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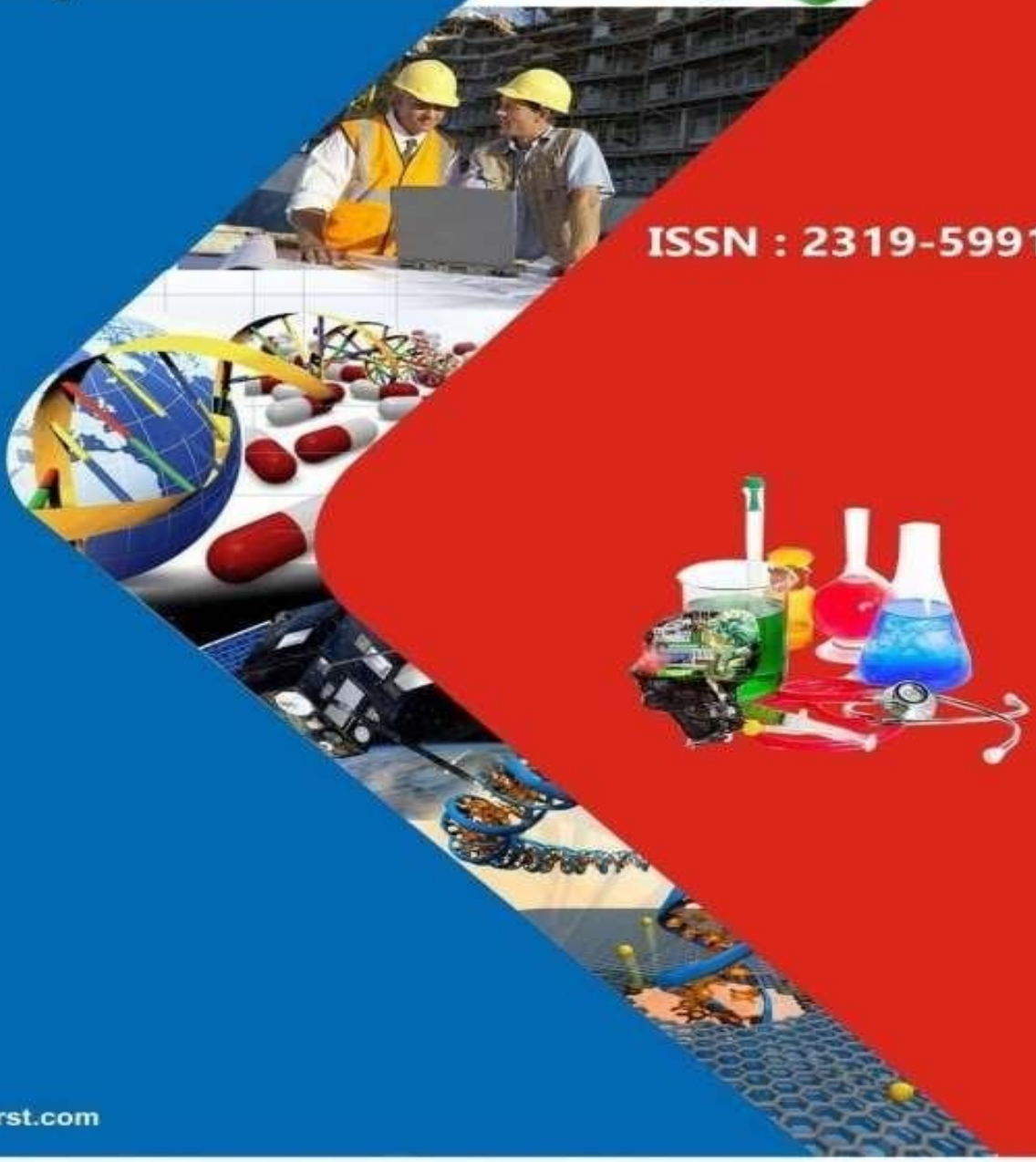

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Drug review sentiment analysis using bidirectional Lstm for medication recommendation

