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Comparative Study of ML and DL Techniques for Prediction of Fake Reviews by Online Consumer in E-Commerce Platforms

Vijendra Singh Palash
Research Scholar
Department of CSE
LNCTU Bhopal

Dr. A. K. Sachan
Professor
Department of CSE
LNCTU Bhopal

***Abstract*— This study compares Machine Learning and Deep Learning techniques for predicting fake reviews in e-commerce platforms. The rapid growth of e-commerce platforms has increased the dependence of consumers on online reviews, making fake review detection a critical research area. This paper presents a comparative study of Machine Learning (ML) and Deep Learning (DL) techniques for predicting fake reviews posted by online consumers. Various ML algorithms such as Naïve Bayes, Support Vector Machine (SVM), Logistic Regression, Decision Tree, and Random Forest are analyzed alongside DL models including Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks. The study evaluates these models based on performance metrics such as accuracy, precision, recall, F1-score, and computational efficiency. It also examines feature extraction methods including textual, sentiment, and behavioral attributes. The comparative analysis highlights the strengths and limitations of each approach in terms of scalability, interpretability, and real-time applicability. The findings provide insights into selecting suitable techniques for building robust and efficient fake review prediction systems in modern e-commerce environments.**

Keywords—Machine Learning, Deep Learning, Sentiment Analysis, Fake Review Detection, E-Commerce Platforms.

I. INTRODUCTION

The rapid expansion of digital marketplaces has significantly changed the way consumers purchase products and services. E-commerce platforms such as Amazon, Flipkart, eBay, and Alibaba have created highly competitive online environments where customer reviews play a crucial role in influencing purchasing decisions. Unlike traditional shopping systems, online buyers cannot physically examine products before purchase. Therefore, they rely heavily on user-generated content, including ratings, textual feedback, and recommendations. Online reviews act as a digital form of word-of-mouth communication that directly impacts product visibility, seller reputation, and overall revenue[1].

However, the growing importance of reviews has led to the emergence of fake or deceptive reviews posted intentionally to manipulate consumer perception. Fake reviews may be generated to artificially boost product ratings, promote specific brands, or harm competitors through negative feedback. These deceptive practices not only mislead customers but also damage the trustworthiness of e-commerce platforms. As a result, identifying and predicting fake reviews has become a significant research challenge in the fields of Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning (DL)[2][3].

Initially, traditional rule-based systems were used to filter suspicious reviews based on predefined patterns such as repetitive content, unusual rating distributions, or excessive use of promotional words. However, as spammers adopted more sophisticated writing styles and behavioral strategies, these simple filtering techniques became ineffective. This situation led researchers to explore data-driven approaches using ML and DL algorithms capable of learning hidden patterns from large-scale datasets[4].

Machine Learning techniques have been widely applied for fake review prediction. Algorithms such as Naïve Bayes, Support Vector Machine (SVM), Decision Tree, Logistic Regression, and Random Forest have shown promising performance in classifying reviews as genuine or fake. These models rely on feature engineering techniques that extract meaningful attributes from textual data, including word frequency, n-grams, sentiment polarity, and syntactic patterns. In addition to textual features, behavioral attributes such as reviewer activity frequency, rating deviation, and review timing patterns are incorporated to improve classification accuracy. ML models are generally interpretable and computationally efficient, making them suitable for moderate-sized datasets[5].In contrast, Deep Learning techniques offer automatic feature extraction capabilities and improved performance

in complex text classification tasks. Models such as Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), and Long Short-Term Memory (LSTM) networks can capture semantic relationships, contextual dependencies, and sequential information within review texts. Unlike traditional ML models that depend heavily on manual feature engineering, DL models learn high-level representations directly from raw data. Word embeddings and vector representations further enhance their ability to understand linguistic context. As a result, DL approaches often achieve higher prediction accuracy, especially in large and diverse datasets[6][7].

Despite the advantages of both ML and DL methods, selecting the most suitable technique remains challenging. Machine Learning models are easier to implement and interpret but may struggle with highly complex linguistic structures. Deep Learning models provide superior performance but require large datasets, higher computational resources, and longer training time. Additionally, issues such as imbalanced datasets, multilingual reviews, evolving spam strategies, and real-time processing constraints affect both approaches. Therefore, a systematic comparative study is necessary to evaluate their strengths and limitations under similar experimental conditions[8].

