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Smart Drug Recommendation System Using Sentiment Analysis of Drug Reviews

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Abstract: Global healthcare disruptions have precipitated extraordinary challenges within medical service delivery systems, culminating in severe healthcare professional shortages and compromised patient access to qualified therapeutic consultation. These circumstances have fostered widespread autonomous medication selection behaviors, frequently resulting in inappropriate or potentially detrimental treatment protocols. Our investigation presents a novel therapeutic advisory framework that harnesses user experience analytics through sophisticated computational intelligence methodologies to furnish personalized and trustworthy pharmaceutical guidance. Our innovative approach transcends conventional computational learning paradigms by establishing a comprehensive digital consultation platform that exhibits therapeutic options alongside exhaustive performance analytics and integrated patient insight compilation. We exploited the extensive Drugs.com user experience database, implementing cutting-edge textual processing methodologies encompassing Term Frequency-Inverse Document Frequency computation, Word2Vec semantic modeling techniques, and sophisticated attribute extraction protocols. Our research examined multiple computational approaches including Logistic Regression modeling, Random Forest classification frameworks, Naive Bayes probabilistic models, and Support Vector Machine architectures for emotional content analysis. The optimized TF-IDF methodology coupled with Linear Support Vector Classification generated outstanding results, attaining 93% classification accuracy. Our user-centric interface exhibits pharmaceutical options through innovative card-based presentations, featuring therapeutic names, performance indicators, comprehensive descriptions, and balanced summaries highlighting therapeutic benefits alongside potential adverse effects. This groundbreaking design amplifies user comprehension while facilitating evidence-based decision-making rooted in authentic patient testimonials, providing crucial support for patients and healthcare providers, especially within geographically isolated regions experiencing healthcare access limitations.

I. INTRODUCTION

Modern healthcare infrastructure confronts unprecedented challenges encompassing inadequate medical workforce allocation, particularly within economically disadvantaged rural communities, alongside increasing therapeutic prescription inaccuracies. Comprehensive studies indicate that pharmaceutical-related adverse events impact millions of individuals worldwide annually. Given continuous pharmaceutical innovation emergence, experienced medical practitioners encounter significant difficulties maintaining current therapeutic knowledge. Artificial intelligence technologies have demonstrated exceptional effectiveness in establishing intelligent assistance frameworks across diverse commercial domains, including retail commerce and entertainment sectors, with these innovations progressively penetrating healthcare environments. Our initial investigation focused on implementing computational learning-driven emotional assessment of patient pharmaceutical feedback to recommend effective therapeutic interventions. However, the preliminary framework lacked intuitive presentation methodologies for delivering recommendations. Through our enhanced development cycle, we strengthened the system foundation by incorporating Google's Gemini API for superior natural language processing capabilities while constructing a comprehensive web-based interface. Patients can instantly input medical conditions and immediately obtain pharmaceutical recommendations featuring detailed scoring mechanisms, therapeutic advantages, and potential limitations. This enhancement transforms the system into a more dependable and practically applicable solution for authentic healthcare environments.

II. LITERATURE REVIEW

Pharmaceutical recommendation platforms consistently encounter constraints attributed to healthcare data complexity. Earlier research introduced ontology-driven frameworks (including GalenOWL) providing pharmaceutical recommendations considering allergic reactions, infectious conditions, and drug interactions. While these methodologies offered significant value, they remained generally limited to structured medical databases lacking capabilities for interpreting unstructured patient feedback.

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Contemporary investigations have implemented computational learning and natural language processing for analyzing pharmaceutical-related emotional patterns, yet limited studies have successfully integrated these approaches with real-time AI APIs or interactive patient platforms. Our framework addresses this research gap by combining natural language processing techniques, emotional classification algorithms, Gemini API integration, and patient-focused interfaces.