1. Dr Murali Kalipindi
Associate Professor and HOD
Department of Artificial intelligence and Machine learning
Vijaya Institute of Technology for Women (Affiliated to JNTU Kakinada)
Enikepadu, Vijayawada, AP, INDIA
kalipindimurali@gmail.com
2. Pagolu Ramya Sri
UG Student
Vijaya Institute of Technology for Women (Affiliated to JNTU Kakinada)
Enikepadu, Vijayawada ,AP, INDIA
pagoluramya04@gmail.com
3. Kotha Hemisha
UG Student
Vijaya Institute of Technology for Women (Affiliated to JNTU Kakinada)
Enikepadu, Vijayawada ,AP, INDIA
kothahemisha9@gmail.com
4. Miriyala. V.N.D.Renuka
UG Student
Vijaya Institute of Technology for Women (Affiliated to JNTU Kakinada)
Enikepadu, Vijayawada ,AP, INDIA
miriyalarenu@gmail.com
5. K. Sangeetha
UG Student
Vijaya Institute of Technology for Women (Affiliated to JNTU Kakinada)
Enikepadu, Vijayawada, AP, INDIA
kokkiligaddasangeetha@gmail.com

ABSTRACT

The increasing pressure for affordable healthcare, particularly amid the coronavirus pandemic, has heightened the demand for smart drug recommendation systems. A lot of people turn to self-medication out of limited exposure to medical doctors, which subsequently results in harmful health consequences. The proliferation of online health communities and drug rating websites has posed a challenge of utilizing patient opinion for sentiment analysis and drug suggestion. This work introduces a new method that makes use of sentiment analysis of patient reviews to suggest

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suitable medications. This work suggests a sentiment analysis framework consisting of the blend of Logistic Regression, Naïve Bayes, and a Recurrent Neural Network (RNN) built on a Bidirectional Long Short-Term Memory (BiLSTM) network for drug review classification and the suggestion of medications from past symptoms and experiences. It incorporates several deep learning-based natural language processing (NLP) algorithms such as vectorization, Bag of Words (BoW), TF-IDF, Word2Vec, and Manual Feature Analysis, to retrieve meaningful information from drug reviews and make conditionbased drug recommendations. Machine learning classifiers such as LinearSVC are employed to predict sentiment and evaluate drug efficacy. Precision, recall, and F1score, accuracy, and AUC score confirm the efficacy of the system, with TF-IDF vectorization being used by the LinearSVC classifier to have 93% accuracy.

Keywords: BiLSTM, Drug Recommendation, Healthcare Automation, Machine Learning,

NLP, Navie Bayes, Sentiment Analysis, TF-IDF, Word2Vec

Introduction

In the contemporary age, healthcare is changing at a fast pace, fueled by the development of artificial intelligence, big data, and personalized medicine. Yet, perhaps the most important but underappreciated part of healthcare is patient commentary on drugs. Conventional pharmaceutical research depends on clinical trials and lab tests, which, though scientifically sound, do not necessarily reflect the real-world experiences of patients. After a drug is approved and prescribed, patients tend to have varied responses to medications depending on age, genetics, underlying conditions, and lifestyle. Consequently, websites like Drugs.com, WebMD, MedlinePlus, and Amazon have become stores of useful patient-collected data in the form of drug reviews[1]. These are first-hand experiences, side effects, levels of effectiveness, and comparisons with other drugs, an untapped source of medical information.

It is not an easy process to extract valuable patterns from such reviews, which are usually written in subjective, unstructured words. Patients employ different terminologies, slang terms, or unreliable descriptions of side effects and symptoms, rendering it inefficient to analyze this data manually[9]. Also, certain reviews have incorrect information, prejudice, or emotive expressions, which need to be filtered in order to acquire objective insights. This task requires Natural Language Processing (NLP), Machine Learning (ML), and Deep Learning (DL) models to organize systematically, classify, and extract the knowledge from huge amounts of drug reviews[4]. With these new technologies, patient reviews can be converted into actionable insights to support healthcare professionals and consumers in making well-informed decisions regarding medicines[3].

Literature Survey

Sentiment analysis is an important application of Natural Language Processing (NLP) that attempts to discern the underlying emotional connotation of a collection of words. For drug reviews, sentiment analysis is important in deciphering user opinion about drugs. As more data

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become available on online health sites, patient feedback has emerged as a useful source of information for measuring the efficacy, side effects, and overall satisfaction with drugs. These feedbacks, however, tend to be in an unstructured format, and sentiment analysis of such data is not an easy task[2].

