LawKey — Law Constitution Chatbot

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***Abstract*—In response to a pervasive lack of legal awareness among Sri Lanka, this research introduces a law constitution chatbot utilizing Natural Language Processing (NLP). The chatbot is designed to offer precise legal guidance by extracting pertinent laws from the Sri Lankan constitution based on user input. Building on existing studies at the intersection of NLP and the legal domain, this chatbot addresses the lack of relevant legal context for Sri Lanka. Reinforcement learning is integrated to refine the chatbot's behavior through user feedback, ensuring optimal selection of the most relevant laws. An exploration of applications in countries like Canada and India, where NLP and machine learning have successfully addressed legal information gaps, focuses on various legal domains in Sri Lanka with the aim of empowering the public. The research methodology involves leveraging the Sri Lankan constitution as the dataset, extracting keywords from legal documents, and employing various NLP models, and limitations of the application. A comprehensive literature review reveals the potential energy of NLP techniques in legal chatbots. The global analysis of legal chatbots significantly contributes to the theoretical foundation of this project. In summary, this project seeks to advance legal chatbot technology in Sri Lanka, utilizing NLP and reinforcement learning techniques to empower citizens with legal knowledge and enhance overall legal awareness, thereby addressing the critical issue of legal unawareness and fostering a more informed society.**

***Index Terms*—Natural Language Processing (NLP), Q-learning, Reinforcement Learning, Chatbot, Sri Lankan Constitution.**

I. Introduction

This project endeavors to address the prevalent issue of legal unawareness among Sri Lankan citizens, a circumstance that significantly exposes them to potential fraud and legal pitfalls. The lack of accessible and understandable legal information is a barrier that many face, leading to uninformed decisions and vulnerability to exploitation.

This research builds upon prior work at the intersection of Natural Language Processing and the legal domain, drawing from studies conducted in countries like the United States, the United Kingdom, and Canada, where legal chatbots have been explored to enhance access to legal assistance. However, these models often lack the relevance and specificity needed for the unique legal context in Sri Lanka. To address this gap, this project proposes developing a chatbot that leverages advanced NLP techniques to deliver tailored and context-specific legal guidance for Sri Lankan users. The literature review emphasizes the potential of combining NLP techniques in legal chatbots and highlights the adaptability of these techniques in enhancing decision-making processes. To achieve this, the project uses the Sri Lankan constitution as its primary dataset, implementing key NLP models such as word2vec and TF-IDF. These models are selected for their efficacy in processing natural language, which is essential for the chatbot to accurately interpret user input and retrieve relevant legal information. By extracting key legal terms and leveraging these NLP techniques, the chatbot is designed to respond effectively to queries in natural language, making legal information more accessible to the public.

The research methodology includes a detailed analysis of the Sri Lankan constitution, followed by the extraction of pertinent keywords and phrases commonly used in legal contexts. This process is enhanced through the use of word2vec to understand semantic relationships between words and TF-IDF to assess the importance of terms within legal documents. As user feedback and interaction are incorporated, the chatbot's accuracy and relevance improve over time, making it a more reliable resource for users seeking legal guidance. This project contributes not only by providing a technological solution to legal unawareness but also by engaging with the broader conversation around the integration of legal systems and innovative technologies. By harnessing NLP techniques and adapting them to the specific needs of Sri Lankan citizens, the chatbot aspires to promote legal accessibility and empower individuals to navigate legal complexities more effectively. Through this work, the project lays a foundation for informed and empowered citizens within Sri Lanka's legal landscape.

II. Literature Review

The literature review provides a comprehensive overview of the current state and advancements in Natural Language Processing (NLP) within the legal field, particularly focusing on applications in Sri Lanka. The research aims to address gaps in existing legal applications and enhance the effectiveness of NLP tools for users in this context.