III. METHODOLOGY

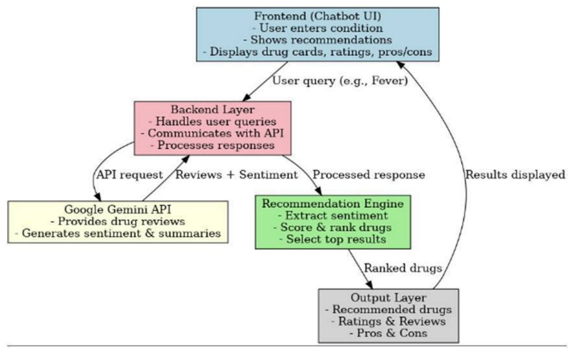

Fig1: Architecture Diagram

Our proposed solution functions through a triple-layered framework integrating a patient interface module, backend processing enhanced via Google's Gemini API, and a comprehensive pharmaceutical feedback repository. These components collaborate seamlessly to generate precise and user-friendly pharmaceutical recommendations.

A. Primary Layer: Patient Interaction Module

We developed a web-enabled interface ensuring maximum system accessibility for patients. Through this platform, users input disease terminology or medical conditions to receive appropriate therapeutic recommendations. Following query submission, the interface establishes communication with backend processing systems to retrieve relevant suggestions. Results display through interactive formats where each pharmaceutical appears as a card containing drug names, overall effectiveness ratings, comprehensive descriptions, and summarized positive and negative patient feedback. This design ensures patients receive recommendations plus supporting evidence through genuine patient experiences.

B. Secondary Layer: Backend Processing Infrastructure

The backend coordinates communication between the patient interface and intelligent processing components. This module establishes connections with Google's Gemini API, enhancing natural language comprehension and contextual interpretation of patient reviews. Additionally, the backend incorporates various computational learning models including Logistic Regression, Naive Bayes, Random Forest, and Support Vector Classification. These models underwent training on the dataset for categorizing reviews into positive or negative sentiments. Linear Support Vector Classification combined with TF-IDF vectorization delivered optimal accuracy achieving 93% precision.

The operational workflow functions through this sequence: patients submit queries through the interface, forwarding them to backend processing systems. The Gemini API interprets queries while computational learning models analyze datasets to identify effective pharmaceuticals for specified medical conditions. Subsequently, recommendations display through visually organized formats enabling straightforward effectiveness comparisons alongside benefits and limitations.

C. Tertiary Layer: Information Repository Module

This component serves as the knowledge foundation for our recommendation infrastructure. The project utilizes the publicly accessible Drug Review Dataset from Drugs.com, obtained through the UCI Machine Learning Repository. The dataset encompasses attributes including pharmaceutical names, prescribed medical conditions, patient-authored reviews, effectiveness ratings, and utility indicators. Prior to training, data preprocessing eliminated null values and duplicates, filtered unnecessary stop words, and applied lemmatization to reduce words to base forms, ensuring standardized text processing. These preprocessing procedures maintained data cleanliness, consistency, and structural integrity for comprehensive analysis.

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For emotional content analysis, dataset reviews received classification into sentiment categories. Reviews scoring above five obtained positive designations, while those scoring one through five received negative classifications. This binary classification established foundations for training and testing computational learning models. Classifier performance evaluation utilized standard assessment metrics including Accuracy, Precision, Recall, F1-Score, and Area Under Curve measurements.

Throughout experimental phases, we assessed multiple classification algorithms encompassing Logistic Regression, Naive Bayes, Random Forest, and Support Vector Classification. Linear Support Vector Classification combined with TF-IDF vectorization achieved superior performance with 93% accuracy. This demonstrated TF-IDF's effectiveness in representing reviews by capturing word significance while minimizing common term influence.

