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Millie Pant
Kusum Deep
Atulya Nagar *Editors*

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

SocProS 2023, Volume 2

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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 Dhirendra 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 — Millie Pant
Roorkee, India — Kusum Deep
Liverpool, UK — Atulya Nagar

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Editors and Contributors

About the Editors

Prof. Millie Pant (MP) is a professor in the Department of Applied Mathematics and Scientific Computing (DAMSC), Saharanpur Campus of Indian Institute of Technology Roorkee, joint faculty at the Mehta Family School of Data Science and Artificial Intelligence at the Indian Institute of Technology Roorkee and adjunct faculty at AIT Thailand, Bangkok. Her expertise is in optimization algorithms, soft computing techniques, image processing, and decision-making processes. She has published more than 200 research articles in various journals and conferences of national and international repute. She has more than 8000 Google Scholar citations, and her H-index is 44. She has supervised 14 Ph.D. students and currently 10 students are doing Ph.D. under her supervision. She has completed four bilateral sponsored projects with Germany and Russia, UK and Czech Republic and two national projects sponsored by DST and DRDO. She has conducted several short-term courses sponsored by Deloitte, TSW, DST, and QIP in the areas of optimization, evolutionary algorithms, and artificial intelligence. She is one of the founder chairs for SocProS conferences and has been the chair of several other conferences as well.

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 categorises 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