

Lecture Notes in Networks and Systems 995

Millie Pant
Kusum Deep
Atulya Nagar *Editors*

Proceedings of the 12th International Conference on Soft Computing for Problem Solving


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Editors

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Preface

We are delighted that the 12th International Conference on Soft Computing for Problem Solving, SocProS 2023, took place at Indian Institute of Technology (IIT) Roorkee, India during August 11–13, 2023. The SocProS conference series has a glorious history; the earlier editions of the conference have been organised in the various prestigious institutions of India and the UK. Along with IIT Roorkee the Liverpool Hope University, UK, has been one of the key institutions that initiated this prestigious event. Continuing the trend, once again the 12th edition of this conference touched many milestones in terms of quality research papers and fruitful discussions. The theme of SocProS 2023 was “*Moving Towards Society 5.0*”.

It was a privilege that the event was graced by Mr. Nitin Mittal, Principal, US Generative AI Leader, Global Consulting Emerging Markets Leader, Deloitte Consulting as the chief guest for the conference. Mr. Vishal Sharma, National Managing Director and President, Deloitte Consulting India Pvt. Ltd. was the distinguished guest and Ms. Sanghamitra Pati, Managing Director, Strategy and Analytics, Deloitte Consulting was the special guest. Mr. Nitin Mittal emphasised the role of Generative AI and Chat GPT in today’s world. Mr. Vishal Sharma spoke about Academic-Industry collaboration and offered new ways in which Deloitte can join hands with IIT Roorkee for a win-win situation for students, research scholars and faculty members. Professor Millie Pant, Head of Applied Mathematics and Scientific Computing welcomed the delegates and narrated the glorious history of IIT Roorkee. Professor Kusum Deep, Professor of Mathematics and Convenor of the Conference, narrated how this series of SocProS Conferences initiated in 2011 in collaboration with Prof. Atulya K. Nagar, Professor of Mathematical Sciences and Pro Vice Chancellor of Liverpool Hope University, UK.

Presiding over the Inaugural Function Prof. Umesh Kumar Sharma, Officiating Director IITR emphasised that such events are the need of the hour as these events provide a platform to young, early career, as well as seasoned researchers to come together and discuss cutting edge research ideas.

Professor Ali Sadiq, Associate Professor, School of Science and Technology, Nottingham Trent University, UK; Prof. Seyedali Mirjalili, Director, Centre for Artificial Intelligence Research and Optimization at Torrens University, Australia;

Prof. Brij B. Gupta, Director, International Centre for AI and Cyber Security Research and innovations (CCRI), Asia University, Taiwan, Dr. Amreek Singh, DRDO Chandigarh, Dr. Shailesh Chansarkar, Center for Artificial Intelligence and Robotics, DRDO Bangalore and Prof. Sudesh Kaur Khanduja, IISER Mohali were the keynote speakers.

Out of 380 papers submitted to the Conference only 185 were accepted and presented in four parallel sessions.

On the second day, one of the noteworthy events was a special lecture by Mr. Ayush Agarwal and Mr. Jitendra Kumar from Commonwealth Bank of Australia (CBA, Bangalore Office) on the use of AI and Data Science in modelling customer satisfaction. This was followed by a quiz which was open to delegates of the Conference as well as students of IIT Roorkee. The prizes of the quiz were sponsored by CBA.

The valedictory function was held on the Third day at the Saharanpur Campus of IIT Roorkee. Professor Sudesh Kaur Khanduja was the Chief Guest, Prof. M. K. Barua, Dean Students Welfare was the Distinguished Guest and Prof. S. Chattopadhyay Dean of Saharanpur presided over the Function.

The Overall Best Paper Award was bagged by Pushpendra Gupta (IIT Kharagpur), Dilip Kumar Pratihar (IIT Kharagpur) and Kalyanmoy Deb (Michigan State University, USA) for their paper entitled “A Knee-based Multi-objective Optimization for Gait Cycle of 25-DOF NAO Humanoid Robot”.

The Best Student Paper Award was given to Indira Roy (IIT Hyderabad), Lohithaksha Maniraj Maiyar (IIT Hyderabad) for their paper entitled “An ecologically sustainable omnichannel fresh food distribution model considering freshness-keeping effort and carbon emissions”.