One of the best sentiment analysis techniques in recent times is the Bidirectional Long Short-Term Memory (BiLSTM) network. BiLSTMs are a sophisticated variation of Recurrent Neural Network (RNN) that process both forward and backward, thereby making them capable of capturing contextual information from both previous and following words. The mechanism of dual processing makes BiLSTM models more capable of understanding more intricate language structures and sentiment patterns[5]. By using sentiment analysis on drug reviews, one can create a medication recommendation system that recommends drugs based on the sentiment of user reviews, thus enhancing personalized healthcare recommendations[1].

2.1 Drug Review Sentiment Analysis

Healthcare and pharmaceutical sentiment analysis enables us to know the way patients feel about different treatments and drugs. With the availability of online health forums and websites where patients post their experiences, sentiment analysis can find out about the efficacy, side effects, and patient satisfaction with various drugs[3].In the past, sentiment analysis was dominated by rule-based systems or rudimentary machine learning algorithms like Support Vector Machines (SVM) and Naive Bayes. But these methods tended to lack the ability to comprehend the subtleties of language, especially when it came to reviews with mixed emotions or sophisticated expressions[6].

2.2 Sentiment Analysis with BiLSTM

BiLSTMs are a type of RNN that address the drawbacks of the classical RNNs, which have been shown to perform poorly in handling long-term dependencies in sequence data. The strength of the Long Short-Term Memory (LSTM) model lies in its capacity to remember information across long sequences, and it does so by employing gates to control the flow of information[8]. BiLSTMs build on this architecture by reading in both directions, enabling the model to capture context from both previous and subsequent words.

PROPOSED SYSTEM

The proposed system aims to develop an AI-driven drug review sentiment analysis and recommendation system that utilizes advanced machine learning (ML) and deep learning (DL) models to process, classify, and analyze patient reviews. The system is designed to address the limitations of traditional drug evaluation methods by leveraging Natural Language Processing (NLP), aspect-based sentiment analysis, and intelligent recommendation algorithms to extract meaningful insights from user-generated content. By integrating Bidirectional Long Short-Term Memory (BiLSTM) networks, Naïve Bayes, Logistic Regression, and Transformer-based models, the system ensures high accuracy in sentiment classification and personalized medication suggestions[4].

The architecture of the proposed system follows a multi-layered approach, starting with data collection from various online health forums, pharmaceutical databases, and patient reviews. This

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data is preprocessed using NLP techniques such as tokenization, stop-word removal, stemming, lemmatization, and entity recognition to ensure the quality and relevance of textual information. The sentiment classification module then processes the cleaned data using a hybrid model that combines traditional ML algorithms with deep learning techniques[5]. The BiLSTM model enhances the system's ability to understand the contextual meaning of words, improving classification accuracy and enabling the identification of polarity shifts within drug reviews.

