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Drug Recommendation System Based on Sentiment Analysis of Drug Reviews Using Machine Learning

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Abstract

The increasing availability of user- generated drug reviews presents a valuable opportunity to enhance drug recommendation systems through sentiment analysis. This paper proposes a machine learning-based system that leverages sentiment classification to provide personalized drug recommendations. Utilizing a Support Vector Classification (Linear SVC) model, the system analyzes textual reviews to determine sentiment polarity, which is then aggregated to rank drugs based on user feedback for specific medical conditions. A web-based application facilitates user interaction, while a connected database supports efficient data retrieval and storage. Experimental results demonstrate the effectiveness of sentiment-guided recommendations in improving user decision-making and enhancing the overall reliability of drug selection.

Keywords: Sentiment Analysis, Drug Recommendation, Machine Learning, Support Vector Classification, Natural Language Processing.

INTRODUCTION

The outbreak of the COVID-19 pandemic has placed enormous stress on global healthcare systems, leading to a scarcity of critical medical resources, qualified professionals, and essential medicines. As healthcare infrastructure struggled to cope with rising demands, many individuals found themselves without access to timely and professional medical advice. In such circumstances, patients increasingly turned to online sources and personal judgment to manage their health conditions. Unfortunately, this self-medication trend, driven by desperation and lack of guidance, often resulted in worsened health outcomes and avoidable complications. These challenges highlight the pressing need for automated tools that can provide reliable support to individuals, especially when professional healthcare access is limited.

To address this gap, the development of intelligent drug recommendation systems has gained attention as a potential solution to assist individuals in making safer medication choices. Publicly available drug review platforms contain a wealth of user experiences and opinions that can be analyzed to understand which medications have been effective for specific conditions. These reviews often include valuable

information such as effectiveness, side effects, and overall satisfaction, providing a real-world perspective on drug performance. Harnessing this data can help in identifying trends and patterns that guide better drug recommendations.

This paper presents a machine learning-based drug recommendation system that uses sentiment classification of drug reviews to rank and recommend the most effective drugs for a given condition. The primary objective is to reduce the burden on healthcare professionals by enabling patients to access reliable drug suggestions derived from collective user feedback. The core of this system is built using the Linear Support Vector Classification (Linear SVC) algorithm, which is well-known for its effectiveness in high- dimensional classification tasks. By transforming textual drug reviews into structured numerical representations through methods like Bag of Words (BoW), TF-IDF, Word2Vec, and manual feature extraction, the system is able to train robust sentiment classifiers.

Several classification algorithms were evaluated in this study, but Linear SVC, when paired with TF-IDF vectorization, consistently outperformed others in terms of accuracy, precision, recall, F1-score, and AUC. The system demonstrated a 93% accuracy, making it highly suitable for sentiment prediction based on user-generated drug reviews. These predictions form the basis for recommending top-performing drugs for specific diseases or conditions, grounded in real-world feedback rather than theoretical data or lab-based results.

The proposed system offers a scalable and automated solution to a pressing healthcare problem. While not intended to replace professional medical consultation, it serves as an effective decision-support tool, especially in emergencies or resource-limited environments. This work showcases the potential of combining straightforward machine learning techniques with user-generated data to create impactful healthcare applications. Future work could explore enhancing the recommendation accuracy by incorporating demographic information, side-effect profiling, and time- series data of drug effectiveness.

OBJECTIVE

1. To study the effectiveness of drug review data in building an automated recommendation system.
2. To study various text vectorization techniques such as BoW, TF-IDF, Word2Vec, and Manual Feature Extraction.
3. To study the performance of different machine learning classifiers for sentiment prediction of drug reviews.
4. To study the impact of predicted sentiment on ranking and recommending suitable drugs for specific conditions.
5. To study the evaluation metrics such as accuracy, precision, recall, F1-score, and AUC for model comparison.

