Hybrid Deep Neural Architecture for Fine-Grained Sentiment and Sarcasm Detection in Movie Reviews

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***Abstract*—In the digital era, people express their opinions on movies through online reviews and social media. Analyzing such vast and unstructured data manually is difficult, while traditional sentiment analysis methods fail to capture sarcasm, irony, and aspect-specific sentiments.**

This project, "AI-Based Sentiment Analysis for Movie Re- views," presents a deep learning model using LSTM, Graph Convolutional Networks (GCN), and BERT embeddings to per- form fine-grained, aspect-based sentiment analysis. The system identifies sentiments for specific film attributes such as acting, direction, and music, while also detecting sarcasm for improved accuracy.

An interactive dashboard visualizes results and trends, enabling filmmakers and marketers to understand audience perceptions more effectively. With cloud integration and strong accuracy, the system transforms movie reviews into actionable insights, bridging the gap between audience emotion and data-driven decision-making.

Index Terms - Sentiment Analysis, Aspect-Based Sentiment Analysis (ABSA), Deep Learning, Natural Language Processing (NLP), Movie Reviews, LSTM, Graph Convolutional Networks (GCN), BERT, Sarcasm Detection, Opinion Mining, Artificial Intelligence (AI), Text Analytics.

***Index Terms*—component, formatting, style, styling, insert**

I. INTRODUCTION

In the digital age, individuals frequently share opinions, emotions, and feedback through online platforms such as social media, blogs, and review websites. This massive and continuous generation of text data holds valuable insights into public perception of products, services, and entertainment con- tent. However, analyzing this data manually is time-consuming and inefficient.

Sentiment Analysis, also known as Opinion Mining, uses natural language processing (NLP) and machine learning techniques to automatically determine the sentiment (positive, negative, or neutral) expressed in a text. It bridges the gap between human emotions and computational understanding, enabling automated systems to comprehend public opinions at scale.

The project, "AI-Based Sentiment Analysis for Movie Re- views," focuses on developing an intelligent analytical system capable of interpreting audience opinions on films. It leverages advanced models such as LSTM (Long Short-Term Memory) and Graph Convolutional Networks (GCNs) integrated with BERT-based embeddings to achieve aspect-based sentiment analysis (ABSA). The system aims to provide fine-grained evaluations of movie aspects like acting, direction, cine-matography, and music, helping stakeholders make informed decisions.

II. PROBLEM DEFINITION AND SCOPE

Problem Definition

Movie reviews often include sarcasm, irony, or mixed opinions, which pose challenges for traditional sentiment analysis models. Existing systems struggle to understand contextual nuances and aspect-specific sentiments within a single review. For example, a review might praise the acting but criticize the storyline — something binary sentiment classification cannot capture.

Therefore, this project proposes a deep learning-based model using LSTM and GCN architectures to:

- Accurately classify sentiment polarity (positive, negative, neutral)
- Detect sarcasm and irony in complex expressions
- Deliver aspect-based insights for better analysis of movie feedback.

A. Maintaining the Integrity of the Specifications

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the head margin measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

III. EXISTING SYSTEMS

Existing sentiment analysis systems primarily rely on lexicon-based or shallow machine learning models such as Na¨ıve Bayes and Support Vector Machines.

These models perform well on simple sentiment classification tasks but fail to interpret:

- Contextual dependencies between words
- Domain-specific vocabulary
- Sarcasm or irony
- Multiple sentiments within the same review.

Additionally, existing systems usually provide overall sentiment polarity (positive/negative) rather than aspect-specific evaluations (e.g., acting, direction, cinematography).

As a result, they produce coarse-grained outputs that do not adequately capture the complexity of human emotions and opinions in movie reviews.

IV. DISADVANTAGES OF EXISTING SYSTEMS

- Inability to Handle Sarcasm and Irony: Systems often misclassify sarcastic comments such as “The movie was so thrilling, I fell asleep!” as positive instead of negative.
- Lack of Contextual Understanding: Traditional algorithms fail to interpret contextual word meanings. For example, the word “dark” can be positive in a thriller but negative in a comedy.
- Limited Aspect Detection: Conventional systems cannot differentiate sentiments across various attributes (acting, direction, etc.), providing only a single sentiment score per review.
- Data Imbalance and Bias: Many datasets are dominated by positive reviews or specific genres, leading to biased and inaccurate model behavior.
- Poor Generalization: Models trained on one dataset (e.g., IMDb) perform poorly on other platforms (e.g., Letterboxd) due to linguistic and cultural variations.
- High Manual Effort: Manual labeling and preprocessing of large datasets are time-intensive and error-prone.

V. PROPOSED SYSTEM

The proposed AI-based system enhances sentiment analysis through deep learning and advanced NLP techniques. It employs an Aspect-Based Sentiment Analysis (ABSA) frame- work that classifies sentiments for specific movie aspects and detects sarcasm automatically.