A. Relevant Work

Existing research highlights the pivotal role of NLP in legal applications, emphasizing its utility in processing complex legal language [1] and responding to user queries with relevant information [2]. Q-learning, a form of reinforcement learning, is integral to this study, enabling chatbots to adapt based on user feedback and effectively select pertinent laws. Successful uses of Q-learning across various domains underscore its effectiveness in complex decision-making [1]. In countries like Canada and India, NLP and machine learning have been employed to enhance legal information accessibility. This research aims to provide a comprehensive resource for Sri Lankans, covering civil, criminal, motor traffic, labor laws, and fundamental rights, to empower users and mitigate fraud risks.

A comparative analysis of global legal chatbots reveals notable achievements: the LAW-U chatbot in Thailand boasts an 88.89% success rate [3], the Children's Legal Center in Wales shows impressive F1 scores [4], and the Legal Artificial Assistance Agent for refugees has made significant progress [5]. These examples illustrate the diverse methodologies and advancements in legal chatbot systems, contributing to the theoretical foundation of this project.

B. Critical Review of Relevant Works

Notable works in the field of legal chatbots have utilized various technologies to advance legal assistance, though challenges remain. One approach uses Natural Language Processing (NLP) and Trie structures for efficient law retrieval, enhanced by Q-Learning, which adapts based on user interactions. This system improves legal awareness by providing precise access to Indian constitutional laws. Its primary strength is tailored information retrieval, but its effectiveness depends on the accuracy of indexed keywords and may struggle with vague queries [1]. Another study employs transformer-based models, specifically XLM-RoBERTa, to classify criminal intents in Thai legal texts through the LAW-U chatbot. This method aids sexual violence survivors by offering accurate legal guidance, though it faces challenges such as limited data diversity and the need for frequent updates to keep pace with evolving legal language [2]. IBM Watson powers a chatbot designed for continuous legal assistance to immigrants and refugees. This system leverages AI and NLP to handle a broad range of queries efficiently, enhancing access to justice. However, it may struggle with the complex and varied legal needs of these populations, necessitating a more nuanced approach [5].

A different study uses neural networks, Long Short-Term Memory (LSTM) models, pre-trained embeddings, and Named Entity Recognition (NER) to develop a chatbot for children. This system improves accessibility to legal advice by classifying speech acts and streamlining case processes. Challenges include accurately simulating children's language and covering a broad range of legal issues to provide effective assistance [6].

C. Additional Findings

The literature review has revealed the potential of combining NLP and reinforcement learning techniques in legal chatbots, with a particular emphasis on the adaptability of Q-learning in decision-making tasks. Furthermore, the comprehensive analysis of existing legal chatbots globally, including notable examples such as LAW-U in Thailand, the Children's Legal Center framework in Wales, and the Legal Artificial Assistance Agent for refugees, showcases the diverse applications and methodologies applied in the development of legal chatbot systems worldwide.

III. Methodology

The application accommodates both text and voice inputs, utilizing advanced voice-to-text conversion. When a user query is received, the chatbot processes it through tokenization and keyword extraction. These keywords are then mapped to a dataset to retrieve relevant laws. The chatbot's responses are precisely crafted, ensuring a conversational and user-friendly interaction. This approach enhances accessibility and demonstrates the system's advanced natural language processing capabilities

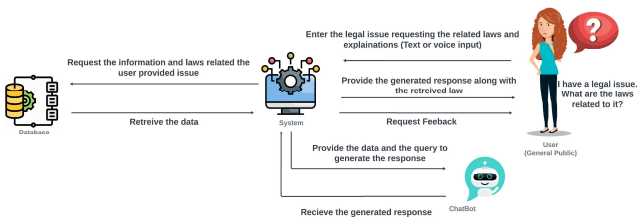

Fig. 1. Rich Picture

A. System Requirement Analysis

The research methodology commenced with comprehensive surveys conducted among the general public in Sri Lanka to assess the demand and preferences for a legal information access application. The surveys revealed a significant need for such information, with many participants facing challenges due to its unavailability.

The survey of 101 target audience participants showed strong demand for legal information access, with 89% of respondents finding it crucial or needed. Over half (55.4%) reported facing challenges due to the lack of access, supporting the need for this application. The most sought information included fundamental rights, motor traffic laws, civil laws, and labor laws, all within the project's scope. Users preferred a combination of text and voice interfaces (76.2%) and favored

conversational interactions (42.6%). The domain experts' survey of 20 responses confirmed the feasibility and relevance of the legal topics, recommending authoritative sources like the Constitution and Lawbook for the dataset. Experts emphasized the importance of data reliability and validation. They also suggested ensuring the application uses the most current legal documents.