There was a tie for The Best Application Paper Award. The first one was awarded to Pankaj Pratap Singh, Devanshu Kumar and Madhusmita Basumatary, Aakriti Srivastava (all from Central Institute of Technology (CIT) Kokrajhar), Shitala Prasad (IIT Goa) for their paper entitled “A CNN model-based approach for disease detection in Mango plant leaves”. The second one was awarded to Kinsuk Giri (NITTTR Kolkata), Tuhin Kumar Biswas (NIT Durgapur) for their paper entitled “Identifying Outliers using Voronoi Circles”.

The Kusum Deep Best Ph.D. Thesis Award 2023 went to Dharendra Prajapati, (PDPM Indian Institute of Information Technology, Design and Manufacturing Jabalpur), for his Ph.D. Thesis entitled “Decision Support Systems for Sustainable E-Commerce Logistics and Supply Chain Operations”.

The SocProS 2023 was sponsored by Deloitte, DRDO, Liverpool Hope University and many other medium and small-scale enterprises (SMEs) and industries.

These two-part edited volumes, as proceedings, are an outcome of the 12th meeting of SocProS community and include a collection of selected high-quality articles on various topics related to Soft Computing and Artificial Intelligence and their Applications. The book, being prepared in two volumes, covers the recent advances and challenges in the themes of Machine Learning, Neural Networks, Scientific Computing and Intelligent Systems and includes several chapters addressing the problems arising in real-life applications comprising that of Image Classification, Deep Learning, Fuzzy Systems, Flow Shop Scheduling, Support Vector Machines,

Mobile Robot Path Planning, P-Systems, Machine Learning and Spiking Neural Networks, to name a few contributions. We have also tried to capture the Impact aspects of research in this area; particularly, impact beyond the academic world. We have made further efforts in this direction to embed impact as part of our conference series and going forward we very much hope that, as was agreed at the conference, we will continue to mainstream impact in our work and intensify our efforts to reach out to non-academic beneficiaries and users to realise impact from our research.

Highlighting theoretical perspectives and empirical research, it is hoped that this two part edited volume will prove to be a comprehensive reference source for researchers, practitioners, students and professionals interested in the current advancements and efficient use of Soft Computing as well as in making impact happen. We express our heartfelt gratitude to all the authors, reviewers and Springer personnel for their motivation and patience.

Roorkee, India
Roorkee, India
Liverpool, UK

Millie Pant
Kusum Deep
Atulya Nagar

Contents

Using Opinionated-Objective Terms to Improve Lexicon-Based Sentiment Analysis	1
Bayode Ogunleye, Teresa Brunson, Tonderai Maswera, Laurence Hirsch, and Jotham Gaudoin	
Explaining the Artificial Neural Network Using Evolutionary Fuzzy Association Rule Mining (EFARM)	25
Abhishek Toofani, Sandeep Paul, and Lotika Singh	
Study of Optimality Strategies for Two-Person Game Model Under Interval Uncertainty	45
Sana Afreen, Ajay Kumar Bhurjee, and Rabia Musheer Aziz	
L-BFGS Optimization-Based Human Body Posture Rectification—A Smart Interaction for Computer-Guided Workout	61
Rajarshi Saha, Debosmit Neogi, Rapti Chaudhuri, and Suman Deb	
Optimizing Pneumonia Detection from Scarce Chest X-Ray Data: A Comparative Analysis of Advanced Augmentation Techniques Using Deep Learning	77
Saqib Ul Sabha, Nusrat Mohi Ud Din, Assif Assad, and Muzafar Rasool Bhat	
Unleashing the Potential of Deep Learning for Precise Nuclei Segmentation and Classification in H&E-Stained Whole Slide Images	97
Tabasum Majeed, Syed Wajid Aalam, Abdul Basit Ahanger, Rayees Ahmad Dar, Tariq Ahmad Masoodi, Muzafar Ahmad Macha, Ajaz A. Bhat, Muzafar Rasool Bhat, and Assif Assad	

Submitted for Special Session#3: “Softness in AI Computing Techniques for Not so Easy Computational Problems” Matrix Games Having Linguistic q -Rung Orthopair Fuzzy Payoffs 111
 Sarita Gahlawat, Geeta Sachdev, and Shalini Arora

