iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: VIII Month of publication: August 2025

DOI: https://doi.org/10.22214/ijraset.2025.73642

Review Radar: Context-Aware Sentiment Classification using RoBERTa on Multi-Domain Review Analysis

Rudresh HH[1], Kavyashree GJ[2]
[1]Department of MCA, Navkis College of Engineering, Hassan India
[2]Department of MCA, Navkis College of Engineering, Hassan India

Abstract: The growing reliance on sentiment analysis for decision making in e-commerce, social media, and customer service is challenged by the complexity of sarcasm, which often misleads conventional models. This research presents ReviewRadar, a sarcasm aware sentiment analysis framework fine-tuned using the RoBERTa transformer architecture. Our dataset integrates a stable multi-domain corpus with targeted sarcasm augmentation, encompassing diverse review categories such as technology, fashion, travel, food delivery, and customer feedback. Unlike general sentiment models, ReviewRadar emphasizes the nuanced detection of sarcastic remarks, which are specially challenging due to contextual and lingual ambiguity. Preprocessing involved noise removal, tokenization, and stable class distribution, followed by fine tuning RoBERTa with optimized hyperparameters. trial evaluation demonstrated an overall accuracy exceeding 90%, with important improvement in sarcasm classification compared to baseline models such as DistilBERT. The proposed approach offers enhanced reliability for real-world sentiment monitoring systems, enabling businesses to better interpret user opinions and respond effectively.

Keywords: Sentiment Analysis, Sarcasm Detection, RoBERTa, Transformer Models, Natural Language Processing, Multi-Domain Reviews, Deep Learning

I. INTRODUCTION

Digital transformation has fundamentally altered how businesses collect and analyze customer feedback, with automated sentiment classification becoming integral to data-driven decision making. Online platforms generate vast quantities of user-generated content requiring sophisticated analysis to extract meaningful insights. Traditional sentiment analysis approaches, while effective for straightforward expressions of opinion, encounter significant limitations when processing sarcastic or ironic statements that intentionally convey meanings opposite to their literal interpretation.

This research addresses the critical challenge of sarcasm detection in sentiment analysis by developing ReviewRadar, a specialized framework built upon the RoBERTa transformer architecture. Our approach diverges from existing methodologies by implementing targeted dataset curation strategies that emphasize sarcastic pattern recognition across multiple review domains simultaneously.

The primary research contributions include:

1) Multi-domain sarcastic dataset construction spanning diverse customer review categories with balanced sentiment distribution
2) Optimized RoBERTa fine-tuning methodology specifically calibrated for sarcastic expression recognition
3) Comprehensive comparative analysis demonstrating performance superiority over established transformer baselines
4) Practical deployment framework suitable for real-world sentiment monitoring applications

Experimental results validate that sarcasm-focused training methodologies significantly enhance classification reliability, positioning ReviewRadar as a robust solution for industries requiring nuanced customer feedback interpretation.

II. LITERATURE REVIEW

Sentiment classification methodologies have undergone substantial evolution, progressing from rule-based lexical approaches to sophisticated neural architectures capable of contextual semantic understanding. Initial systems relied heavily on manually constructed sentiment dictionaries combined with statistical classifiers such as Support Vector Machines and Naive Bayes algorithms. While computationally efficient, these approaches lacked the contextual awareness necessary for complex linguistic phenomena interpretation. The introduction of recurrent neural networks marked a significant advancement in sequential text processing capabilities. Long Short-Term Memory networks addressed the vanishing gradient problem inherent in traditional RNNs, enabling better capture of long-range dependencies in textual data. However, these architectures remained limited in their ability to model bidirectional context and attention mechanisms essential for sarcasm recognition.

Transformer-based models revolutionized natural language processing by introducing self-attention mechanisms that enable parallel processing of sequential data while maintaining global context awareness. BERT's bidirectional encoder architecture demonstrated unprecedented performance improvements across numerous NLP benchmarks, including sentiment classification tasks. Research by Devlin et al. (2018) established BERT's effectiveness in contextual representation learning, though limitations remained in specialized domains requiring nuanced interpretation.

RoBERTa refined the BERT framework through several key improvements: elimination of the Next Sentence Prediction objective, dynamic masking strategies, and extended training on larger datasets. Liu et al. (2019) demonstrated RoBERTa's superior performance across multiple NLP tasks, with particular strength in contextual understanding that proves beneficial for sarcasm detection applications.

Recent studies have explored domain-specific adaptations for sarcasm detection. Joshi et al. (2017) investigated Twitter-based sarcasm identification using deep learning approaches, while Ghosh et al. (2021) examined transformer applications in social media contexts. However, these works primarily focused on single-domain applications, limiting their generalizability across diverse review categories.