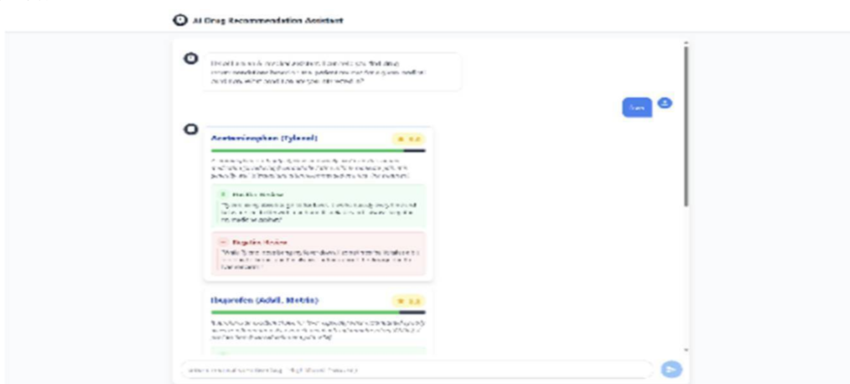
IV. EVALUATION & RESULTS

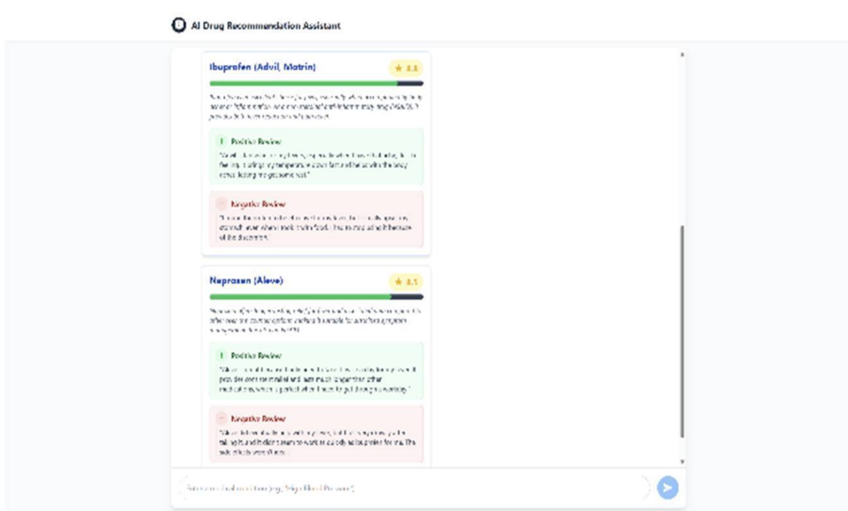
Beyond quantitative performance metrics, our system underwent comprehensive usability assessment. Unlike previous iterations presenting results through tables and raw metrics, our current system delivers recommendations through patient-friendly web interfaces providing results in accessible, comprehensible formats.

The capability for displaying both positive and negative pharmaceutical perspectives creates balanced and transparent recommendations, enabling patients to make informed choices without depending exclusively on professional consultations. This proves especially valuable for individuals in remote or underserved geographical locations.

For example, when investigating headache treatments, the interface might showcase Advil with a 9.0 rating, emphasizing positive characteristics like rapid pain relief alongside negative aspects such as gastric irritation. Similarly, Aleve might appear with an 8.5 rating, incorporating feedback regarding prolonged effectiveness but potential digestive discomfort. This balanced presentation enables patients to compare alternatives effectively and select pharmaceuticals optimally suited to individual requirements.

Experimental outcomes demonstrate robust sentiment classification performance while improving practical usability through interactive interfaces. Gemini API integration further enhances contextual comprehension, making recommendations more accurate and relevant to patient queries.





V. CONCLUSION

This investigation introduced an intelligent pharmaceutical consultation assistant integrating emotional analysis, computational learning classification algorithms, Google's Gemini API, and interactive web interfaces. Our system achieved robust performance metrics (93% accuracy in sentiment prediction) while demonstrating practical utility by providing results in accessible formats.

The capability for presenting both positive and negative pharmaceutical perspectives creates balanced and transparent recommendations, enabling patients to make informed decisions without relying entirely on professional consultations. This proves particularly valuable for individuals in remote or underserved regions with limited healthcare access.

Future enhancements may incorporate real-time patient health data, additional pharmaceutical databases, and advanced deep learning architectures to further improve recommendation quality and expand therapeutic coverage.