Research Analysis on Current Advances in Parkinson’s Disease Detection Using Signal Processing and Machine Learning-Based Techniques 133
 Kshitij Goel, Neetu Sood, and Indu Saini

Analysis of Different Inference Implementations for Deep Learning Model on ADITYA-U Tokamak 145
 Ramesh Joshi, Joydeep Ghosh, Nilesh Kalani, and R. L. Tanna

Deciphering the Pathways Towards Analysis of Existing HealthCare Services by Use of AI to Respiratory Diseases Concerning Cough Study: Future Challenges and Applications 157
 Nitin Kataria, Sapna Sinha, and Himanshu Monga

Predicting Impact Strength of Natural Fiber Composites Using Optimized Gradient Boosting Approach 177
 Aditi Mahajan, Inderdeep Singh, and Navneet Arora

Multiobjective Diabetic Diet Model Using Neutrosophic Fuzzy Programming 185
 Kumari Divya and Prabjot Kaur

Performance Analysis of Ann-Based Multi-Input Hybrid Power Conversion System 191
 Dilip Yadav, Bijendra Singh Verma, Gaurav Singh, Nidhi Singh, and M. A. Ansari

ECCO: Cloud Energy Optimization and Load Balancing 211
 Ram Narayan Shukla, Bhupesh Kumar Dewangan, Anoop Chaturvedi, Saumitra Chattopadhyay, Tanupriya Choudhury, and R. D. Patidar

Recommender Process Based on Trust-Distrust Factor for Signed Social Networks 225
 Roshan Lal and Sanjay Kumar Sharma

GA Based Order Abatement Technique for Linear Dynamic Systems 237
 Babita Singh, Nidhi Singh, and Dipti Singh

Bibliometric Analysis: A Trends and Advancement in Clustering Techniques on VANET 251
 Anish Shandilya, Varuna Gupta, and Garima Anand

Chaotic Swarm Bat Algorithm with Improved Search 265
 Reshu Chaudhary

Random Forest Modeling for Prediction of Thrust Force During Drilling of Flax/PP Composite 281
 Deepak Kaushik, Aditi Mahajan, and Inderdeep Singh

An Application of Sentiment Analysis to Analyze the Performance of Players on Endorsed Brands Using Social Media 289
 Ayush Maheshwari, Narayan Chaturvedi, and Ashish Garg

Automatic Number Plate Detection System for Indian Vehicles Using Yolov5 and EasyOCR 305
 Ameya Srivastava, Pragati Narote, Shreeniket Fatangare, Suhas Kakade, and Rohan Kulkarni

Evaluating Performance of SMOTE and ADASYN to Classify Falls and Activities of Daily Living 315
 Rajbinder Kaur, Rohini Sharma, and Manpreet Kaur Dhaliwal

Advancing Digital Image Forensics: Enhancing Image Forgery Detection Through Error Level Analysis and Convolutional Neural Networks 325
 Khizar Baig Mohammed, Ishita Agrawal, Manasa Datta Kandimalla, Phiny Francis Govathoti, Choudary Shyam Prakash, and Priyanka Singh

Creating a Binary AHA Algorithm with Varied Transfer Function 341
 Pratyksh Dhapola and Vijay Kumar

OPTUNA—Driven Soft Computing Approach for Early Diagnosis of Diabetes Mellitus Using ANN 355
 Tarun Vats, Sunil K. Singh, Sudhakar Kumar, Mehak Preet, Aishita Sharma, Shivam Goyal, Priyanshu, Brij B. Gupta, and Priyanka Chaurasia

Comparative Study of Clustering Techniques for Extractive Text Summarization 373
 Sushant Yadav and Archana Singhal

A CNN Model Based Approach for Disease Detection in Mango Plant Leaves 389
 Pankaj Pratap Singh, Devanshu Kumar, Aakriti Srivastava, Madhusmita Basumatary, and Shitala Prasad

FuzzyBack—A Hybrid Neuro-Fuzzy Ensemble for Concept Drift Adaptation in Stream Mining Using Neural Network 401
 Saket Sarin, Sunil K. Singh, Sudhakar Kumar, Utkarsh Chauhan, Shivam Goyal, Tushar Singh, Priyanshu, Brij B. Gupta, and Francesco Colace