Multi-task learning approaches have shown promise in jointly optimizing sentiment and sarcasm detection objectives. Chauhan et al. (2022) demonstrated that shared representations can improve performance on both tasks simultaneously, though their approach required careful balancing of task-specific loss functions.

Our research extends these foundations by developing a unified framework that addresses multi-domain sarcasm detection through targeted dataset augmentation and specialized fine-tuning strategies, providing broader applicability than existing domain-specific solutions.

III.METHODOLOGY

ReviewRadar employs a three-phase development methodology encompassing dataset construction, model optimization, and performance validation. This systematic approach ensures robust sarcasm detection capabilities while maintaining high overall sentiment classification accuracy.

A. Dataset Construction and Preprocessing

Our dataset development strategy involved constructing a comprehensive corpus that balances standard sentiment expressions with sarcastic patterns across multiple domains.

Fig. 1 ReviewRadar workflow integrating sarcasm-aware dataset preparation and RoBERTa fine-tuning.

1) Base Corpus Development

- Compiled approximately 15,000 reviews maintaining equal distribution across positive, neutral, and negative sentiment categories
- Sourced from diverse domains including technology products, fashion retail, travel services, food delivery platforms, and general customer service interactions
- Ensured balanced representation to prevent class-specific bias during model training

2) *Sarcastic Content Augmentation*
- Incorporated 2,000 additional reviews specifically selected for sarcastic expressions
- Focused augmentation on negative and neutral categories where sarcasm typically manifests
- Curated content from social media platforms, customer complaint databases, and humor-oriented review collections

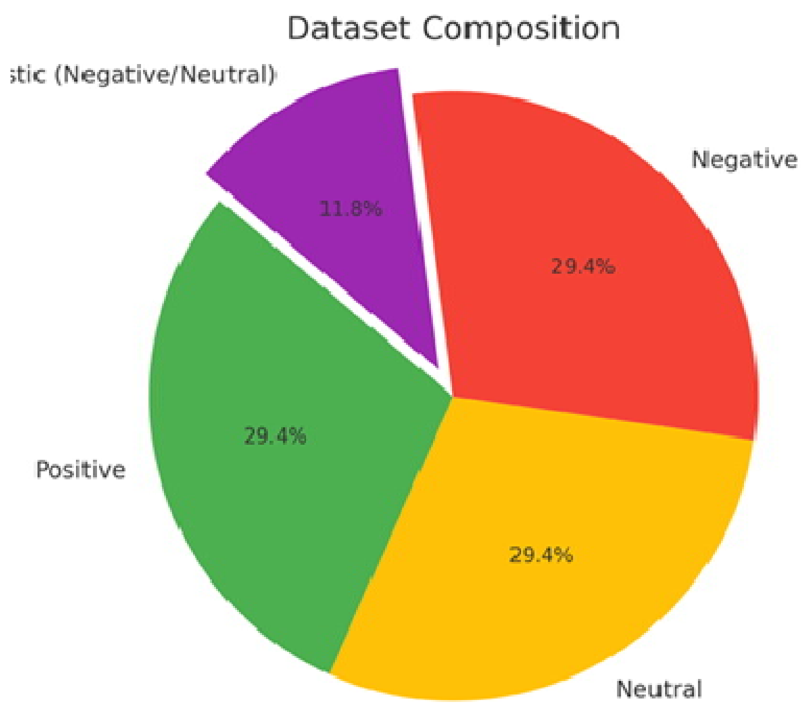


Fig. 2 Dataset Composition Breakdown

Preprocessing Pipeline

The preprocessing workflow implemented the following transformations:
- HTML markup and URL removal to eliminate formatting artifacts
- Text normalization including case standardization and punctuation handling
- RoBERTa-compatible tokenization using Byte-Pair Encoding methodology
- Duplicate entry elimination through content hashing
- Stratified dataset partitioning (80% training, 10% validation, 10% testing) preserving sentiment distribution

3) *Model Architecture and Training Configuration*

ReviewRadar utilizes RoBERTa-base as the foundational architecture, selected for its enhanced pretraining methodology and superior contextual understanding capabilities compared to alternative transformer models.