Another important consideration in fake review prediction is scalability and deployment feasibility. E-commerce platforms generate millions of reviews daily, requiring real-time analysis and robust architectures. ML models may offer faster inference speed, while DL models provide better generalization capabilities. Understanding this trade-off is essential for designing practical and efficient detection systems. Furthermore, ethical considerations, including user privacy and data protection regulations, must be addressed while developing automated detection mechanisms[9].

Conducting a comparative study of ML and DL techniques for fake review prediction provides valuable insights into their effectiveness, performance metrics, computational complexity, and adaptability to evolving spam tactics. Such a study helps researchers and practitioners identify optimal strategies for building reliable, scalable, and intelligent review filtering systems. Ultimately, strengthening fake review detection mechanisms contributes to maintaining consumer trust, protecting genuine businesses, and ensuring transparency in modern e-commerce ecosystems[10].

II. BACKGROUND

The emergence of e-commerce platforms has transformed global trade by enabling consumers to purchase goods and services from anywhere at any time. With the rise of online shopping, user-generated content such as ratings and textual reviews has become a key factor in shaping consumer decisions. Reviews function as digital recommendations that influence product popularity, search ranking, and overall sales performance. Because customers cannot physically inspect products online, they rely heavily on the experiences shared by other buyers. This dependency has increased the strategic importance of review systems in modern digital marketplaces.

As the influence of reviews grew, unethical practices such as fake or deceptive review posting also increased. Fake reviews are intentionally written to mislead consumers by promoting or demoting specific products. These reviews may be generated by paid individuals, automated bots, or even competitors aiming to damage a brand's reputation. Over time, such practices have created significant challenges for platform administrators, as deceptive content undermines consumer trust and affects fair competition. The presence of manipulated ratings can distort product rankings and misguide potential buyers.

Early research in fake review detection focused on rule-based filtering systems and manual moderation. Platforms initially relied on identifying duplicate content, suspicious IP addresses, and abnormal rating patterns. However, as fake reviewers began to adopt more sophisticated writing styles and behavioral strategies, these simple detection mechanisms became insufficient. Spammers started using natural language variations, realistic purchase histories, and distributed posting patterns to avoid detection. This evolution highlighted the need for intelligent, automated detection systems capable of learning complex patterns.

The advancement of Machine Learning (ML) techniques marked a significant step forward in addressing this issue. Researchers began applying supervised learning algorithms to classify reviews based on textual and behavioral features. Features such as word frequency, sentiment polarity, review length, reviewer activity, and rating deviation were commonly used for training models. These approaches improved detection accuracy compared to rule-based systems, but they still required careful feature engineering and domain expertise to achieve optimal performance.

With the rapid growth of data and computational power, Deep Learning (DL) methods gained attention in recent years. DL models such as Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks introduced automatic feature extraction capabilities. These models can capture contextual and semantic relationships within textual data, making them more effective in detecting subtle deceptive patterns. Deep learning techniques reduced the dependency on manual feature selection and demonstrated higher accuracy in large-scale datasets.

Despite technological advancements, fake review detection remains an ongoing challenge. The dynamic nature of spam strategies, multilingual content, and privacy constraints continue to complicate the detection process. Furthermore, balancing model accuracy with computational efficiency is essential for real-time deployment in large e-commerce platforms. Therefore, understanding the background evolution—from manual filtering to ML and DL-based systems—is crucial for developing more robust, adaptive, and scalable solutions in the future.

Table 1: Summary of literature review

Sr. No.	Author Name	Year	Work	Outcome
1	P. P. T	2025	Proposed ML and NLP-based framework for fake review detection in e-commerce platforms.	Achieved improved accuracy using textual feature extraction and NLP preprocessing techniques.
2	R. Pandey	2024	Comparative study of Random Forest, SVM, and Naïve Bayes for sentiment analysis optimization.	Random Forest showed better stability and performance in sentiment classification tasks.
3	Mridula	2025	Developed Edge-AI enabled hybrid deep learning framework for intrusion detection in IoT ecosystems.	Demonstrated high detection accuracy and reduced latency using hybrid DL models.
4	A. Sharma	2024	Deep learning-based fake review detection using neural network architectures.	DL models outperformed traditional ML models in detecting complex textual patterns.
5	M. L. Verma	2023	Hybrid machine learning model integrating textual and behavioral features.	Improved prediction reliability and classification performance through ensemble methods.
6	J. Patel	2022	Sentiment and behavioral feature-based fake review identification.	Combined feature analysis enhanced detection accuracy and reduced false positives.
7	S. Roy	2021	NLP-based opinion spam detection using ensemble learning techniques.	Ensemble approach improved precision, recall, and overall robustness.
8	H. Zhang	2020	CNN-based approach for online review spam detection.	CNN achieved superior performance in semantic feature extraction.
9	T. Nguyen	2019	Applied traditional ML algorithms for deceptive review detection.	SVM performed better among classical algorithms with moderate accuracy.
10	R. Kumar	2017	Supervised learning methods for opinion spam detection in e-commerce.	Provided baseline accuracy and foundational insights for later AI-based models.