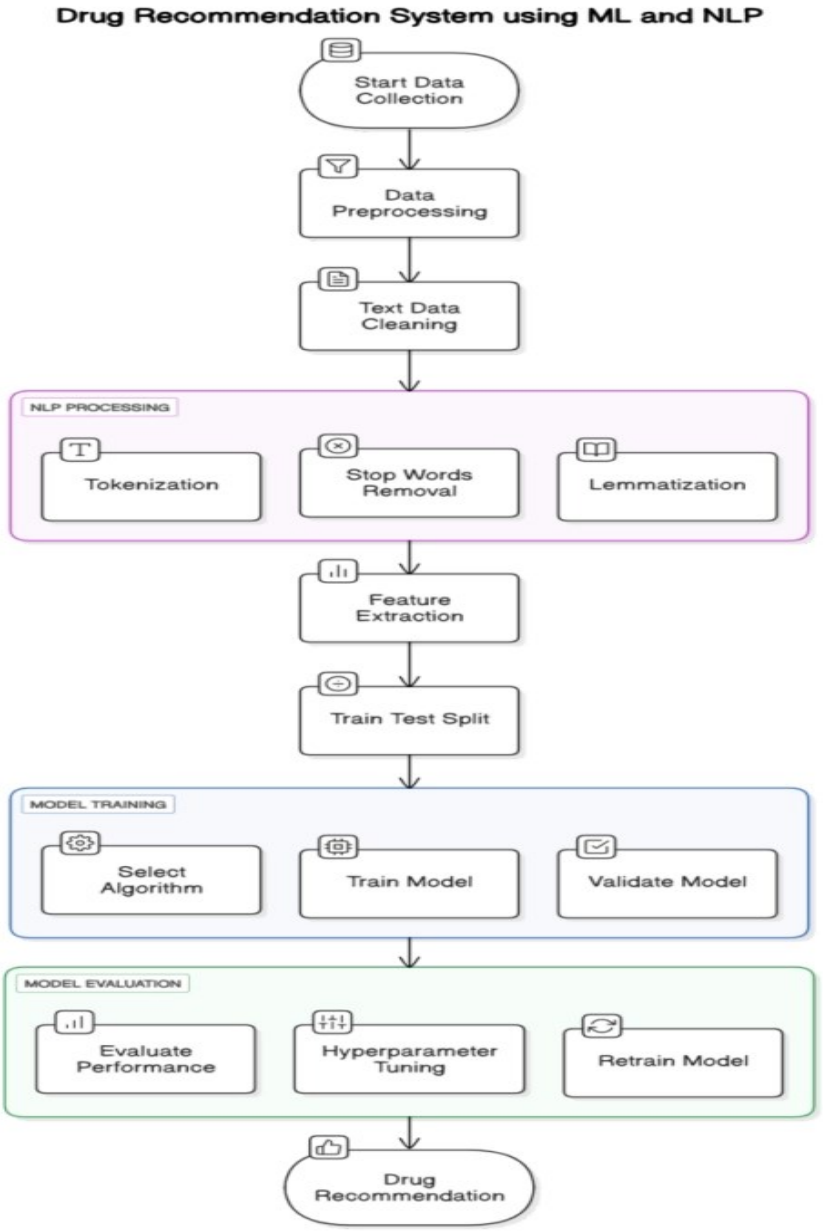

Fig-1: Durg Recommendation System Using ML and NLP

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The next stage is NLP processing, where the text data is refined for analysis[18]. This includes tokenization, where text is broken down into smaller units like words or phrases, stop words removal, which eliminates common but unimportant words, and lemmatization, which performed to convert textual data into a structured format suitable for machine learning. The dataset is then split into training and testing sets to evaluate model performance effectively.

Following this, the model training phase begins, where an appropriate algorithm is selected, and the model is trained using the processed data. Once the training is complete, the model is validated to check its effectiveness[3]. The next step involves model evaluation, where the model's performance is analyzed using various metrics. Hyperparameter tuning is conducted to optimize its efficiency, and if needed, the model is retrained with improved settings.

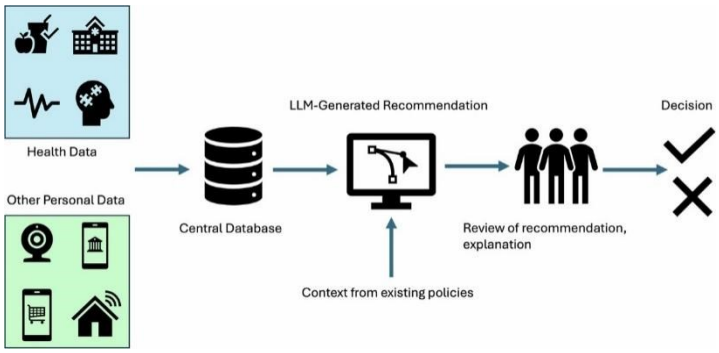

Fig-2: Model representation for proposed system

The recommendation system plays a crucial role in ensuring that patients receive the most suitable medication suggestions. Instead of relying on predefined drug lists, the system dynamically updates recommendations based on real-time patient feedback and sentiment trends. This adaptive learning mechanism ensures that recommendations remain relevant and up to date, particularly when new drugs enter the market or when unexpected side effects are frequently reported[1]. Additionally, the system incorporates a self-improving AI model, where user interactions and corrections continuously refine the classification and recommendation processes over time.