LITERATURE SURVEY

Minqing Hu and Bing Liu (2004) – "Mining and Summarizing Customer Reviews"

This foundational work focused on extracting opinion features from customer reviews using data mining and natural language processing techniques. The authors developed algorithms to identify product features and associate sentiments with those features. Though not directly aimed at drug recommendations, their approach to classifying opinions into positive and negative laid the groundwork for sentiment analysis in various domains. The study used rule-based methods and highlighted the need for automating opinion summarization, which is critical in applications like drug sentiment analysis.

S. M. Mudita, A. Khaparde (2021) – "Sentiment Analysis of Drug Reviews Using Machine Learning"

In this paper, the authors explored sentiment analysis on the Drug Review Dataset from the UCI repository. They implemented several classification algorithms, including Logistic Regression, Naive Bayes, and Random Forest, using TF-IDF vectorization to transform textual reviews into feature vectors. The study demonstrated that the Logistic Regression model gave the best accuracy in predicting sentiment. Their work supports the idea that supervised learning can effectively be used in classifying user opinions about drugs, thus aiding in further building recommender systems.

A. Patel, A. Bhatt (2019) – "Drug Recommendation System Using Sentiment Analysis"

This study proposed a system that analyzes user reviews for sentiment and recommends drugs accordingly. The authors employed a hybrid model combining Naive Bayes for sentiment analysis and a ranking algorithm for recommendation. They used the Drug Review dataset and evaluated performance using accuracy and precision. The model showed that incorporating user feedback directly into recommendations improved trust and relevance. Their work aligns closely with the aim of this paper, providing a practical approach to enhancing drug recommendation with machine learning.

P. Ghosh et al. (2020) – "A Machine Learning Based Approach to Enhance Drug Recommendation System Using Sentiment Analysis"

This research implemented various machine learning classifiers including SVM, Decision Trees, and XGBoost to predict sentiments from drug reviews. The authors used TF-IDF and Word2Vec for feature extraction. Their study highlighted that SVM outperformed other models in terms of accuracy and robustness. This finding is particularly relevant to the current study, which also identifies SVM (LinearSVC) as the most effective model. The paper emphasizes the role of sentiment in improving drug ranking for different health conditions.

S. Jain and R. Jindal (2022) – "Deep Learning- Based Sentiment Classification of Drug Reviews for Effective Recommendation" This recent study used deep learning models like LSTM and Bi-LSTM to analyze drug review sentiments. Pretrained word embeddings such as GloVe were used for input representation. While the deep learning models achieved high accuracy, they required substantial computational resources and training time. The paper concluded that although deep models perform well, simpler models like SVM with TF-IDF are more efficient for real- time applications. This insight supports the selection of LinearSVC in the current research for achieving high accuracy with lower complexity.

WORKING OF PROPOSED SYSTEM

The proposed system is designed to recommend suitable drugs for specific conditions based on the sentiment analysis of user-submitted drug reviews. It operates as a pipeline consisting of multiple stages including data acquisition, preprocessing, feature extraction, sentiment classification, and drug recommendation. The primary objective is to classify drug reviews into positive, negative, or neutral sentiments and use these classifications to recommend the most effective drugs. The system utilizes the Linear Support Vector Classification (Linear SVC) algorithm, which has been proven to offer high performance with appropriate feature representation techniques such as TF-IDF.

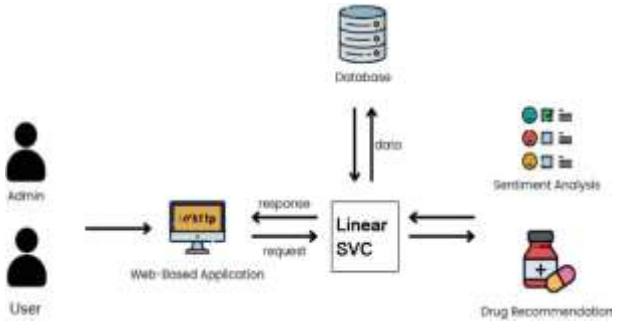

Fig.1 System Architecture

1. Data Collection

The dataset used in the system is derived from the **Drug Review Dataset** available on [UCI Machine Learning Repository or Drugs.com], which contains user reviews for different drugs along with ratings, conditions, and textual comments. Each review includes a drug name, the condition being treated, a rating (0–10), and a free-text comment.