Combining insights from both surveys, the research establishes a strong foundation for developing a legal information access application tailored to the needs of Sri Lankan users, with a focus on usability and authoritative content.

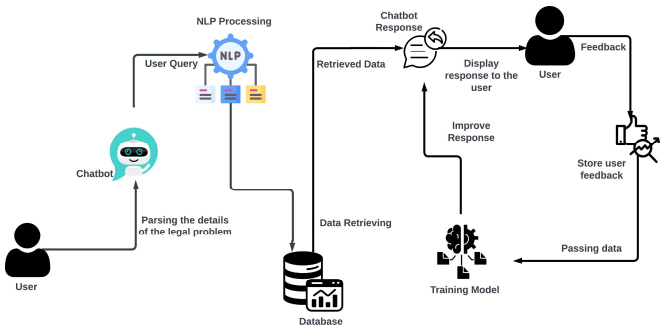

Fig. 2. Prototype Diagram

B. Data Collection and Dataset Creation

The data collection process involves extracting information from official PDF documents, specifically focusing on key legal documents such as the Penal Code, Constitution, Civil Procedure Code (both updated and new addons), Maintenance Act, Motor Traffic Amendment, and National Minimum Wage Act.

Additionally, it includes the Right of Access to Information and the Assistance to and Protection of Victims documents. The filtration and extraction of the relevant laws from these documents align with the project's defined scope, encompassing civil law, criminal law, labor law, motor traffic law, and fundamental rights. This process is conducted via consultation with domain experts and through a several surveys.The extracted data undergoes meticulous compilation, structured into a CSV file format. This dataset encapsulates comprehensive information on laws sourced from the PDF documents and is enriched with their corresponding vectors, legal area, and keywords. Such a systematic approach ensures the creation of a robust and organized dataset, validated by domain specialists, positioning itself as a foundational resource for subsequent analyses and applications within the legal domain.

This methodical data creation process, involving expert consultation and survey validation, enhances the reliability and relevance of the dataset, underpinning its significance in advancing legal awareness and understanding within Sri Lanka.

C. Voice to Text conversion

The development of the legal chatbot incorporates voice-to-text functionality using the Python SpeechRecognition library, rather than relying on the Google Speech-to-Text API. This integration enables the chatbot to accept voice input from microphones or pre-recorded audio files, converting spoken words into text. Given the specialized vocabulary and context of legal language, the system faces challenges in ensuring accurate transcription. To address this, the recorded audio is carefully processed into a format suitable for the library, ensuring precise speech recognition for legal queries.

To enhance reliability, extensive testing is conducted across diverse linguistic and legal contexts. Error-handling protocols are implemented to manage transcription inaccuracies, and user feedback tools are integrated to improve the overall experience. Privacy, security, and legal compliance are prioritized when handling sensitive data. Comprehensive documentation supports both developers and users, streamlining the implementation and use of the voice-to-text feature within the chatbot.

Additionally, a text-to-speech (TTS) feature powered by the Google Text-to-Speech (gTTS) module has been added to improve accessibility. This functionality converts the chatbot's textual responses into audible speech, making interactions more engaging and inclusive for users, particularly those with visual impairments or auditory preferences. The gTTS module ensures natural-sounding, clear output, reflecting the commitment to leveraging advanced technologies to enhance user experience and digital communication.

D. Chatbot Response Generation

The developed chatbot utilizes key functionalities provided by Rasa, focusing on legal assistance. It is designed to help users retrieve legal information and manage related inquiries effectively. At the heart of the chatbot's backend, various Rasa features ensure seamless interaction and accurate responses.