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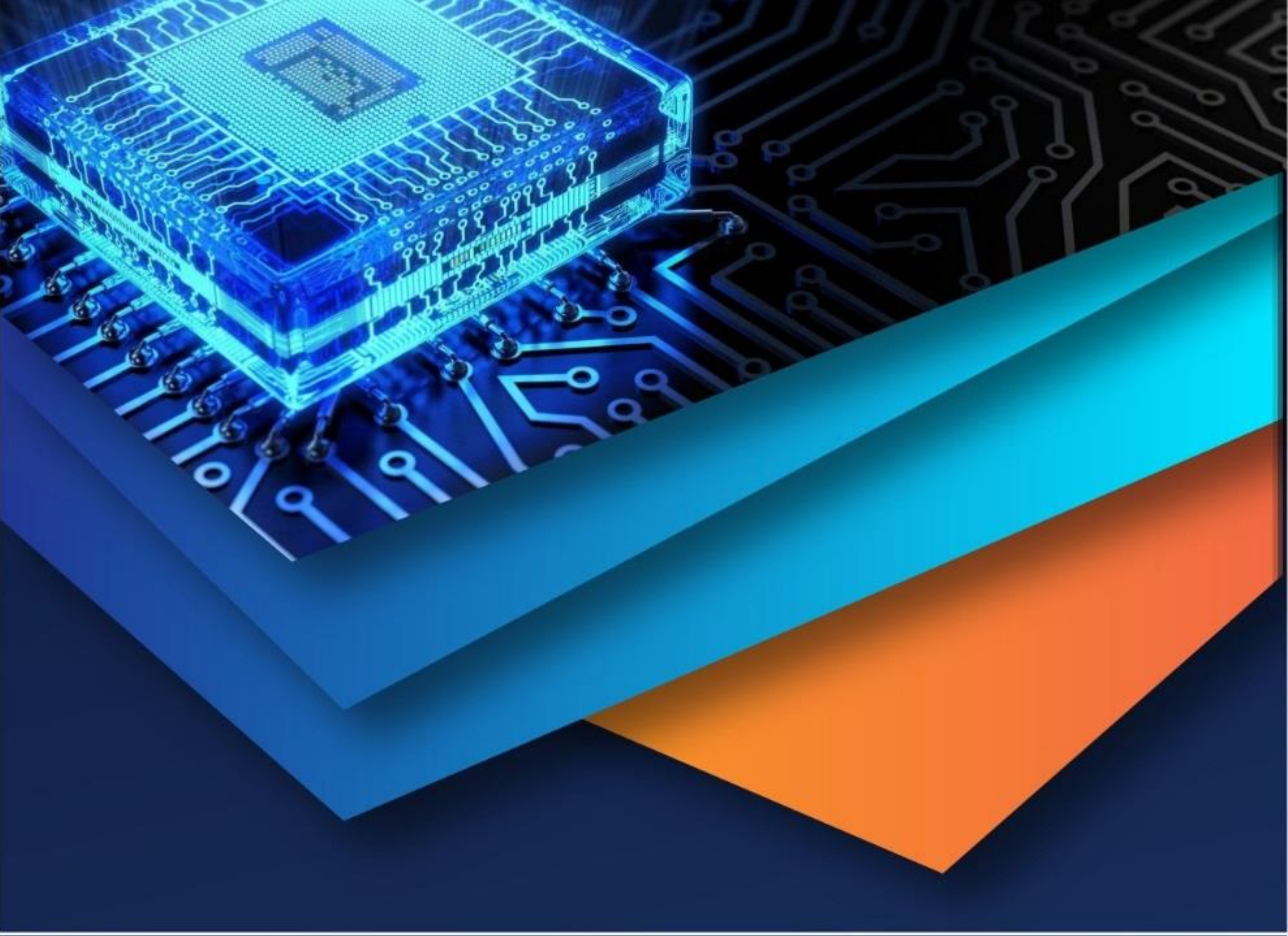

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