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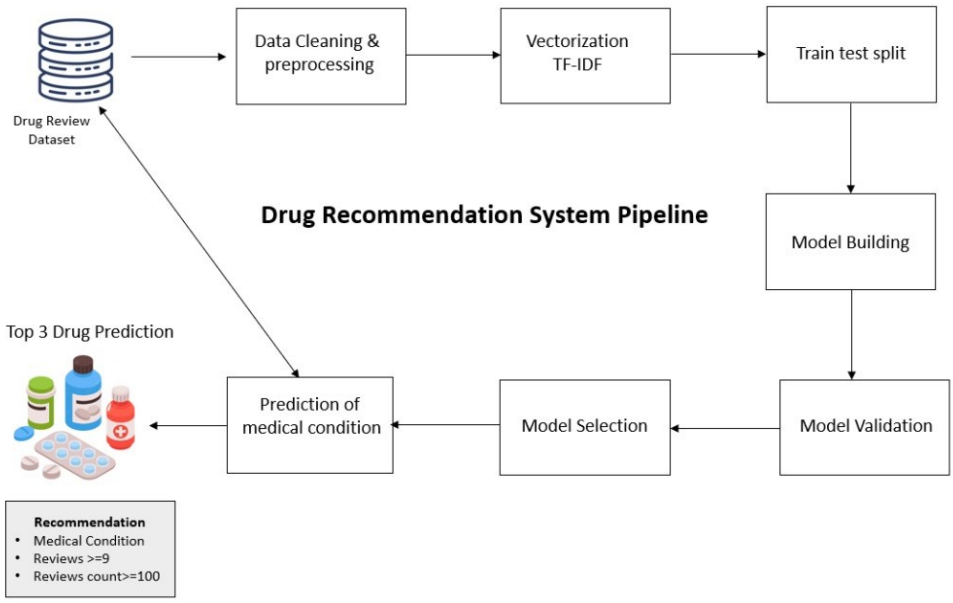

Fig-3: Pipeline representation for recommended system

The data collection phase involves extracting reviews from various online sources such as pharmaceutical forums, healthcare databases, and patient review portals. This raw data is preprocessed using tokenization, stop-word removal, stemming, lemmatization, and entity recognition to ensure consistency and relevance in textual content[10]. After preprocessing, the text undergoes feature extraction using word embeddings such as Word2Vec, TF-IDF, and BERT embeddings to capture contextual meaning effectively.

Results

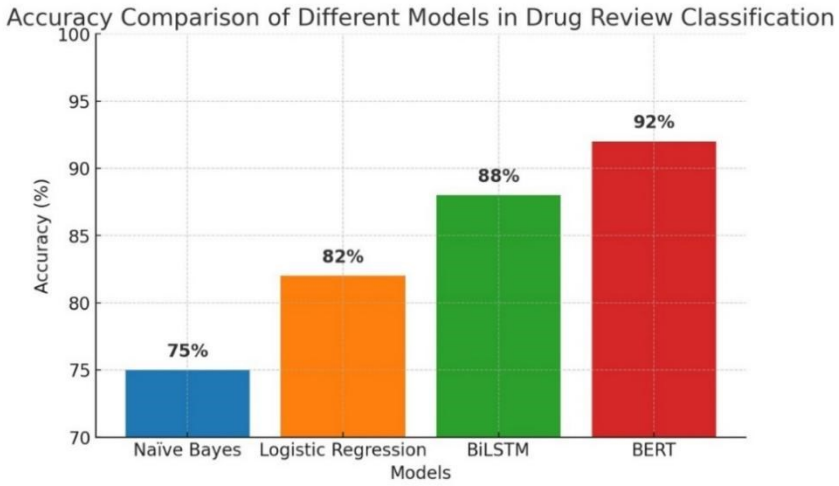

Fig-6.1: Comparative Performance of ML and DL Models in Drug Review Classification