The chatbot recognizes several intents such as greetings, farewells, expressions of appreciation, and inquiries related to legal information. This capability is powered by Rasa's natural language understanding (NLU) module, which identifies the user's intent from their input. For instance, when a user initiates a conversation with a greeting, the bot recognizes this intent and responds with a welcoming message using the "utter_greet" response. The primary function of the chatbot is to assist users with retrieving legal information. This is achieved through the "retrieve_laws" action, triggered when the bot identifies an intent related to querying laws. The chatbot can provide information on various legal domains such as motor traffic, civil laws, labor laws, criminal laws, and maintenance laws, ensuring users can access relevant legal information quickly and efficiently.

In situations where users need to file a complaint, the chatbot leverages the "handle_complaint_details" action. This allows the bot to gather necessary details about the user's complaint regarding chatbot performance and save it to a CSV file, ensuring structured and efficient interaction. The chatbot

incorporates Rasa Core for managing conversation flow and handling user intents based on context. This component is crucial for maintaining coherent and contextually relevant interactions throughout the conversation. Rasa Core helps the bot maintain state and manage dialogue transitions smoothly, ensuring that user queries are addressed appropriately and that responses are consistent with the context of the ongoing conversation.

The chatbot includes responses to handle various user sentiments. For instance, if a user expresses displeasure or issues an apology, the bot responds with "utter_express_apology" or "utter_apology" to address the user's concerns and offer further assistance. This empathetic approach enhances user experience and maintains a positive interaction.

Additionally, the chatbot identifies when users challenge its capabilities, using the "utter_iamabot" response to clarify its role and limitations as a legal assistance bot. This transparency helps manage user expectations and directs them to other resources when necessary.

Overall, the chatbot's backend effectively utilizes Rasa's intent recognition, action handling, and Rasa Core's conversation management features to provide comprehensive legal assistance, ensuring users receive accurate information and support for their legal inquiries.

E. Retrieval Function

The process of law retrieval in this project involves several systematic steps, ensuring accuracy and relevance in matching legal queries with appropriate laws. The legal dataset undergoes an initial pre-processing phase utilizing the Natural Language Toolkit (NLTK). This phase is critical for cleaning and preparing the text data for further analysis.

During pre-processing, each law is tokenized, breaking down the text into individual words or tokens. This step is followed by the removal of stopwords, punctuation, and extraneous characters, which do not contribute significant meaning to the sentence. This feature extraction and pre-processing procedure is uniformly applied to all laws in the dataset, ensuring consistency and reliability in the subsequent steps. The processed data is systematically stored, ready for vectorization.

Afterwards, the pre-processed tokens are transformed into vectors using two distinct methods. First, the pre-trained Google News 300 Word2Vec model is employed to generate vectors that capture the semantic meaning of the keywords. These vectors represent the semantic meaning between words. Second, the Term Frequency-Inverse Document Frequency (TF-IDF) vectorizer is used to create vectors that emphasize the importance and weight of words within the legal texts. When the legal query is received through the Rasa Chatbot, it is processed using the same pre-processing pipeline as the legal dataset.

The query is then vectorized separately using both the Word2Vec model and the TF-IDF vectorizer. This dual vectorization approach ensures that both semantic meaning and word importance are considered.To match the legal query with relevant laws, cosine similarity is calculated for the vectors produced by both the Word2Vec model and the TF-IDF vectorizer.

Cosine similarity measures the cosine of the angle between two vectors, providing a value that indicates the similarity of the two sets. Cosine similarity is a measure of similarity between two non-zero vectors of an inner product space that measures the cosine of the angle between them.

$$CosineSimilarity = (A.B/|A||B|) \quad (1)$$

The cosine similarity is calculated separately for both sets of vectors (Word2Vec and TF-IDF) using Eq. 1, and these values are stored in a dataframe. In order to determine the final similarity score, the average (mean) of the two cosine similarity values (from Word2Vec and TF-IDF) is computed using Eq. 2.

$$MeanSimilarity = ([Word2Vec + TFIDF]/2) \quad (2)$$

The top three laws with the highest mean similarity values are then selected. These laws, along with their explanations, are extracted from the dataset and presented to the user through the Rasa Chatbot interface. This ensures that the user receives the most relevant legal information according to their query.