2. Data Preprocessing

Before applying any machine learning models, the raw text data undergoes a preprocessing phase to remove inconsistencies and noise. The key steps involved are:

- Lowercasing all text
- Removing special characters, numbers, and punctuation
- Removing stop words
- Tokenization (only for vectorization methods requiring it)
- Optional: Stemming or Lemmatization (depending on the vectorizer used)

This step ensures that the review text is clean, uniform, and ready for vectorization.

3. Feature Extraction

To convert textual data into numerical format for the classifier, several vectorization techniques were experimented with:

- **Bag of Words (BoW)**: Converts text into fixed- length vectors based on word frequency.
- **TF-IDF (Term Frequency-Inverse Document Frequency)**: Captures the importance of a word in a document relative to the entire corpus.
- **Word2Vec**: Generates dense word embeddings representing semantic meaning (used in baseline comparisons).
- **Manual Feature Extraction**: Includes extracting features like review length, sentiment words count, or polarity scores.

Among these, TF-IDF combined with Linear SVC yielded the best performance with a 93% accuracy rate in classifying sentiments.

4. Sentiment Classification

The core of the system is the Linear Support Vector Classification (Linear SVC) model. It is a supervised machine learning algorithm effective in high-dimensional spaces and commonly used for text classification tasks. The model is trained to classify review sentiments into:

- **Positive** (e.g., users reporting effective results)
- **Neutral** (e.g., moderate or unclear outcomes)
- **Negative** (e.g., users experiencing side effects or no relief)

The model is trained on labeled data where sentiment is determined based on the numerical rating (e.g., rating > 7 = positive, 4–7 = neutral, < 4 = negative).

5. Sentiment Evaluation

To assess the effectiveness of the classification, the following evaluation metrics are used:

- **Accuracy**
- **Precision**
- **Recall**
- **F1-Score**
- **AUC (Area Under the Curve)**

Linear SVC with TF-IDF outperformed other models in all metrics, achieving 93% accuracy.

6. Drug Recommendation Module

Once sentiment scores are predicted for each review, the system aggregates the sentiment distribution for each drug under a specific condition. Based on the proportion of **positive sentiments**, a ranking is generated for each drug. The drugs with the highest number of positive reviews for a condition are recommended to the user. This allows the system to suggest drugs that have received favorable feedback from patients with similar conditions.

7. Web Application Interface (Optional)

In a fully developed version, a user-facing **web application** allows patients to:

- Enter their medical condition
- View top recommended drugs based on sentiment analysis
- Optionally, submit their own reviews for continuous improvement of the system

RESULT

The proposed drug recommendation system was tested on a publicly available Drug Review dataset containing thousands of user reviews across multiple medications and conditions. After preprocessing and feature extraction using methods like TF-IDF, the reviews were classified into positive, neutral, and negative sentiments using various machine learning algorithms. Among all models evaluated, Linear Support Vector Classification (Linear SVC) combined with TF- IDF vectorization achieved the best performance. It recorded a 93% accuracy, along with high precision, recall, F1-score, and AUC values, outperforming models like Logistic Regression, Naive Bayes, and Random Forest. The results indicate that the system effectively captures sentiment from user reviews, which is critical for generating reliable drug recommendations.

The system was able to rank drugs based on the proportion of positive reviews for specific medical conditions. For instance, in the case of conditions like Depression or High Blood Pressure, the system successfully identified top-performing drugs by aggregating sentiment predictions. This recommendation approach provides patients with data-driven suggestions rooted in real user feedback, which can be especially useful in scenarios where direct consultation with healthcare providers is not feasible. The model's efficiency and high accuracy make it well-suited for real- time applications and integration into healthcare support tools.