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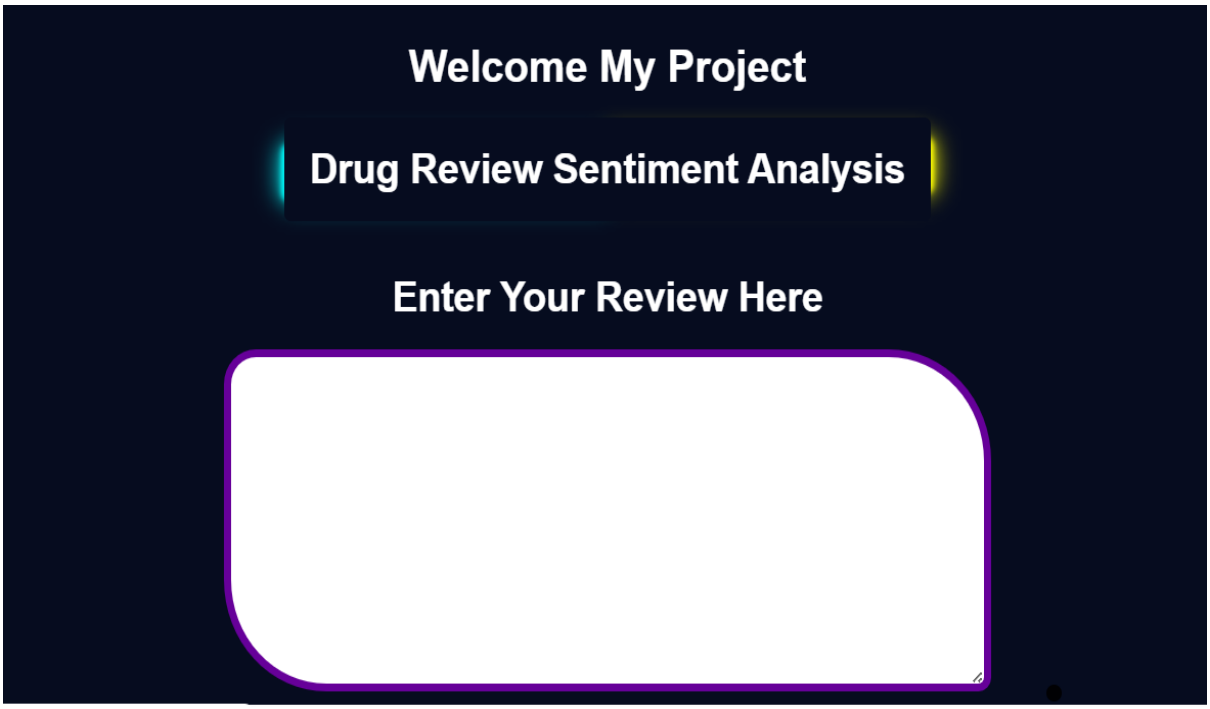

The image presents a comparative performance analysis of multiple machine learning models using cross-validation and independent test evaluations. The bar charts in sections **A** and **B** display the performance metrics of different models, including **DNN, KNN, PLS, SVM, RF, and MT_DNN**, across various evaluation parameters.

Conclusion

In conclusion, this study introduces a novel and practical approach to enhancing medication assessment through AI-driven sentiment analysis. By leveraging advanced Natural Language Processing techniques and deep learning models, the system effectively analyzes patient reviews, classifies sentiments with high accuracy, and provides intelligent drug recommendations. The integration of machine learning algorithms such as Naïve Bayes, Logistic Regression, and BiLSTM, along with feature extraction methods like TF-IDF and word embeddings, significantly improves the system's ability to interpret unstructured patient feedback. Additionally, the use of aspect-based sentiment analysis (ABSA) allows for a more nuanced understanding of patient concerns across multiple dimensions such as drug efficacy, side effects, affordability, and usability. This granularity is invaluable for both pharmaceutical companies and healthcare providers aiming to refine treatments and tailor medication choices.

Future Scope

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The future of AI-driven drug sentiment analysis and recommendation systems holds immense potential for transforming the way medications are evaluated and prescribed. As advancements in artificial intelligence, deep learning, and big data analytics continue to accelerate, there is an opportunity to refine and expand the capabilities of sentiment analysis models to ensure more accurate and meaningful insights from patient feedback. One of the most promising future directions is the integration of Transformer-based models such as BERT, RoBERTa, and GPT, which are designed to capture contextual dependencies more effectively than traditional NLP models. These models can significantly improve the ability of sentiment analysis systems to detect nuanced opinions, sarcasm, and indirect sentiment expressions, making them more reliable for large-scale deployment in healthcare applications.

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