- Aspect Identification: Automatically detects movie- related attributes such as acting, direction, music, and screenplay using pre-defined taxonomies.
- Context-Aware Sentiment Classification: Utilizes LSTM and GCN architectures with BERT embeddings to under- stand context and word dependencies.
- Sarcasm Detection Module: Incorporates an LSTM-based sarcasm detection component to handle irony and context- reversal statements.
- Analytical Dashboard: Provides visual representations such as sentiment distribution graphs, aspect-based com- parisons, and temporal sentiment trends.
- Scalability and Cloud Integration: Designed for deployment on cloud platforms like AWS with GPU support for real-time analysis.
- APIs for Integration: Offers RESTful APIs for review submission, batch processing, and third-party integration with external systems.
- Security and Compliance: Ensures data security using encryption (TLS 1.3, AES-256) and privacy regulations (GDPR, CCPA).

Expected Outcomes:

- Accurate aspect-level sentiment predictions (¿85
- Real-time analysis with under 2-second processing time per review.
- Scalable, explainable, and user-friendly sentiment interpretation platform.

VI. FUTURE SCOPE

Multimodal Sentiment Analysis: Integrate text, audio, and visual cues (from trailers or video reviews) for deeper emotional understanding.

Cross-Lingual and Cross-Platform Learning: Extend the system to handle multilingual datasets and

various review platforms (YouTube, Reddit, etc.).
Explainable AI (XAI): Develop models that can explain why a particular sentiment was assigned, enhancing trust and transparency.
Ethical AI and Governance: Ensure fairness, reduce bias, and prevent misuse of sentiment analytics in opinion manipulation.
Meta-Learning and Few-Shot Learning: Enable model adaptation for new genres or low-resource domains with minimal retraining.
Continuous Model Evolution: Incorporate automated re- training pipelines and real-time monitoring to adapt to evolving language patterns and trends.

VII. CONCLUSION

The proposed AI-based sentiment analysis system offers an innovative approach to understanding movie reviews through deep learning and natural language processing. By perform- ing aspect-based analysis and sarcasm detection, the system surpasses traditional sentiment models in accuracy and inter-pretability.
This project bridges the gap between human emotion and computational analysis, enabling entertainment industries to make data-driven decisions. While challenges such as bias, interpretability, and evolving language persist, future advancements in explainable and multimodal AI will continue to refine and expand the system's capabilities.
Ultimately, this project contributes to the broader goal of human-centered AI, where machines can understand and respond to emotional expressions with precision and empathy.

VIII. ACKNOWLEDGMENT

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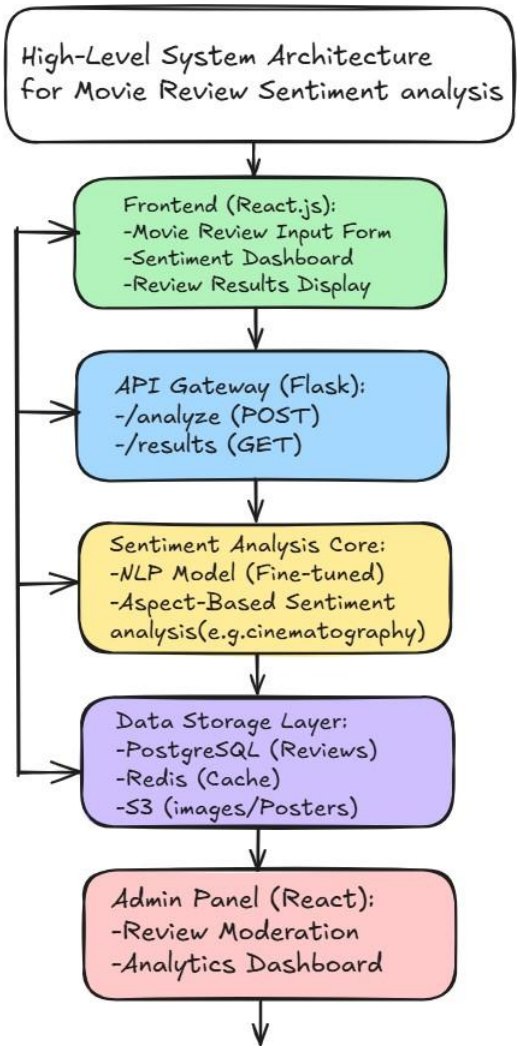

Fig. 1. Data Flow Diagram

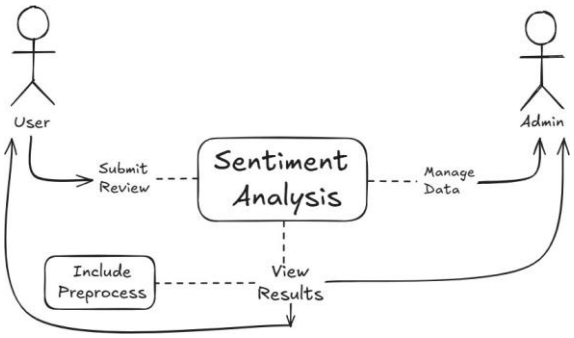

Fig. 2. UML: Use Case Diagram

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