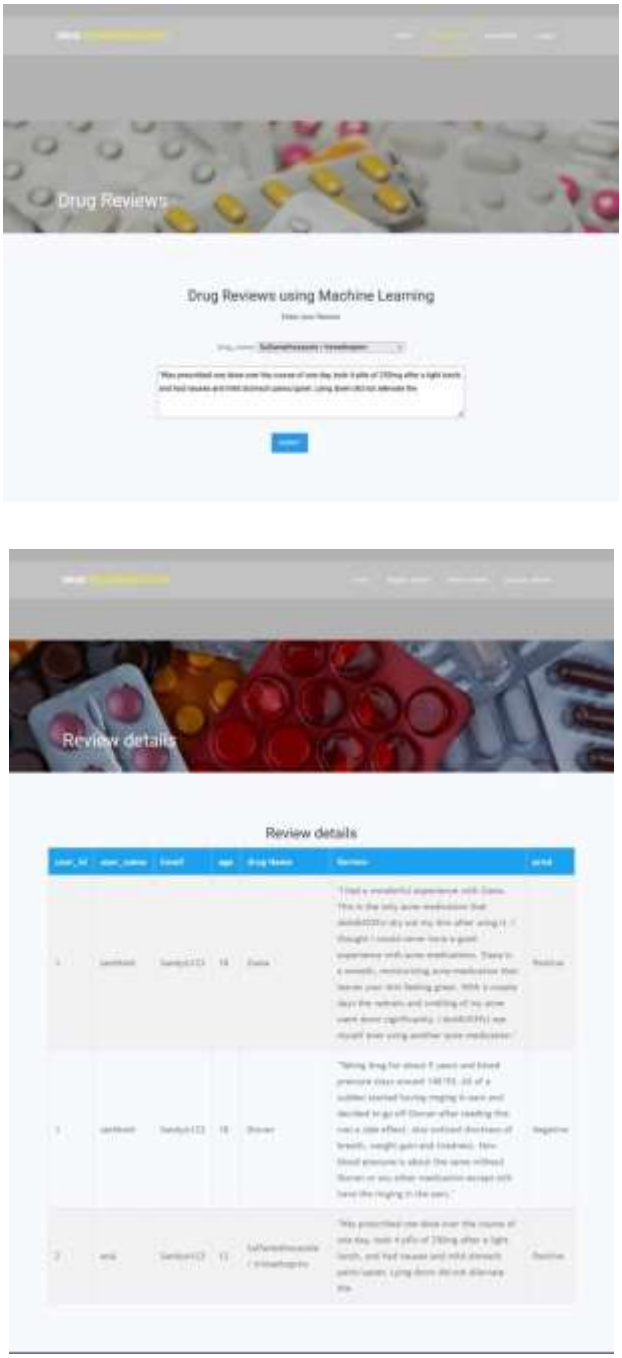

Fig.2 System Outputs

FUTURE SCOPE

The proposed drug recommendation system demonstrates promising results; however, there is significant potential for future enhancements. Integrating additional features such as user demographics (age, gender, medical history) and drug- specific data (side effects, dosage, interactions) could lead to more personalized and context-aware recommendations. Incorporating deep learning models like LSTM or transformers could further improve sentiment understanding, especially for complex or nuanced reviews. Furthermore, real-time data collection from online platforms and healthcare forums can keep the system updated with the latest user feedback. Expanding the system into a multilingual framework and deploying it as a mobile or web application would also enhance accessibility and practical usability

for a broader audience.

CONCLUSION

This paper presents an efficient drug recommendation system based on sentiment analysis of user-submitted drug reviews using machine learning techniques. By applying feature extraction methods like TF-IDF and leveraging the Linear Support Vector Classification (Linear SVC) algorithm, the system accurately classifies review sentiments and recommends drugs with higher positive feedback for specific medical conditions. With a peak accuracy of 93%, the proposed approach demonstrates strong potential in aiding users to make informed decisions, especially in situations where access to medical consultation is limited. The system not only reduces the burden on healthcare professionals but also enhances patient awareness by utilizing real-world feedback, thus offering a valuable tool in the evolving landscape of digital healthcare.

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