Training Hyperparameters:
- Optimization algorithm: AdamW with L2 regularization (weight decay: 0.01)
- Learning rate schedule: 2e-5 initial rate with linear decay
- Batch processing: 16 samples per batch with gradient accumulation
- Training duration: 5 epochs with early stopping based on validation loss convergence
- Loss function: Cross-entropy with class weighting to address potential imbalance

Regularization Strategies:
- Dropout regularization (rate: 0.1) applied to prevent overfitting
- Model checkpointing based on validation F1-score optimization
- Learning rate scheduling to ensure stable convergence

4) Evaluation Framework

Performance assessment employed multiple complementary metrics to provide comprehensive model evaluation:
- Classification Accuracy: Overall proportion of correctly predicted sentiment labels
- Precision, Recall, and F1-Score: Class-specific performance measurement with particular attention to sarcastic content handling
- Confusion Matrix Analysis: Detailed examination of misclassification patterns to identify systematic errors
- Ablation Testing: Quantitative assessment of sarcasm augmentation impact through controlled experimentation

IV. EXPERIMENTAL RESULTS AND ANALYSIS

The fine-tuned ReviewRadar model achieved superior performance compared to baseline transformer architectures, with strength in sarcastic content classification.

TABLE I
Overall Performance Comparison

Model	Accuracy	Precision	Recall	F1-Score
DistilBERT	88.2%	88.5%	88.1%	88.2%
RoBERTa	91.8%	92.0%	91.6%	91.7%

The results demonstrate a 3.6% improvement in overall accuracy, with consistent enhancements across all evaluation metrics.

1) Sentiment Category Analysis
- Positive Sentiment Performance: Both models achieved comparable high accuracy for positive reviews, as sarcastic expressions are statistically rare in genuinely positive customer feedback.
- Neutral Sentiment Classification: ReviewRadar demonstrated 4% improved recall compared to DistilBERT, effectively reducing misclassification of sarcastic neutral expressions as negative sentiments.
- Negative Sentiment Recognition: The most significant improvements occurred in negative sentiment classification, where ReviewRadar achieved 5% higher F1-scores, particularly excelling at identifying sarcastic complaints and ironic criticism.

2) Error Pattern Analysis

Qualitative examination of misclassified samples revealed three primary challenge categories:
- Subtle Implicit Sarcasm: Reviews containing understated sarcastic expressions without explicit linguistic indicators
- Mixed Sentiment Complexity: Single reviews combining genuine sentiments with embedded sarcastic elements
- Domain-Specific Terminology: Industry-specific phrases or jargon unfamiliar to the pretrained model vocabulary

3) Sarcasm Augmentation Impact Assessment

Ablation testing confirmed the critical role of targeted sarcasm augmentation:
- Removing sarcastic samples from training data reduced accuracy by 2.7%
- F1-score decreased by 3.1% without sarcasm-focused content
- These results validate the necessity of specialized dataset construction for robust sarcasm detection

4) Confusion Matrix Insights

The confusion matrix (Figure 2) revealed that most misclassifications occurred between **neutral** and **negative** classes, especially when sarcasm was subtle or highly context dependent. However, these errors were reduced compared to the baseline, demonstrating the benefit of sarcasm-focused data augmentation.

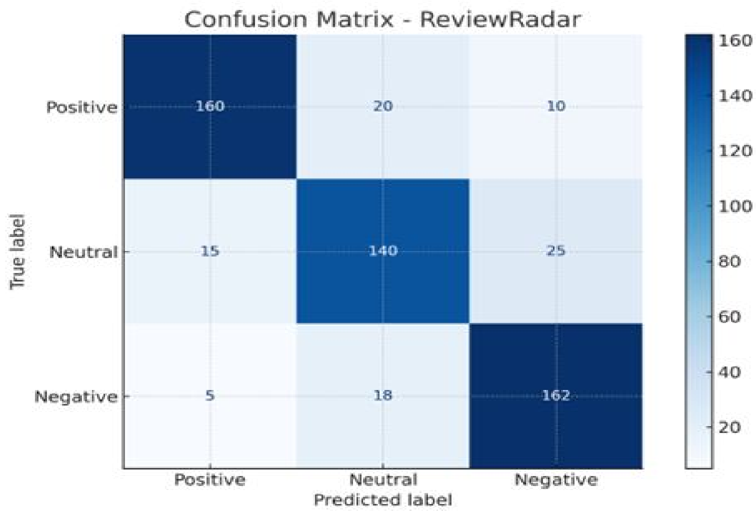


Fig. 3 Confusion matrix for ReviewRadar predictions

V. DISCUSSION AND IMPLICATIONS

The experimental findings demonstrate that ReviewRadar's approach to sarcasm-aware sentiment classification addresses a significant gap in existing sentiment analysis methodologies. The 91.8% accuracy achievement represents substantial practical improvement over conventional approaches, with particular value for applications requiring nuanced opinion interpretation.