F. Reinforcement Learning

Reinforcement Learning (RL) is employed in the chatbot to enable adaptive learning from user interactions, allowing it to improve its response accuracy over time. Despite its cost-effectiveness challenges, RL is valuable for applications requiring continuous feedback-based learning, like conversational agents. In this system, the Q-learning algorithm forms the basis for decision-making, where each user query acts as a state and the chatbot's responses are actions. The chatbot starts with an initialized Q-table, which maps these state-action pairs to anticipated rewards. As the chatbot gathers feedback on its responses, it updates the Q-values, refining its ability to select the most relevant responses based on previous interactions.

The Q-value updating process leverages a learning rate to control adaptation speed and a discount factor to balance immediate versus long-term rewards. This balance between exploration (trying new responses) and exploitation (using successful past responses) allows the chatbot to optimize its response strategies while remaining open to discovering new approaches. This iterative learning framework enables the chatbot to become increasingly accurate as it collects more interaction data, evolving its policy to better reflect user preferences and conversational contexts.

Using RL in the chatbot brings the advantage of continuous improvement and self-adaptation to dynamic user needs. However, the system's performance heavily depends on the quality of feedback it receives. RL can also introduce complexity, as the exploration process might occasionally yield suboptimal responses. Additionally, the need for extensive feedback data can make RL resource-intensive, requiring careful calibration

of parameters to avoid inefficiencies. Despite these challenges, RL remains a powerful tool in building a responsive and adaptable chatbot system.

IV. Discussion of Results

The evaluation of the retrieval function and Rasa chatbot was conducted through rigorous testing and performance measurement, adhering to standard metrics of accuracy, precision, recall, and F1 score.

A. Evaluation of the Retrival Function

The retrieval function's performance was evaluated using a confusion matrix, which offers a detailed view by categorizing outcomes as true positives (TP), true negatives (TN), false positives (FP), and false negatives (FN). This approach enabled the calculation of accuracy, precision, recall, and F1-score, providing a quantitative measure of the model's performance. The confusion matrix is instrumental in identifying areas for improvement and optimizing model performance in machine learning tasks.

To assess law retrieval with Natural Language Processing (NLP), multiple methods were compared: Word2Vec for vectorization, TF-IDF with cosine similarity, and a combination of Word2Vec and TF-IDF using mean cosine similarity.

Each method was analyzed through metrics like accuracy, precision, recall, and F1-score to determine effectiveness in retrieving legal information. The combined Word2Vec and TF-IDF method demonstrated the highest accuracy, capturing both semantic meanings and the weighted importance of terms, making it the most effective approach.

In addition to the confusion matrix and performance metrics, the evaluation process involved rigorous testing and validation to ensure the robustness of the retrieval system. By combining different vectorization techniques and leveraging the strengths of each, the model demonstrated superior performance in accurately matching user queries with relevant legal documents.

```
Accuracy using only the word2vec model
Accuracy: 0.8320209973753281
Precision: 0.766185476815398
Recall: 0.8320209973753281
F1-score: 0.7867016622922135
```

```
Accuracy using TF-IDF
Accuracy: 0.5354330708661418
Precision: 0.44044390284547763
Recall: 0.5354330708661418
F1-score: 0.46317434848309275
```

```
Accuraacy using the Word2Vec model and TF-IDF
Accuracy: 0.8503937007874016
Precision: 0.791994750656168
Recall: 0.8503937007874016
F1-score: 0.8103237095363081
```

Fig. 3. Accuracy for each approach.

From the below accuracy measures and the scatterplot, it is evident that retrieval achieves a solid accuracy of 0.810323. But there remains a likelihood of the application occasionally making errors in law recommendations.