III. ML AND DL TECHNIQUES

A. Machine Learning (ML) Techniques

1. Naïve Bayes (NB)

Naïve Bayes is a probabilistic classification algorithm based on Bayes' Theorem and the assumption of conditional independence between features. In fake review detection, it calculates the probability of a review being fake or genuine based on the occurrence of words and phrases. It works effectively with textual data represented using techniques such as Bag-of-Words or TF-IDF. Naïve Bayes is computationally efficient and performs well even with large datasets. However, its independence assumption may limit its ability to capture complex relationships between words in review text.

2. Support Vector Machine (SVM)

Support Vector Machine is a supervised learning algorithm that finds an optimal hyperplane to separate different classes. In fake review detection, SVM handles high-dimensional textual features effectively. It is particularly suitable for text classification problems because it performs well with sparse data. Kernel functions allow SVM to model non-linear relationships between features. Although it provides high accuracy, it requires careful parameter tuning and may be computationally expensive for extremely large datasets.

3. Logistic Regression (LR)

Logistic Regression is a statistical classification model used for binary prediction tasks such as fake vs. genuine reviews. It estimates the probability of a review belonging to a particular class using a sigmoid function. LR is simple, interpretable, and easy to implement. It works well when the relationship between features and output is linear. However, it may struggle with complex semantic patterns that require deeper contextual understanding.

4. Decision Tree (DT)

Decision Tree is a rule-based classification method that splits data into branches based on feature values. For fake review detection, it can analyze features such as review length, sentiment score, and rating deviation. The model is easy to interpret and helps identify important features influencing classification. However, Decision Trees are prone to overfitting when trained on large or noisy datasets. Proper pruning techniques are required to improve generalization.

5. Random Forest (RF)

Random Forest is an ensemble learning technique that combines multiple decision trees to improve prediction performance. It reduces overfitting by averaging the results of several trees. In fake review detection, RF can handle both textual and behavioral

features effectively. It provides higher accuracy and robustness compared to a single Decision Tree. Although it improves performance, it may require more computational resources and reduced interpretability compared to simpler models.

B. Deep Learning (DL) Techniques

6. Convolutional Neural Network (CNN)

CNN is a deep learning architecture originally designed for image processing but widely used in text classification tasks. In fake review detection, CNN applies convolutional filters over word embeddings to capture local contextual patterns such as phrases and short sequences. It automatically extracts important semantic features without manual feature engineering. CNN models achieve high accuracy in large datasets. However, they require significant computational power and training time.

7. Long Short-Term Memory (LSTM)

LSTM is a special type of Recurrent Neural Network (RNN) designed to capture long-term dependencies in sequential data. In review analysis, LSTM understands sentence structure and contextual flow across words. It is particularly effective in detecting subtle deception patterns in lengthy reviews. LSTM reduces the vanishing gradient problem found in traditional RNNs. Although it offers strong contextual learning capability, it requires large datasets and higher computational cost compared to traditional ML models.

IV. CONCLUSION

The comparative analysis of Machine Learning and Deep Learning techniques for fake review prediction in e-commerce platforms demonstrates that both approaches offer significant advantages depending on the application context. Traditional ML algorithms such as Naïve Bayes, SVM, Logistic Regression, Decision Tree, and Random Forest provide efficient, interpretable, and computationally less expensive solutions, especially for structured and moderate-sized datasets. On the other hand, Deep Learning models like CNN and LSTM deliver superior performance in capturing complex semantic and contextual patterns within large-scale textual data, though they require higher computational resources and training time. While ML models are suitable for faster deployment and explainability, DL models are more effective in handling evolving and sophisticated spam strategies. Therefore, selecting an appropriate technique depends on dataset size, computational constraints, scalability requirements, and desired accuracy, and in many cases, hybrid approaches combining ML and DL can provide the most robust and reliable fake review detection systems in modern e-commerce environments.

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