose input parameters include the blasting point and charge per delay while peak particle velocity is corresponding output, and the model was trained using backpropagation algorithm with the Levenberg-Marquardt function. The performance of the proposed model was evaluated using a total of 100 dataset from blast induced ground vibration in granite quarries obtained from a site located in Ibadan, Oyo State, Nigeria. In comparison with a multilinear regression (MLR) model, the proposed ANN model achieved a significantly higher coefficient of determination of 0.988 as against the MLR model (0.738). Therefore, the outcome of the study suggests that the proposed ANN model can accurately predict the peak particle velocity.

Finally, in the bid to address the limitations of the conventional approach for constructing engineering properties of materials, [27] proposed the use of artificial intelligence based ensemble learning technique for validating the engineering properties of material. The authors further validated the performance of the method using two different ensemble learning models including XG-Boost and Random Forest on variants of hydroxyapatite samples across various density and time, while considering a fixed amount of 10,000 base estimators. The results show that the Random Forest marginally outperforms the XG-Boost in the testing phase but requires a much longer computing time. Overall, the proposed ensemble method yielded a coefficient of determination ($R2 > 0.997$) and a significant decrease in computational complexity ($\geq 99.83\%$) relative to the time spent when generating the experimental data. The outcomes of this study suggest that the proposed technique could be adopted for estimating the engineering properties of materials in practical applications.

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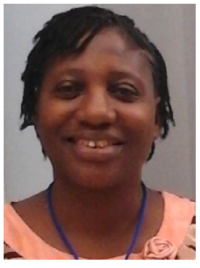

Bolanle Ojokoh is currently an Associate Professor in the Department of Information Systems of the Federal University of Technology, Akure (FUTA), Nigeria. She was a visiting Ph.D and Postdoctoral researcher in the School of Electronic Engineering & Computer Science Peking University, Beijing, China in 2009 and 2010. She is a member of the Nigeria Computer Society (NCS), Organization of Women in Science for the Developing World (OWSD), Computer Professionals Registration Council of Nigeria (CPN) and Association of Computing Machinery (ACM). She has mentored up to 20 Masters students and 8 PhD students to graduation. Her research interests include Question Answering, Information Retrieval, Filtering and Extraction, Recommender Systems, and Gender issues in Science and Information Technology. She is currently focusing on Data Science and its applications to issues in developing economies. She has been an invited speaker on topics related to Big Data, Analytics and Artificial Intelligence in several international events. She has participated in several funded projects including the National High Technology Research and Development, MOE China, TWAS-COMSTECH and TETFUND Nigeria. She has over 80 publications in reputable journals and conferences, and has been a reviewer for several journals. She is currently an Executive Board Member of the TWAS Young Affiliates Network (TYAN). She was the Scientific Chair for OWSD- Nigeria in 2015, and a Program Committee of the ACM/IEEE Joint Conference of Digital Libraries, (JCDL) – New Jersey, 2016 and Toronto, 2017.

Oluwarotimi Williams Samuel is an Associate Professor in the Center for Neural Engineering, Shenzhen Institutes of Advanced Technology (SIAT), Chinese Academy of Sciences (CAS), China. He obtained the Ph.D. degree in Pattern Recognition and Intelligent Systems from the University of Chinese Academy of Sciences, Beijing courtesy of CAS-TWAS President's Fellowship. As principal investigator, he did receive several research funding including the National Natural Science Foundation of China, Outstanding Youth Innovation Research Fund of SIAT-CAS, Foundation for the Support of Science and Technology, and others as co-investigator. He received the 2020 Merit award of SIAT-CAS, 2019 IEEE Outstanding Young Investigator Research Visit award to Sapienza University, 2019 CAS President's International Fellowship Initiative award, Best Academic Paper awards (IEEE-ICCC'2019, IEEE-ICBHI'2015, & GHI'2015), 2018 Outstanding Young Researcher, Distinguished Ph.D. Dissertation, Outstanding Graduate Student, Excellent Foreign Student, and Excellent International Graduate awards (Courtesy of SIAT-CAS and UCAS, 2015–2018) amongst others. His-research interest includes applied machine intelligence, rehabilitation robotics, biomedical signal/image processing, data mining and knowledge discovery. He is the author/co-author of more than 90 articles in reputable journals and conference proceedings with over 1350 citations (h-Index:20) on Google Scholar. He is a member of the organizing committee of international conferences including 2018 IEEE-CBS, 2020 & 2021 IEEE MetroInd4.0&IoT. Also, he is a member of the board trustees of Doctorsinsight Initiative, IEEE & ACM professional member, an editorial board member of the Frontiers in Neurorobotics, Artificial Intelligence, and Neuroscience Journals, and a reviewer for IEEE-(TNRST, JBHI, TBME), AIIM-Elsevier, BSPC-Elsevier and other reputable peer-review journals.

Olatunji M. Omisore obtained his Ph.D. degree from the University of Chinese Academy of Sciences (UCAS); courtesy of CAS-TWAS President's fellowship. Currently, he is with the centre for Medical Robotics and Minimally Invasive Surgical Devices, Shenzhen Institutes of Advanced Technology, Chinese Academy of Sciences (SIAT-CAS), China. He has over eight years of academic and research experience in pattern recognition and intelligent systems, biomedical image and signal processing, and flexible surgical robotics. He is the principal investigator of several research projects funded by the National Natural Science Foundation of China, Shenzhen Natural Science Foundation, Outstanding Youth Innovation Research Fund of SIAT-CAS, and many more as co-investigator. He is a recipient of the 2020 Heidelberg Laureate award for outstanding young scientists in Computer Science and Mathematics, CAS President's International Fellowship Initiative award, 2019 Excellent International Graduate award of UCAS and SIAT-CAS, second position award for the 2019 World Robotics Competition in Beijing, and student travel award for 2017 ICIT in Canada. He has published more than 40 peer-reviewed articles in top-ranked journals and conferences with over 400 citations on Google scholar and H-index of 11. He is a member of IEEE, ACM, and Nigeria Computer Society. He serves as a reviewer for many prestigious journals including Applied Soft Computing, IEEE TBioCAS, IEEE JAS, Advances in Mechanical Engineering, and International Journal of Information Research Retrieval; and as a program committee member for several international conferences. His-research interests include medical robotics (automation and control), health informatics, Xplainable AI, and machine learning.

Oluwafemi A. Sarumi is currently a faculty member at the Department of Computer Science, the Federal University of Technology–Akure (FUTA), Nigeria. He received his Ph.D. degree in Computer Science with a specialization in Data Science. He was awarded the prestigious Association of Commonwealth Universities (ACU) fellowship for a research visit to the University of Manitoba, Canada in 2018. He won the BIGDAS 2019 Best Paper Award on Big Data Applications and Services. He is a recipient of the Heidelberg Laureate award for an outstanding young scientist in Computer Science and Mathematics in 2020. He is a fellow of the Integrated Research on Disaster Risk(IRDR) Young Scientists Programme. He received the University award among others for the best graduating student in Computer Science when he obtained his first degree in 2007 at FUTA. He has served as the program committee member for many international conferences such as INCoS 2020, INCoS 2019, IEEE Smart-Data 2018, DaWaK 2018, INCoS 2018, ISE-HPCS 2017 and DaWaK 2016. Also, he has several publications in reputable peer-reviewed journals and has served as reviewers for several peer-reviewed journals. His-overarching research interest in the area of Data Science and Artificial Intelligence. Specifically, his research is geared towards developing scalable data mining algorithms and machine learning models to discover actionable insights and novel knowledge from large datasets in real-life application domains. He is a professional member of IEEE computer society and the Association of Computer Machinery (ACM).

Peter Adebayo Idowu is an Associate Professor in the Department of Computer Science and Engineering, Obafemi Awolowo University, Nigeria. Dr Idowu received MPhil (Computer Science) and PhD (Computer Science) from Aston University, Birmingham, United Kingdom and Obafemi Awolowo University, Ile-Ife, Nigeria. His-research focus is on Applied Computing that is application of computing to address and solve health related problems in Sub Saharan Africa. He developed the first Health Data Model for Nigeria. He is currently researching into HIV/AIDS, Sickle Cell Anaemia, Sex Classification Model, disease modeling and cloud computing in health care delivery. He is a Member of British Computer Society, Internet Society Nigeria Chapter, Nigerian Computer Society, Computer Professional Registration Council of Nigeria, Nigerian Young Academy, International Geospatial Society, International Association of Engineersand International Federation of Information Processing WG 9.4. His-research interest includes Health Informatics, Data Mining, Software Engineering, Geographical Information System, and Informatics. Within the last seven years, Dr Idowu has successively trained over 30 graduate students (including PhD). He has published over 90 scientific research articles in journals and refereed conference proceedings. He is blessed with three Research Associates; Praise, Vicky and Peter. He enjoys reading and driving.

Emile R. Chimusa* is Associate Professor of computational medical populations genetics and genetics epidemiology at the University of Cape Town, South Africa (http://www.idm.uct.ac.za/Emile_Chimusa). He obtained his PhD in Computational Biology and Bioinformatics. His-main focus of research is on methodologies of improving the analysis of large scale genomic studies such as genome-wide association studies or fine-mapping studies and analysing genome wide patterns of variation within and between species to address fundamental questions in biology, anthropology, and medicine. He has an outstanding research record in tackling relevant African health challenges by leveraging large scale African sequence data in developing genomics tools using machine intelligence and computational statistics. He has been very active in training young researchers across African countries in big genomics data sciences within machine intelligence using advanced High-Performance Computing.