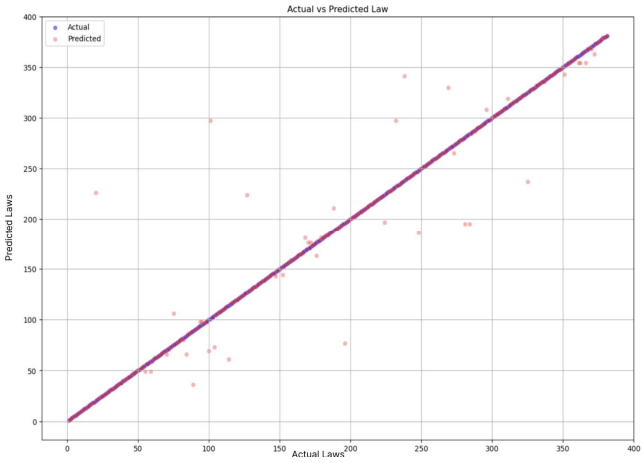

Fig. 4. Actual vs Predicted Law - Scatterplot

This highlights that, with an acceptable accuracy of 0.810323, the retrieval function performs well overall but is not entirely flawless. Occasional mismatches or errors in law recommendations indicate that, while the model effectively captures most user queries, it may still misinterpret or inaccurately match certain cases. These errors underscore the potential need for further refinements to enhance the application's reliability and reduce the probability of inaccurate recommendations.

B. Evaluation of Rasa Chatbot

The evaluation of the Rasa chatbot involved testing both the Rasa Core and Rasa NLU models. The Rasa Core model achieved perfect scores, with an F1 score, precision, and accuracy all recorded at 1.000. This was reflected in the test results, which showed 74 correct predictions out of 74, indicating a robust dialogue management capability.

Similarly, the Rasa NLU model was evaluated through an intent confusion matrix and an intent report, which measured the model's ability to predict user intents accurately. The intent report showed perfect scores across all evaluated intents, such as "file_complaint," "appreciation," "greet," "goodbye," "bot_challenge," "query_law," "ask_about_services," "express_displeasure," and "express_apology." Each intent recorded an F1 score, precision, and recall of 1.0, demonstrating the model's high accuracy and reliability.

TABLE I
Rasa NLU Intent Report

Intent	Result			
	Precision	***Recall***	***F1-Score***	***Support***
file complaint	1.0	1.0	1.0	36
appreciation	1.0	1.0	1.0	12
greet	1.0	1.0	1.0	13
goodbye	1.0	1.0	1.0	10
bot challenge	1.0	1.0	1.0	43
query law	1.0	1.0	1.0	51
ask about services	1.0	1.0	1.0	9
express displeasure	1.0	1.0	1.0	9

The overall accuracy of the Rasa NLU model was recorded at 1.0, with macro, weighted, and micro averages all reflecting perfect scores. This high level of performance indicates that the chatbot can accurately understand and respond to a wide range of user queries, providing effective legal assistance.

In summary, the model and Rasa chatbot were evaluated using standard performance metrics and confusion matrices. The combined Word2Vec and TF-IDF approach demonstrated optimal performance in law retrieval, while the Rasa chatbot showed high accuracy and reliability in understanding and responding to user intents. Although the system performs well overall, occasional mismatches or errors in law recommendations are inevitable. These limitations, such as mistakes made by the machine, highlight the importance of further refinement to improve accuracy and reduce the likelihood of inaccurate recommendations. potential for malpractices, including professional liability concerns arising from machine errors. These challenges are inherent to the technology, but continued improvements can enhance the system's reliability and user experience. The evaluations underscore the effectiveness of the developed system in providing precise and user-friendly legal assistance.

V. Conclusion

This research introduces a novel solution to address the issue of legal unawareness in Sri Lanka by developing a constitution-focused chatbot powered by Natural Language Processing (NLP). The chatbot interprets user queries to provide relevant legal guidance directly from the Sri Lankan constitution, offering tailored explanations of legal rights and concepts. This application empower citizens with better access to legal rights and to reduce exploitation. However, limitations including reinforcement learning and professional liability issues, are inherent to the system and highlight areas for future improvement.

Additionally future enhancements include expanding its functionality to cover additional legal areas and integrating a mobile application version. Plans to enhance user security are also prioritized, with features such as two-factor authentication, encryption, and support for Sinhala and Tamil in both text and audio formats. By incorporating these elements, this project aims to create a secure, comprehensive, and accessible legal tool that supports Sri Lankan citizens in understanding and exercising their legal rights more effectively.

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