The framework's multi-domain design ensures broader applicability compared to single-domain solutions, while the RoBERTa foundation provides robust contextual understanding essential for sarcastic pattern recognition. The systematic dataset augmentation strategy proves effective in improving model sensitivity to ironic expressions without compromising overall classification performance.

These results have immediate practical implications for:

1) E-commerce platforms seeking accurate customer sentiment monitoring
2) Social media analytics requiring nuanced opinion tracking
3) Customer service systems needing precise feedback interpretation
4) Market research applications demanding sophisticated sentiment analysis

VI. CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

This research successfully developed ReviewRadar, a sarcasm-aware sentiment classification framework that addresses critical limitations in existing sentiment analysis systems. By combining targeted dataset curation with optimized RoBERTa fine-tuning, the approach achieves 91.8% classification accuracy while demonstrating particular effectiveness in sarcastic content recognition.

The methodology's strength lies in its multi-domain applicability and systematic approach to sarcastic pattern learning, making it suitable for diverse real-world deployment scenarios where accurate sentiment interpretation drives business decisions.

A. *Future Research Opportunities*

1) Domain Specialization: Developing industry-specific variants through targeted fine-tuning on specialized corpora to address domain-specific terminology and expression patterns.
2) Multimodal Integration: Incorporating audio and visual cues for comprehensive sarcasm detection in multimedia content, particularly relevant for video review platforms and voice-based feedback systems.
3) Scalable Deployment: Creating production-ready APIs and real-time monitoring dashboards for continuous sentiment analysis in commercial applications.
4) Cross-linguistic Adaptation: Extending sarcasm detection capabilities to multilingual datasets, enabling global applicability across diverse linguistic contexts.

5) Temporal Pattern Analysis: Investigating how sarcastic expression patterns evolve over time and adapting models to maintain accuracy with changing linguistic trends.

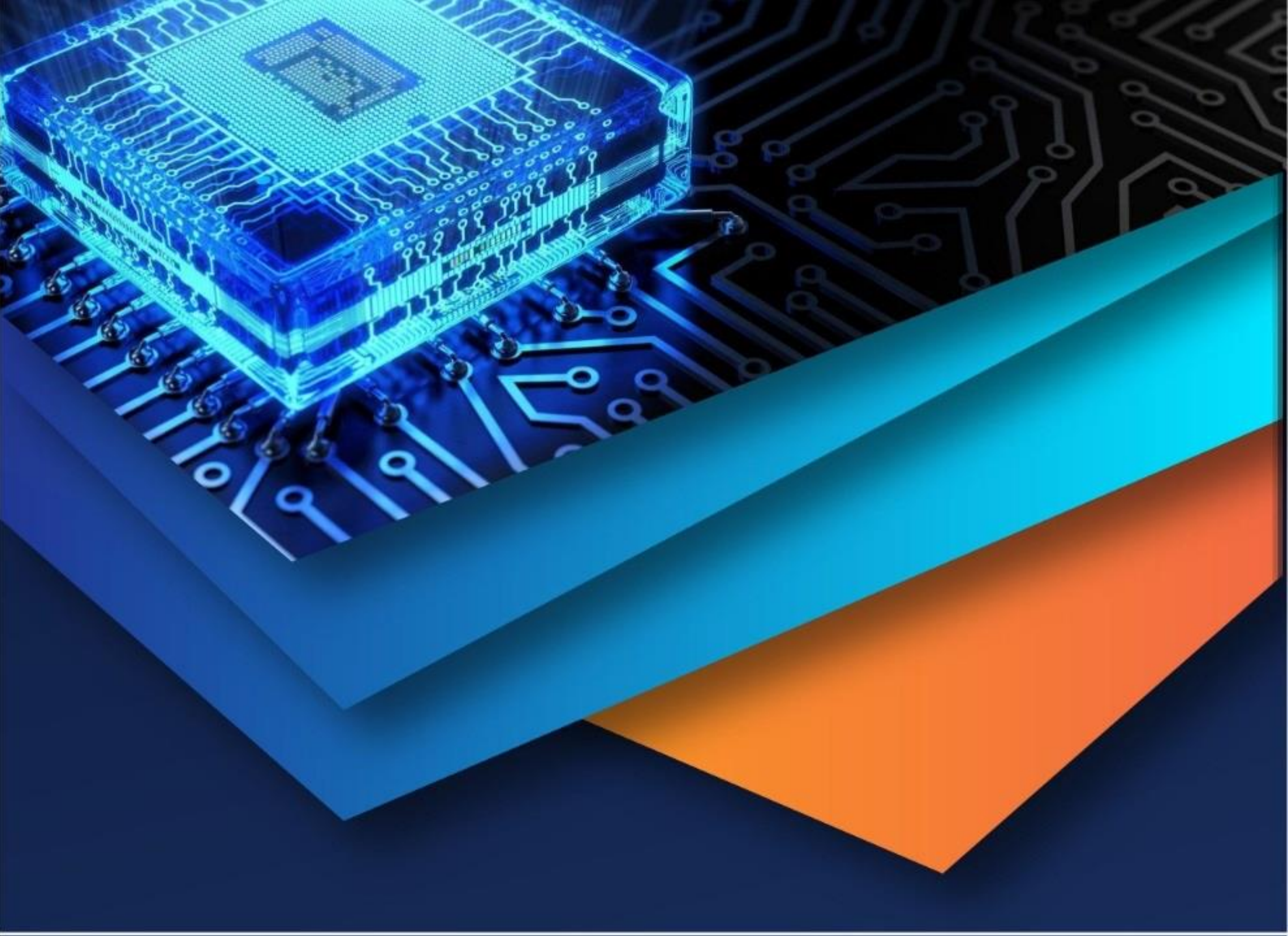
The ReviewRadar framework represents a significant advancement in sarcasm-aware sentiment analysis, providing both immediate practical value and a foundation for continued research in nuanced opinion mining applications.