Clustering in WSN: Techniques and Future Challenges 413
 Nishi Gupta, Shikha Gupta, Aprna Tripathi, and Mohit Agarwal

A Comparative Study in Image Fusion Using Orthogonal and Biorthogonal Wavelet 425
Saroj Kumar Pandey, Ankit Kumar, Gaurav Kumar,
Kamred Udham Singh, Teekam Singh, Sandeep Srivastava,
and Tanupriya Choudhury

Exploring and Evaluating Energy-Efficient Clustering Schemes in AODV: An Implementation and Comparative Study 439
Ankit Kumar, Saroj Kumar Pandey, Gaurav Kumar,
Kamred Udham Singh, Teekam Singh, Sandeep Srivastava,
and Tanupriya Choudhury

Exploring the Power of Deep Learning in Anomaly Detection: A Comprehensive Review and Analysis 453
Gaurav Kumar, Ankit Kumar, Saroj Kumar Pandey,
Kamred Udham Singh, Teekam Singh, Lalan Kumar,
and Tanupriya Choudhury

Design and Implementation of Deep Learning Models for Tomato Plant Leaf Disease Classification 463
Mihir Mittal, H. Santhi, J. Anuradha, and P. Boominathan

Insights from Deploying Industry 4.0 Technologies Toward Sustainable Business Performance: A Study Based on Applied Methodology of SLR 475
Pritesh Shukla, Kumar Rohit, Avadhesh Dalpati,
and Ramesh Chandra Gupta

Heart Arrhythmia Detection Through Real-Time ECG Acquisition by Machine Learning Techniques 499
Vishal Jaimin Vakil and Sneha Soni

Facial Image Enhancement Limitation of Using Spatial Domain Histogram Enhancement Methodologies 513
Santosh Kumar Jha, Prashant Kumar Jain, and Prabhat Patel

Predicting Traffic Flow with Deep Learning 527
Nishtha Srivastava, Raja Devarakonda, Ruthwik, Vamsi Krishna,
Bhavan Bharadwaj, and Bhavesh N. Gohil

Model Order Reduction of Linear Continuous and Discrete Systems Using Grey Wolf Optimization 543
Pranay Bhadauria, Nidhi Singh, and Dipti Singh

DQNOCHN: Design of an Efficient Dyna Q Network for Enhancing Onboard and Offboard Charging Performance of Energy Harvesting Networks 557
Jaya Dipti Lal

Integrating Image Visibility Graph and Topological Data Analysis for Enhanced Texture Classification 575
 Rahul Pal, Sanoj Kumar, and Manoj K. Singh

Traffic Volume Prediction Using Regression Modeling Approach 587
 Abhay Narayan Tripathi and Bharti Sharma

Feature Selection and Reduction for Analysis of Histopathology Images 601
 Shiksha Singh, Ankit Kumar Jaiswal, and Rajesh Kumar

A Novel Approach for Generalized Decagonal Neutrosophic Linear Programming Problem 613
 Kailash Lachhwani

Strengthening IoT Supply Chain Integrity: A Blockchain-Based Approach to Identify Malicious Devices 639
 Udit Agarwal, Vinay Rishiwal, Mano Yadav, and Vinay Maurya

A Review on Heart Diseases Using Machine Learning and Deep Learning Techniques 651
 K. Mallikarjunamallu and Khasim Syed

Natural Disaster Twitter Data Classification Using CNN and Logistic Regression 681
 Siddharth Parasher, Prahlada V. Mittal, Sejal Karki, Sukriti Narang, and Ankush Mittal

Deep Learning Based Framework for Multi-disease Detection Using CNN-BiLSTM 693
 Pooja Yadav, S. C. Sharma, and Hemant Yadav

Sound Database of Industrial Machine for Audio Anomaly Detection 707
 Kader B. T. Shaikh, Naresh P. Jawarkar, and Vasif Ahmed

Snorkel AI Method for Supply Chain Event Extraction and Risk Assessment 721
 Saureng Kumar and S. C. Sharma

ANFIS for Markovian Unreliable Retrial Queue with Differentiated Vacation 735
 Palak Mehta, Madhu Jain, and Anamika Jain

Mathematical Driven Model for Closed-Loop Supply Chain Network Design 759
 Ajay Kumar Pandey, Amit Kumar, Sneha Kushwaha, Ashish Dwivedi, and Saurabh Pratap

LSTM-Based Bi-Directional Sequence-To-Sequence Model for Solving Arithmetic English Word Problems	771
Harshal Kotwal and Girish Kumar Patnaik	
Parameter Estimation of a Solar Module by Wild Horse Optimizer	789
Tina Sharma, Anuj Kumar, Manoj K. Singh, and Sangeeta Pant	
Literature Review of Vehicles Routing Problems Using Metaheuristics: Prospects and Trends	803
Chitranshi Mishra, Manjari, Suneet Singh, Sunil K. Jauhar, Saurabh Pratap, and Ajay Kumar Pandey	
Determination of Significant Barriers Towards Ad-dressing the Industry 4.0 Implementation Prospects: A MCDM Technique-Based Approach	815
Sunil Pipleya and Suwarna Torgal	
Modeling of High-Efficiency Battery Charger for Light EVs Using MATLAB/SIMULINK	829
C. Sheeba Joice, C. Srinivasan, and V. Anitha	
Expected Credits Approach for Scale Efficiency Using Fuzzy DEA	845
Shantnu Verma, Shivi Agarwal, Trilok Mathur, and Ishu	
Performance Evaluation of Public Transport Sector with Missing Data	857
Shivi Agarwal, Jyoti Luhaniwal, Trilok Mathur, and Pankaj Mathur	
Heterogeneous Mixture Model for Software Reliability Prediction	867
Sarvesh Kumar and Madhu Jain	
Impact of Circular Economy on Sustainable Inventory Model with Renewable Energy Under Green Environment	881
S. R. Singh and Dipti Singh	
EPQ Model for Stock-Dependent Demand with Setup Cost Dependent on Population Under Green Environment	895
S. R. Singh, Dipti Singh, and Monika Rani	
Optimized Vaccine Selection Using Machine Learning and Genetic Algorithms: A Study on Side Effects of COVID-19 Vaccines	907
Vishal Soni, Shubham Joshi, Kusum Deep, and Millie Pant	

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Dr. Kusum Deep is an Emeritus Professor with the Department of Mathematics as well as Joint Faculty at the MF School of Data Science and Artificial Intelligence at the Indian Institute of Technology Roorkee, India. Also, she is a Visiting Professor, Liverpool Hope University, UK. With B.Sc. Hons. and M.Sc. Hons. School from Centre for Advanced Studies, Panjab University, Chandigarh, she is an M.Phil. Gold Medalist. She earned her Ph.D. from UOR (now Indian Institute of Technology Roorkee) in 1988. She has been a national scholarship holder and a Post-Doctoral Fellow at Loughborough University, UK assisted by International Bursary funded by Commission of European Communities, Brussels. She has won numerous awards like Khosla Research Award; UGC Career Award; Starred Performer of IITR Faculty; best paper awards by Railway Bulletin of Indian Railways; special facilitation in memory of late Prof. M. C. Puri; AIAP Excellence Award. She is one of the four women from

IIT Roorkee to feature in the ebook “Women in STEM-2021” celebrating the contributions made by 50 Indian women in STEM published by Confederation of Indian Industries. According to Stanford University, she falls within top 2% of the scientists in the world since 2019 till date. In 2021 she bagged the prestigious POWER grant awarded by SERB-DST, Government of India. Since 2022 she is leading a collaborative consultancy project on Artificial Intelligence and Machine Learning funded by Deloitte. On September 5, 2022, she was awarded Uttarakhand State Level “Excellence in Research of the Year 2022 Award”, jointly organised in collaboration with DIVYA HIMGIRI (Premier Weekly News Magazine of Uttarakhand), VMSB Uttarakhand Technical University, Uttarakhand State Council for Science and Technology (UCOST) and Society for Research and Development in Science, Technology and Agriculture (SRADSTA). According to the 9th edition of Research.com ranking of the best researchers in the arena of Computer Science she holds a national rank 100 and world rank 10112. On December 23, 2024, she was awarded Distinguished Alumni Award by Panjab University, Chandigarh. On December 24, 2023 she was awarded Lifetime Achievement Award by The Indian Association for Reliability and Statistics, during Inaugural Function of International Conference on Statistics, Data Science and Reliability: Exploring Trends, Methods and Applications in conjunction with 7th Convention of IARS, hosted by Department of Statistics, M. D. University, Rohtak. Kusum has authored two books, supervised 24 Ph.Ds., and published 135 research papers. She is a Senior Member of ORSI, CSI, IMS and ISIM. She is one of the Editors of Engineering Applications of Artificial Intelligence, Elsevier and many reputed journals. She is General Chair of series of International Conference on Soft Computing for Problems Solving. She has a vast teaching experience in Mathematics, Operations Research, Numerical and Analytical Optimization, Artificial Intelligence, Data Science, Parallel Computing, Computer Programming, Numerical Methods, etc. Her research interests are nature inspired optimization techniques, particularly Evolutionary Algorithms and Swarm Intelligence Techniques and their applications to solve real life problems as well as artificial intelligence and Machine Learning.

Prof. Atulya Nagar holds the Foundation Chair as Professor of Mathematical Sciences and is the Pro Vice-Chancellor (Research) at Liverpool Hope University, UK. He received a prestigious Commonwealth Fellowship for pursuing his doctorate (D.Phil.) in Applied Nonlinear Mathematics, which he earned from the University of York (UK) in 1996. He holds B.Sc. (Hons.), M.Sc., and M.Phil. (with distinction) in Mathematical Physics from the MDS University of Ajmer, India. Professor Nagar is a fellow of the Institute of Mathematics and Its applications (FIMA) and a fellow of the Higher Education Academy (FHEA). His research expertise is in the area of Applied Non-linear Analysis, Natural Computing and Systems Engineering.

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Using Opinionated-Objective Terms to Improve Lexicon-Based Sentiment Analysis



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Abstract Sentiment analysis (SA) has received huge attention to understand customer perception, especially in the movie review (IMDB) domain. This is due to the availability of large, labelled dataset. This has enhanced the use and development of machine learning (ML) algorithms ranging from the traditional machine learning algorithms, deep learning algorithms to large language models. The ML models have shown great performances. However, the application of ML methods for SA is limited in service industry like banking, due to the unavailability of large training dataset. Thus, we consider the use of lexicon-based sentiment analysis appropriate. We employ 346,000 Nigeria bank customers' tweets to develop our corpus and thus, propose SentiLeye, a novel lexicon-based algorithm for sentiment analysis. Our algorithm incorporates corpus-based approach and external lexical resources for sentiment lexicon generation of Pidgin English language terms (a non-English under resourced language). Moreover, we demonstrate the use of verbs and adverbs that express opinion on service experience to improve the performance of lexicon-based sentiment analysis. Results show that SentiLeye outperforms popular off-the-shelf sentiment lexicons with macro F1-score of 76%. We conclude that results from domain specific algorithms such as SentiLeye evidence that general-purpose lexicons cannot replace them.

Keywords Sentiment analysis · Sentiment classification · Lexicon · Banking industry · Pidgin English

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1 Introduction

The banking industry plays a significant role in every nation's economy [7, 9, 27]. Similarly, customers are important to the banks for profitability and stability. Thus, understanding customers' perspectives is vital. To this end, surveys, interviews and polls can be conducted to understand customers' perceptions. However, surveys are labour intensive, expensive and limited to pre-defined variables. The social web has become an alternative data source for academia and industry since 2004 [59]. According to Agnihotri et al. [2], the social web serves as a communication platform for both banks and their customers. This was more obvious during the Covid-19 pandemic. The banks experienced a significant increase in digital transactions since the Covid-19 national lockdown [45, 69]. It also led to increased usage of social media, by customers to express their feelings and experience. This has increased the need for banks to mine their customer's perceptions using social media data. This can be helped using sentiment analysis methods.

Sentiment analysis (SA) classifies words or phrases into sentiment categories such as positive and negative. There are two common SA approaches: lexicon-based and machine learning (ML). The latter uses supervised learning algorithms such as Bi-directional Long-Short Term Memory [5] and Support Vector Machine [69] to predict sentiment polarities. In contrast, the lexicon-based approach uses dictionaries to map words according to their semantic orientation into sentiment categories. A lexicon is a dictionary built for a domain of interest, such as sentiment analysis. The lexicon-based approach performs well across different domains [41, 86]. However, their performance varies across domains. In general, the lexicon-based gives easily interpreted results, but the supervised machine learning approach is more accurate. Recently, the use of large language models (LLMs) like BERT has helped achieve up to 93% accuracy [82]. However, ML approaches tend to be black-box models that are impossible for humans to interpret. They usually also depend on large, annotated datasets which are mostly available in English. Unfortunately, there are languages like Pidgin English that are low resourced. In addition, domains like the banking lack sufficient labelled data [60, 68]. Du et al. [29] added that literature in financial sentiment analysis is limited due to a lack of high-quality large financial datasets because the domain is highly professional. This hinders the use of state-of-the-art (SOTA) ML approaches in this context. Thus, validates the use of lexicon-based sentiment analysis approach in a low-resourced context [32].

Based on this background, we focus on the lexicon-based SA. Unfortunately, only a few studies have applied lexicon-based sentiment analysis in the banking context. Studies like Wu et al. [90], Li et al. [52] and Bos and Frasincar [14] stated that limited literature in financial sentiment analysis is due to the complexity and terminology of the domain, and this warrants a domain specific system. Thus, we propose a novel SentiLeye algorithm to suit this context. Our paper contributes to existing knowledge by comparing lexicon SA models to ascertain the best-performing sentiment lexicon in the banking context. We demonstrate the use of opinionated-objective terms to improve sentiment lexicon performance. Most importantly, we prepared and made

publicly available, benchmark lexical resources in Pidgin English and the banking context to improve and encourage research in this area. The remaining sections of the paper are organised as follows. Section 2 will provide a comprehensive review of the relevant literature, offering the necessary background knowledge for this study. Section 3 will discuss the methodologies employed. Section 4 will present the findings, along with a detailed discussion. Finally, Sect. 5 will present the conclusions drawn from the study and provide recommendations for further research.

2 Related Work

Sentiment analysis (SA) is a task that uses statistical learning, computational linguistic, natural language understanding and processing approaches for generating insight [69]. For example, Yousefinaghani et al. [92] collected 4,552,652 tweets between 7 January 2020 and 3 January 2021. They classified people's opinion on Covid-19 vaccination into positive, neutral and negative and thus showed positive sentiment polarity was dominant towards the vaccination. Furthermore, SA has been applied to understand, patient review of healthcare service experience [37], corporate financial performance [88], public opinion and emotion for non-fungible tokens [73] and predict election outcomes [8, 66, 70, 75, 76]. The concept of sentiment analysis has been extended to cyberbullying detection [10], depression detection [11], fake news detection [6, 44] and recommender system [13, 20]. The lexicon-based sentiment analysis approaches have shown good performance across domains due to their general lexical knowledge [41]. However, the traditional lexicons are not appropriate for social web text due to continuous use of informal words [69]. SentiStrength was developed to address this problem [84]. Based on the consistent performance of SentiStrength, the lexicon has been extended to suit domains like software engineering [43]. Ahmad et al. [3] showed SentiStrength outperformed the other eleven lexicons using Twitter, BBC comments and DIGG comments datasets with performance accuracy of 92–95%. However, the problem of context independent in SentiStrength poses a challenge when dealing with words that have different meanings in different context [43, 77]. Based on this, Saif et al. [77] proposed SentiCircle. The lexicon was created to identify the contextual meaning of words, allowing the algorithm to adjust the sentiment strength and polarity of each word accordingly. Saif et al. [77] conducted an evaluation of SentiCircle using datasets related to the Obama debate, healthcare reform and STS-Gold Twitter. The study demonstrated that SentiCircle has the ability to recognise word patterns across different domains, resulting in higher accuracy compared to MPQA and SentiWordNet. However, SentiCircle was outperformed by SentiStrength in terms of F1-measure. According to Koto and Adriani [50], Afinn is a reliable lexicon, the lexicon showed comparable or superior performance compared to other lexicons such as SentiWordNet, Opinion lexicon and SentiStrength. Ribeiro et al. [74] conducted a comparative study with 24 sentiment lexicons using 18 datasets from social networks, online reviews and comments. Their findings indicated that SentiStrength and Afinn performed well, particularly with