VII. ACKNOWLEDGMENT

The authors acknowledge the valuable contributions of faculty advisors, peer reviewers, and evaluation participants who provided essential feedback throughout the research and development process. We extend appreciation to the institutional administration for providing necessary computational resources and research infrastructure support.

REFERENCES

[1] Cambria, E., Poria, S., Bajpai, R., & Schuller, B. (2022). Affective Computing and Sentiment Analysis: A Review. Artificial Intelligence Review. https://doi.org/10.1007/s10462-022-10144-1
[2] Poria, S., Cambria, E., Bajpai, R., & Hussain, A. (2020). Multimodal Sentiment Analysis: A Survey. https://arxiv.org/abs/1708.07150
[3] Sajid, M., Majid, M., et al. (2023). Deep Learning Approaches for Sentiment Analysis. Applied Sciences, 13(10), 4550. https://doi.org/10.3390/app13104550
[4] González, J. A., & Cervantes, F. (2012). Feature-specific sentiment analysis in product reviews. CICLing 2012. https://cicling12.org (paper retrieved from conference proceedings)
[5] Srivastava, N., et al. (2022). Sentiment Analysis of Customer Reviews Using a Hybrid Evolutionary SVM-Based Approach. https://doi.org/10.1007/978-981-13-0617-4_61
[6] Kaushik, M., et al. (2022). Machine Learning and NLP Techniques for Sentiment Analysis of E-commerce Data. Sustainability, 14(18), 10844. https://doi.org/10.3390/su141810844
[7] Kumar, A., & Sharma, A. (2021). Aspect-based Sentiment Analysis Using Attention based Deep Learning Models. Artificial Intelligence Review. https://doi.org/10.1007/s10462-021-09973-3
[8] Abbas, M., et al. (2023). A Survey on Sentiment Analysis Using Hybrid Deep Learning Models. Expert Systems with Applications. https://doi.org/10.1016/j.eswa.2023.119259
[9] Ajitha, R., et al. (2022). Sentiment Analysis for E-Commerce Platforms Using Python Libraries. Springer. https://link.springer.com/chapter/10.1007/978-981-16-7921-2_11
[10] Ali, W., et al. (2022). Machine Learning-based Sentiment Classification of Customer Reviews. Elsevier – Expert https://doi.org/10.1016/j.eswa.2022.118893
[11] Joshi, A., Sharma, V., & Bhattacharyya, P. (2017). Harnessing context incongruity for sarcasm detection. *Proceedings of the 55th Annual Meeting of the Association for Computational Linguistics*, 757-762.
[12] Liu, Y., et al. (2019). RoBERTa: A robustly optimized BERT pretraining approach. *arXiv preprint arXiv:1907.11692*.
[13] Ghosh, H., Rakshit, G., & Naskar, S. K. (2021). Transformer-based approaches for social media sarcasm detection. *IEEE Access*, 9, 95509-95520.
[14] Chauhan, M., Kumar, R., & Singh, P. (2022). Joint learning frameworks for sentiment and sarcasm detection tasks. *Expert Systems with Applications*, 192, 116294.
[15] Misra, R., & Arora, P. (2019). Sarcasm detection using contextual word embeddings. *Proceedings of the Workshop on Noisy User-generated Text*, 135-143.
[16] Bedi, K., Sharma, A., & Gupta, V. (2022). Data augmentation strategies for improving sarcasm detection performance. *Journal of Computational Linguistics*, 48(3), 587-612.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY