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A Model for Predicting the Outcome of Legal Cases using Machine Learning

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Abstract –

The judicial system is an important component of the nation's democratic system, protecting the rights and liberties of its residents while preserving the rule of law. With time, many necessary changes are made in the judiciary system to maintain peace, trust, and order in the country. But court hearings and proceedings take too much time for a decision. Despite the fact that the legal industry is developing faster than ever with the aid of developing technologies, there are still many unexplored areas and there is always potential for improvement. In this paper, we present a simplified approach, "AI in Law Practice". The model is developed by utilizing, the most disruptive technology - Machine Learning. The dataset is stored in IPFS for legal and ethical considerations. The algorithm can forecast case results, giving departments and attorneys useful information. Predicting the case output with accuracy is the model's problem. The F1-score, accuracy, precision, recall, support, and recall are used to evaluate the system's performance, which also demonstrates the system's practical applicability. The model is trained on 3304 U.S. Supreme Court cases and achieves 95% accuracy. The model that is currently being built will be utilized by legal practitioners, law departments, end users, etc.

I. INTRODUCTION

Important components of law are rules, regulations, rights, and obligations. These are upheld by the country's judicial system. People should have faith in the system because it delivers fair justice. However, it might take months, years, or even decades to get justice. This is due to the fact that the country's legal system is either too complicated, too sluggish, or both [1]. As of July 20, 2023, a total of 5.02 crore cases are still outstanding in the country's courts, which include not just the Supreme Court but also 25 high courts and lower courts [2]. A quite different picture emerges when the number of judges assigned to each case is used to measure judicial performance. This research raises the possibility that India's problem with court delays has other root causes. This can be due to a peculiarity of Indian law, a lack of resources for other branches of the judiciary, or an unknown cause [1]. Court case backlogs occur for a variety of reasons, including but not limited to: a lack of judges and other judicial officers; problems with the court's physical infrastructure and support personnel; complicated facts; evidence types; and the level of cooperation among the Bar, investigating agencies, witnesses, and litigants, among others [2].

The widespread use of artificial intelligence (AI) has revolutionized several fields, with the potential to boost productivity, accuracy, and creativity in the workplace. The revolutionary potential of AI in the legal field is starting to shine through. The creation of case prediction systems powered by artificial intelligence is one of the most exciting uses of AI in the legal profession. Because these algorithms can predict many outcomes of legal cases, including judgments and settlement probabilities, they are prepared to revolutionize the way legal practitioners do their jobs. The implementation of AI-driven predictive analytics has the potential to optimize decision-making, improve resource allocation, and enhance the accessibility and fairness of legal services in a world where legal systems are struggling with growing caseloads, limited resources, and the intricacies of the modern legal landscape.

With the ever-growing list of problems that lawyers and other stakeholders are trying to solve, AI-based case

prediction systems are standing out as a game-changing technology that might completely alter the legal industry. The legal system has stayed relatively disconnected from the IT world, even though computer and legal scientists have explored various opportunities to integrate AI, ML, DL, and NLP into the system [3]. In an endeavor to better the civil justice system, a handful of visionary researchers have taken on the daunting challenge of using ML and NLP techniques to build prediction models that accurately forecast court outcomes. Shortening the time it takes to resolve court disputes and issue judgments is a primary goal. Building effective and precise legal forecasting models is, therefore, of the utmost importance [3]. One such tool that justices and judges might use to make decisions faster is prediction models. In order to better prepare for case argument, lawyers might utilize the prediction models to foresee how cases will turn out. Using Case Prediction Systems as a case study, this article launches an exhaustive examination of artificial intelligence's function and influence on the legal profession. The article explores the role of artificial intelligence (AI) in case result prediction, the technology that powers these systems, and the advantages and disadvantages that these systems bring to the legal industry, courts, clients, and society at large. How AI Is Changing the Legal Profession Artificial intelligence (AI) would thrive in the legal field because to the prevalence of precedent, in-depth examination of the law, and complex arguments. Lawyers have a hard time effectively examining and predicting case outcomes due to the mountain of legal material, including legislation, rules, case records, and historical data. AI systems, enabled by NLP and machine learning algorithms, might potentially outperform humans in terms of speed and accuracy when it comes to analyzing large datasets, finding patterns, and making predictions [3]. Artificial intelligence's impact on the legal profession goes well beyond the precision of predictions. Included in this capability is the ability to democratize access to legal services, improve decision-making, optimize resource allocation, and speed legal research. Artificial intelligence technologies may help lawyers save money for clients by giving them data-driven insights that improve case prioritization, resource allocation, and risk mitigation. With this revolutionary potential, the legal profession may finally put an end to long-standing issues like backlog reduction, inefficient courts, and unequal access to justice, all of which have long plagued the field. Nevertheless, because to the intricate nature of the legal system, it is a difficult and time-consuming endeavor to accurately predict court judgments and case outcomes with plausible explanation (Ruhl et al., 2017). This necessitates a heavy reliance on general IT, NLP, and ML for data purification, modeling, engineering, and extraction, and for training and testing models [4]. Consequently, we likewise want to make a contribution to this challenging task by developing a reliable prediction model that can consistently anticipate US Supreme Court decisions, appeals, and opinions. In addition, we detail our work on a legal prediction model that uses machine learning to successfully anticipate US Supreme Court rulings. Training and testing the model on 3304 Supreme Court decisions yielded an accuracy rate of 95%. A. AI-Powered Educators
Machine learning is a relatively new area of AI that allows computers to mimic human intelligence in many ways, including learning from past mistakes and gaining insight into new situations. It is a well-liked method for analyzing data that may be used to discover trends or predictions in massive datasets collected from many sources [5]. Data collecting, method selection, model training, and validation must all be finished before machine learning can be used in practice. For these procedures, choosing the right algorithm is critical. The two most common forms of machine learning are supervised and unsupervised learning [6]. The presence or absence of labels in the datasets is the primary differentiator between the two types. Using labelled training datasets, supervised learning infers prediction functions. There are input values and predicted output values in every training instance.
In order to construct a prediction model that can anticipate the outcome from the pertinent input data, supervised learning algorithms look for correlations between the input and output values. Naive Bayes, decision trees, support vector machines, random forests, k-nearest neighbors, linear regression, and k-nearest neighbor are just a few of the many supervised learning algorithms that have been created. The two main applications of supervised learning are regression and data classification. On the other side, unlabeled training datasets and unlabeled data are typical tools for unsupervised learning, which may solve many pattern recognition issues. In unsupervised learning, the primary methods for classifying training data into different categories based on their unique properties are dimensionality reduction and clustering [7].

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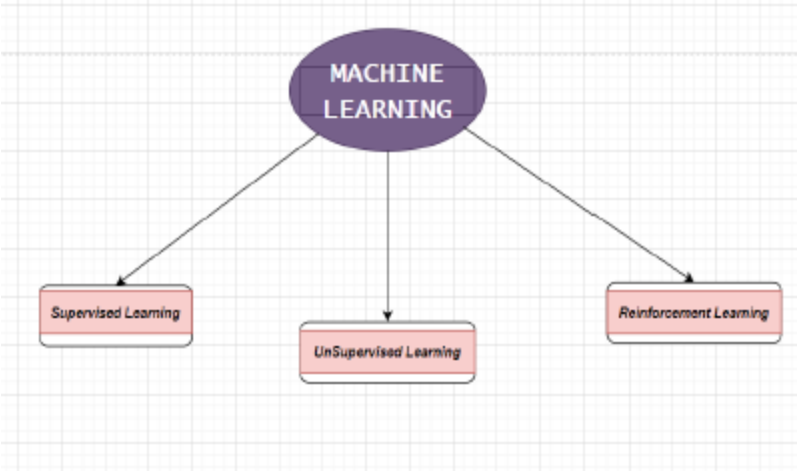

Fig 1. Machine Learning Types

However, the exact number of groups and their meanings remain unknown. This leads many association mining and classification tasks to turn to unsupervised learning [6]. Unsupervised machine learning methods such as principal component analysis (PCA) and K-means are often used. Additionally, reinforcement learning is a subset of machine learning techniques that explains how a computer may generalize and provide correct solutions to problems it hasn't been trained for. Block B. IPFS The Interplanetary File System (IPFS) aims to be a new decentralized storage system that builds upon the principles of peer-to-peer networking and content addressing. [8]. With more than 230,000 peers utilizing IPFS weekly and processing tens of millions of requests per day, it is an interesting large-scale operational network to study. Little is known about its qualities, inner workings, or the outcomes of study, despite the fact that it is an essential part of numerous efforts and studies. The Interplanetary File System (IPFS) aims to create a decentralized, global network for storing and distributing files. It aims to improve the efficiency and resilience of traditional web protocols by facilitating decentralized file storage, making data resistant to censorship, and ensuring availability even when some nodes are down. With its unique features that provide an alternative to the traditional client-server model, the IPFS P2P file-sharing network has gained popularity since its 2014 debut. The protocol has won over many industries, like media and finance, by making decentralized applications (DApps) more scalable, and it has already revolutionized the bitcoin field. IPFS may radically alter the way data is stored, shared, and accessed on the internet. More innovations and widespread use might be on the horizon as this technology continues to advance.

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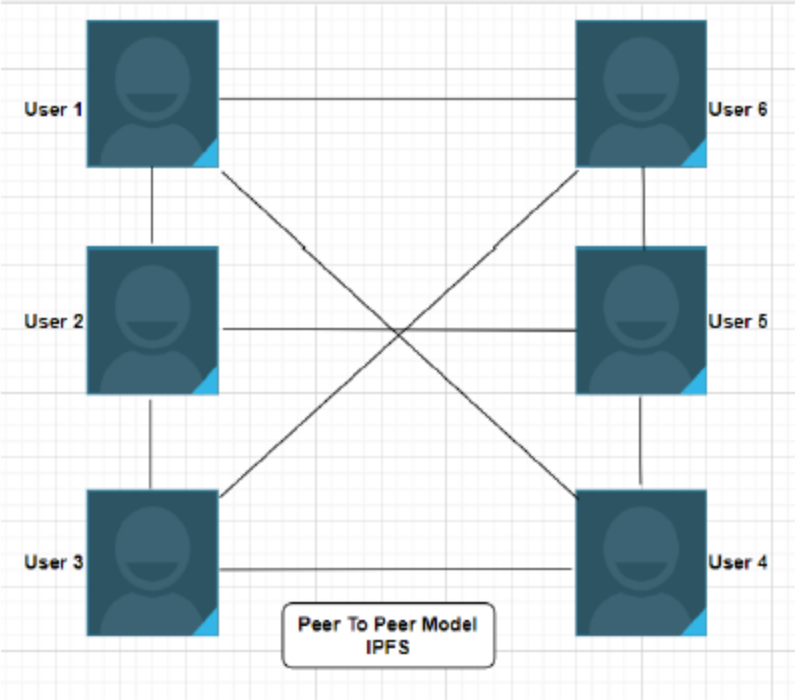

Fig 2. IPFS

The remainder of the work is structured in this manner. Section 2 discusses the relevant literature, with an emphasis on prediction of court decisions. Section 3's issue statement inspired us to conduct this investigation. Section 4 delves into the proposed task. A description of the result is given in Section 5. Section 6 elaborates on the intriguing subject of using ML and NLP to the judicial system. The research wraps up with a brief synopsis of the following procedures in section 7.

II. LITERATURE SURVEY

The study presents a new legal prediction model called eLegPredict, which uses machine learning (ML) to make accurate predictions, has been developed and tested with the Indian Supreme Court [3]. A 76% success rate (F1-score) was achieved by eLegPredict after training and testing on 3072 cases that were heard by the Supreme Court. Legal prediction models, according to the authors, would be both useful and interesting for the legal community. Stakeholders, including judges and attorneys, may utilize these models to better anticipate case outcomes and improve their future actions, such as making decisions faster, strengthening defenses, and supplying arguments with more evidence. However, finding relevant bulk case files, extracting, cleaning, and engineering data are only a few of the complex steps involved in accurately predicting court opinions and case outcomes. These difficulties are addressed by eLegPredict's innovative ML method, which takes into account both the legal and non-legal aspects of a case [3]. The nature of the case, the attorneys' arguments, the applicable legislation and case laws, and the individuals engaged are all aspects of the legal aspect. Included in the non-legal aspects are the judges' backgrounds, the makeup of the bench, and public sentiment on the issue. As soon as new case descriptions are put into a designated directory, eLegPredict automatically reads through the documents and generates a prediction to assist users. According to the authors, eLegPredict is a promising piece of technology that might greatly improve the efficiency and effectiveness of India's judicial system. In 2017, Katz, Bommarito, and Blackman published a paper. "A General Approach for Predicting the Behavior of the Supreme Court of the United States." [9] introduces a novel approach to predicting the US Supreme Court's decisions. This work uses data-driven methods to build a prediction model by mining a large dataset of past Supreme Court rulings, precedents, and other relevant elements. Astonishingly accurate prediction of Court judgments, both voting results and justice-authored opinions, is the goal of the model's development. The authors demonstrate how this strategy might alter public perception of the Court's decision-making process by using machine learning and natural language processing (NLP). The study has significant ramifications for both academic and professional legal studies, as it sheds light on how artificial intelligence and data

analytics may be used to predict rulings from the nation's top court. After researching the topic, developing a prediction method, coding it, and creating an operational prototype, André Lage-Freitas et al. (2019) [10] were able to achieve a 79% accuracy rate when tested and trained on 4,043 Brazilian court cases. To predict if ECHR verdicts violate any human rights article, O'Sullivan and Beel [11] create ML-enabled algorithms in 2019. A total test accuracy of 68.83% is the product of the authors' use of word (echr2vec) and paragraph (doc2vec) embeddings to boost performance. In their study, Pillai and Chandran (2020) [12] examine how Bag of Words and CNN may be used to extract important phrases from Indian court orders, classify them as bailable or non-bailable, and then predict their future classification. About 85% of the time, their prediction model is spot on.

In their study, Sert et al. (2021) used artificial intelligence (AI) methods in conjunction with natural language processing (NLP) word embedding to ascertain if certain decisions issued by the Turkish Constitutional Court infringe against public morality or freedom of speech. The authors claim a 90% forecast accuracy rate.

In their article titled "Automatic Judgment Prediction via Legal Reading Comprehension" [14], the researchers Shangbang Long, Cunchao Tu, Zhiyuan Liu, and Maosong Sun propose a novel approach to using LRC for the purpose of automated judgment prediction. Using the case materials, including the fact description, plaintiffs' pleadings, and law articles, the goal of automatic judgment prediction is to forecast the result of a legal case. Much of what is now available relies on a text categorization paradigm, which fails to adequately account for the complex interrelationships present in varied case materials. Reading comprehension (LRC) is a way to formally practice predicting automatic judgment. The LRC process begins with feeding the model the case materials and then asking it to predict the case's conclusion. Questions like "What is the most likely outcome of the case?" are often asked in a multiple-choice format. The authors introduce AutoJudge, a novel LRC model that successfully represents the complex semantic interrelationships among facts, pleas, and laws. Compared to state-of-the-art models, AutoJudge performs far better on a dataset consisting of actual civil cases. cited as [14]. According to the authors, LRC offers a more thorough and informative approach to reasoning about the case materials compared to typical text categorization algorithms, making it a potential approach to automated judgment prediction.

The use of machine learning for the prediction of case outcomes and court judgments is examined in the paper by Aastha Budhiraja and Kamlesh Sharma titled "Correlation of Language Processing and Learning Techniques for Legal Support System" [15]. Although this is a complex and time-consuming process, the authors note that language processing and learning methods may make it more precise and efficient. The writers provide a classifier that integrates Text CNN with the Att-BLSTM model. Through the use of feature emphasis and full-text accounting, this method may automatically extract more robust features from legal texts. In experiments, the proposed model outperformed document classification methods such as SVM-TFIDF, DPCNN, and HAN. The authors draw the conclusion that their model has potential as a tool for predicting case outcomes and judicial decisions. They contend that this has the potential to be an invaluable resource for lawyers, enhancing the efficacy of the justice system via enhanced decision-making. Because it offers a novel method for forecasting court decisions and case outcomes, the article is pertinent to the area of legal assistance systems [15]. Better and more efficient legal assistance systems may be created using this, which would be good for the public and for attorneys alike.

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Table 1. Literature Survey

Title	Author	Year
Predicting Indian Supreme Court Judgments, Decisions, or Appeals: eLegalls Court Decision Predictor (eLegPredict)	Sharma, S. K., Shandilya, R., & Sharma, S	2023
Harnessing legal complexity	Ruhl, J. B., Katz, D. M., & Bommarito, M. J.	2017
A general approach for predicting the behavior of the Supreme Court of the United States	Katz, D. M., Bommarito, M. J., & Blackman, J.	2017
Predicting Brazilian court decisions	Lage-Freitas, A., Allende-Cid, H., Santana, O., & de Oliveira-Lage, L.	2019
Predicting the outcome of judicial decisions made by the European court of human rights.	O'Sullivan, C., & Beel, J.	2019
Verdict Prediction for Indian Courts Using Bag of Words and Convolutional Neural Network.	Pillai, V. G., & Chandran, L. R.	2020
Using Artificial Intelligence to Predict Decisions of the Turkish Constitutional Court	Sert, M. F., Yıldırım, E., & Haşlak	2021
Automatic judgment prediction via legal reading comprehension.	Long, S., Tu, C., Liu, Z., & Sun, M.	2019
Correlation of Language Processing and Learning Techniques for Legal Support System	A. Budhiraja and K. Sharma	2022

III. PROBLEM STATEMENT

Building an AI model for precise and automatic case prediction and legal research is the issue this paper attempts to solve.

Key Problems

1. Prediction Accuracy
2. Data Collection and Management
3. Feature Engineering
4. Machine Learning Models
5. Ethical and Legal Considerations

Purpose of the planned endeavor • • Improvements in Efficiency: The judicial system handles a high volume of cases, which causes problems with time management and resource allocation. • Risk Mitigation: Clients may make better judgments when they know what to expect from their legal situations. AI-based case prediction may help courts and judges manage their caseloads more effectively, which in turn improves judicial efficiency. It has the potential to

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expedite judicial processes, decrease backlog, and prioritize cases. Legal decisions may be made more consistently and objectively with the use of AI, which eliminates the possibility of human prejudice or subjectivity. • Improved User Experience: Making the UI easy to use makes it more accessible to a wide range of stakeholders and makes user engagement better. • Improved Access to Justice: AI has the capacity to optimize case management, which in turn can make legal services more affordable and accessible. This might mean that underprivileged communities have more opportunities to access justice.

IV. PROPOSED WORK

In order to implement the proposed model, Machine Learning is used. Similarly, it employs Natural Language Processing with the overarching goal of determining, given the available evidence and precedent, which side should emerge victorious from the case. The Python libraries scikit-learn, matplotlib, NumPy, and many more were used to construct this model. In order to ensure the privacy of the data, the dataset is saved in a decentralized storage system, namely IPFS. Careful, ethical, and legal handling of the legal data is of the utmost importance. On the US Supreme Court Dataset, the following models are employed: XGB, Logistic Regression, KNN, and Random Forest. You can see the whole ML model flow in Figure 3. You can see the key components of the model that support this study in the image. The terminology used in recent Supreme Court decisions is not helpful when trying to make predictions, hence the material has to be cleaned up. Similar to how architecture makes use of natural language processing (NLP), the court decisions in PDF format are read as input and cleaned up using this method. Following the completion of any further required natural language processing (NLP) processes, the optimal vector data is incorporated into machine learning (ML). Additional information on the intermediate NLP procedures is provided in this section.

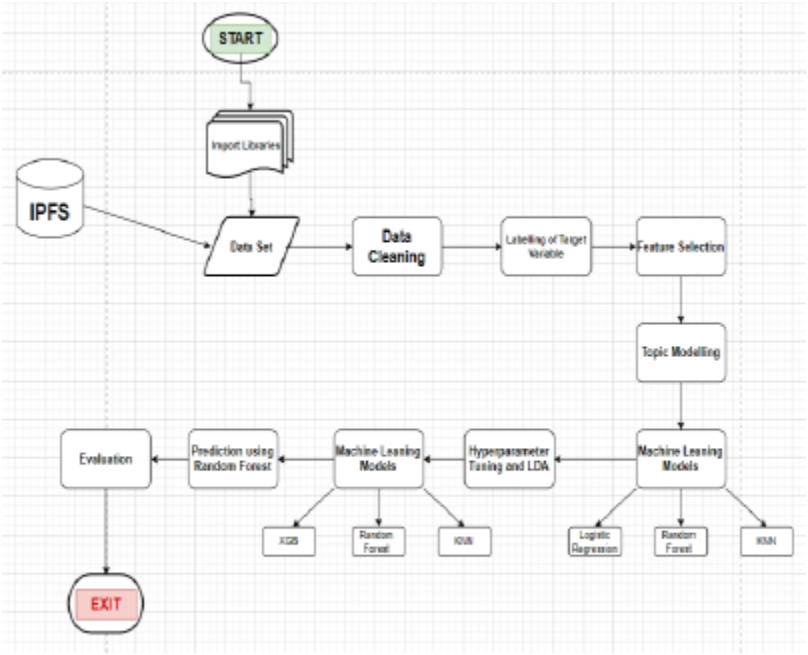

Fig 3. Flow Chart

MODEL DESCRIPTION AND PROCEDURE

The Interplanetary File System (IPFS) is a protocol for a distributed file system that aims to provide a decentralized way to store and move hypermedia. The goal of this P2P hypermedia protocol is to make online information exchange and access more efficient and resilient. Ethical and legal concerns led us to store the dataset on IPFS. It recorded the information and created a hash code known as CID. Both the latency and the persistence of data are provided.

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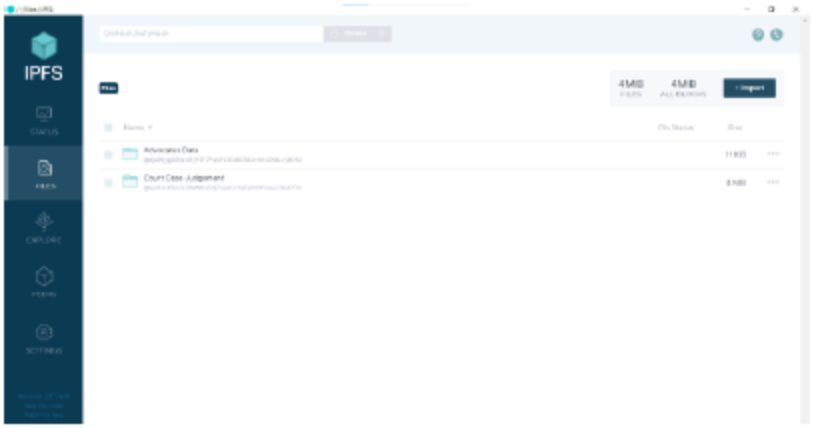

Fig 4. Data stored in IPFS

Data cleaning, data manipulation, data visualization, natural language processing procedures, and model training and testing may all be accomplished by importing python libraries like sklearn, matplotlib, NumPy, pandas, NLTK, and many more.

Our collection includes 3304 decisions decided by the United States Supreme Court up to the year 2021. We need to forecast whether the first party will win or not using the goal variable, first_party_winner.

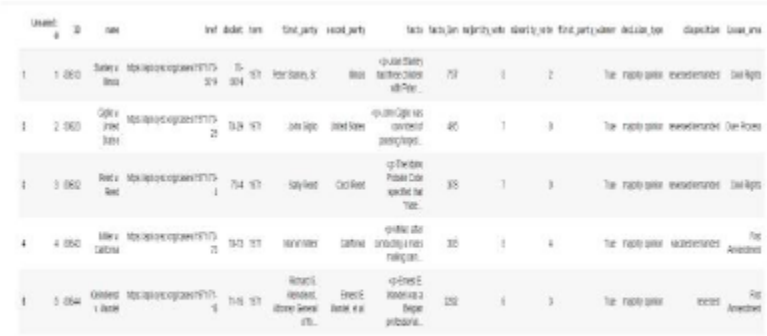

Fig 5. Data set

One of the primary functions of this task is to prepare data and conduct natural language processing models. It performs a plethora of complex intermediate subroutines and procedures, helps read all 3304 case papers (in PDF format), and then produces clean, properly labelled vector data. In order to improve word recognition and boost productivity, this work used a number of important natural language processing (NLP) techniques, including word stemming, digit removal, stop word removal, removing smaller words (less than three characters), and changing all words to lower case. Consideration of all factors leads to the elimination of data that isn't essential for reaching a choice. The file is tokenized and then n-grams are created, where n is a value between 1 and 4. For modeling purposes, it is necessary to convert the textual representation of the words into a numerical form so that we can understand the importance of each word in the document and the corpus overall. This is achieved by making use of the powerful TF-IDF (Term Frequency-inverse Document Frequency) method. The TF-IDF tunes itself so that it disregards terms with a lower frequency (<10%). This allows for even more data refinement and the retention of just the most representative data. As part of the natural language processing (NLP) modeling process, we also develop a system that automatically reads the case document's target phrases, taking note of each document's decision classification and adding it as a label to its tokenized vector representation. Additionally, it produces a tidy CSV data file as an output. neural networks: Logistic Regression, Random Forest, KNN, eXtreme Gradient Boosting (X Gradient Boost), and KNN are the main classifiers used in this article. We used supervised machine learning classifiers to construct our prediction model. The research does not cover the comprehensive mathematical, technical, or scientific aspects of these classifiers; readers

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interested in these topics are directed to other internet resources. To provide the best possible performance, the hyperparameters of each classifier are fine-tuned. The whole dataset is divided into two parts: one for training the model and another for testing it. The main technical tools used in this study are Python, the Scikit-learn ML package, and the Natural Language Toolkit (NLTK) for NLP. We found that Random Forest gives decent accuracy, at 80%, after successfully training the classifiers indicated earlier. This model is therefore chosen for the purpose of prediction. To evaluate, we find a 95% success rate when we use Random Forest for our predictions. Its prediction of the case's victor is spot on.

V. RESULTS & DISCUSSION

Our proposed model is trained and tested using a dataset consisting of 3,304 decisions decided by the US Supreme Court between 1955 and 2021. The case details, judgment outcome, and unique IDs are all part of each case. Other similar datasets, which may be helpful for NLP applications, seldom contained the case details. One potential use of this dataset is to determine the outcome of a case only from its facts. Goal-Setting Factor: Defending Champion: The first side won if this claim is true; the second side won if it's false. Create attributes from the facts column using natural language processing techniques.

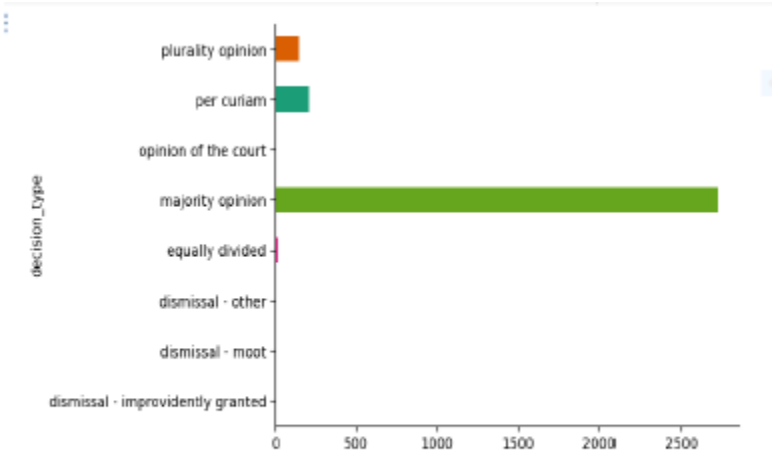

Fig 6. Decision type

A decision-type graph lays down the criteria used to make a call. The court's majority opinion provides the basis for the majority of rulings.

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	facts	facts_clean
0	Joan Stanley had three children with Peter Sta...	joan stanley three child peter stanley stanley...
1	John Giglio was convicted of passing forged mo...	john giglio convicted passing forged money ord...
2	The Idaho Probate Code specified that "males m...	idaho probate code specified male must preferr...
3	Miller, after conducting a mass mailing campai...	miller conducting mass mailing campaign advert...
4	Ernest E. Mandel was a Belgian professional jo...	ernest e mandel belgian professional journalis...
...	...	...
3093	For over a century after the Alaska Purchase i...	century alaska purchase 1867 federal governmen...
3094	Refugio Palomar-Santiago, a Mexican national, ...	refugio palomarsantiago mexican national grant...
3095	Tarahrick Terry pleaded guilty to one count of...	tarahrick terry pleaded guilty one count posse...
3096	Joshua James Cooley was parked in his pickup t...	joshua james cooley parked pickup truck side r...
3097	The Natural Gas Act (NGA), 15 U.S.C. §§ 717–71...	natural gas act nga 15 usc 717717z permit priv...

3098 rows × 2 columns

Fig 7. Clean facts

Since the decision-making data is unclean and machines can't comprehend natural language, we use natural language processing (NLP) methods like tokenization, lemmatization, stop word removal, etc. to clean the data.

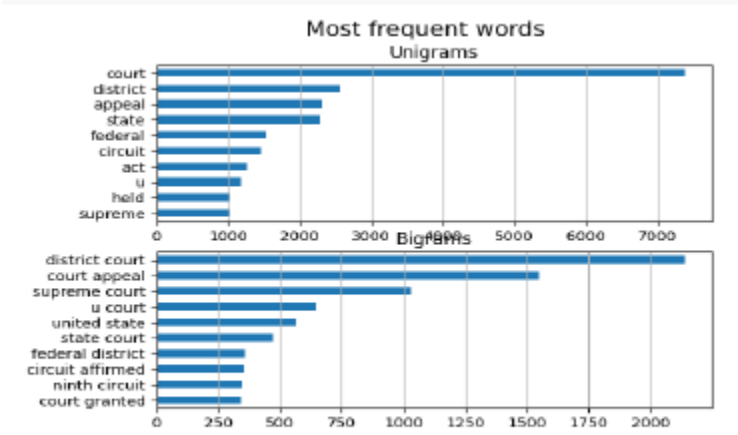

Fig 8. Most frequent words

Terms used in factual contexts are the ones that appear most often. We have used feature engineering to train our model on every word in the corpus since the computer is having a hard time understanding it.

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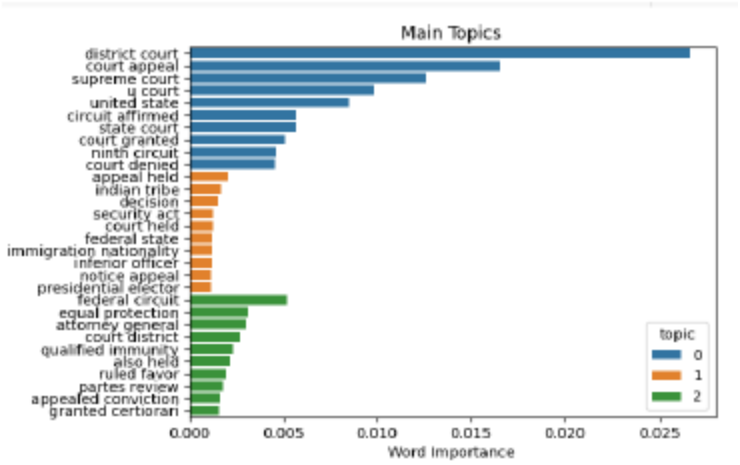

Fig 9. Topic Modelling

Topic modelling is the process in NLP to find out the main topics in the corpus so that our model can understand and learn those topics for further predictions.
Following feature engineering, we use various machine learning algorithms to train our model:

- • logistic regression (54%)
- • Random Forest (64%)
- • KNN (58%)

After performing hyperparameter tuning and LDA, we applied different machine learning models:

- • KNN (63%)
- • Random Forest (80%)
- • XG Boost (66%)

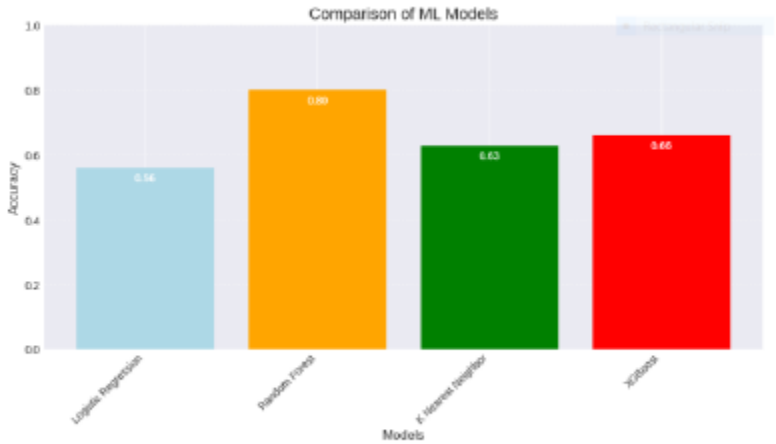

Fig 10. Comparison of ML Models

Random Forest gives good accuracy so we further move on with it and predict the case outcomes using user input.

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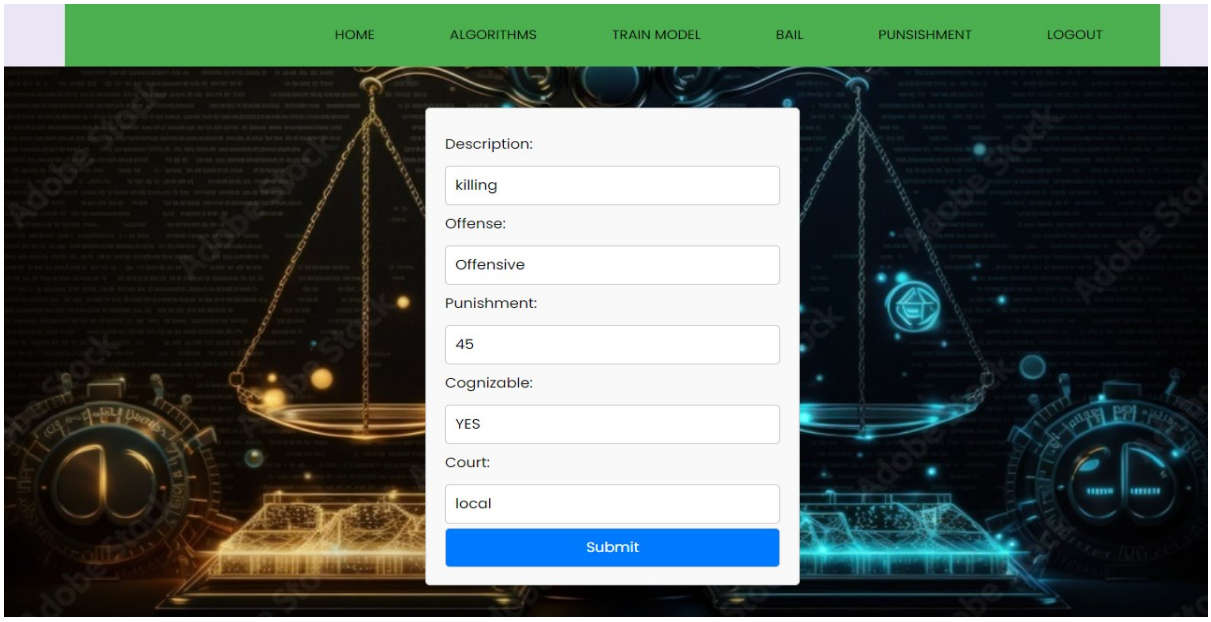
Above fig. shows the evaluation parameter with accuracy of 61%. This demonstrates how well the suggested model predicts the case's conclusion.

Input 1



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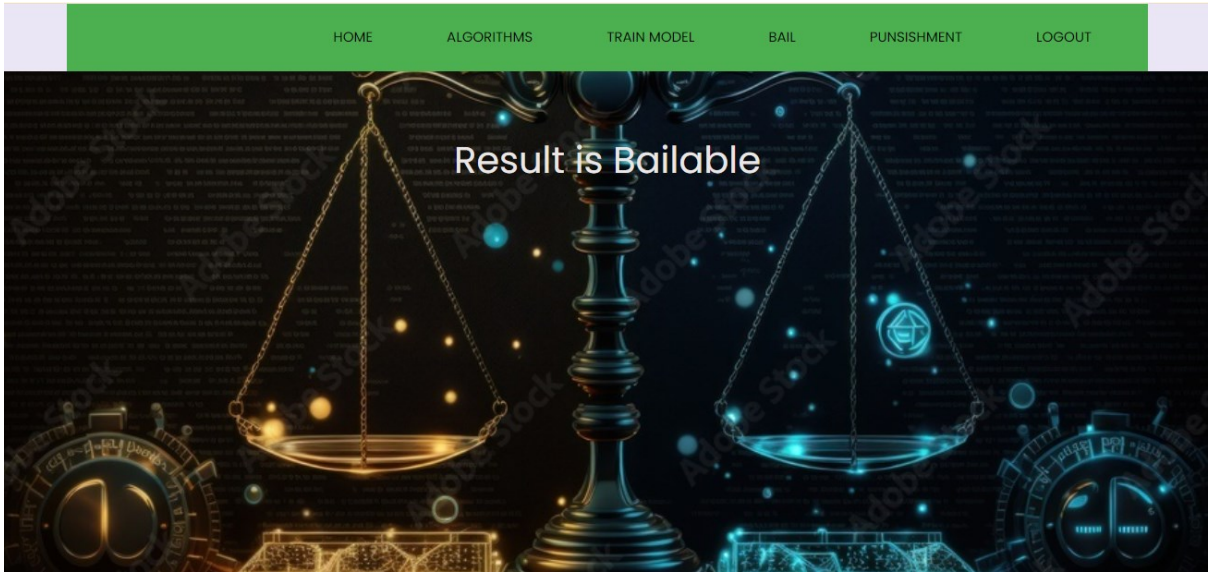

The above figure shows the final output.

VI. CONCLUSION & FUTURE SCOPE

Recent years have seen encouraging advancements in the use of AI for case prediction in the legal profession. Artificial intelligence systems can sift through mountains of legal documents, such as legislation, case laws, and precedents, using natural language processing and machine learning techniques. This allows them to forecast case outcomes and provide significant insights to legal practitioners. Several benefits may be gained by using AI into case prediction, such as: • Greater Precision: By analyzing past data and trends, AI models may make predictions about future events, shedding light on potential case scenarios. Lawyers may use this information to make better judgments. AI systems are efficient because they can handle and analyze massive amounts of legal data rapidly, which means that legal experts and attorneys have more time to focus on case preparation and research. • • Risk Assessment: Artificial intelligence systems may help attorneys evaluate the possible risks of legal methods, which in turn helps them build more effective and successful case strategies. Cost-Effectiveness: Artificial intelligence has the ability to streamline legal research, which might lead to a decrease in the expenses linked to time-consuming legal processes and research. Artificial intelligence's (AI) potential for use in legal case prediction is exciting and will certainly grow in the years to come. Possible development and advances are indicated in many areas: The first step is to improve AI models so they can better grasp the intricacies and subtleties of the law. As machine learning and natural language processing continue to grow, this will result in more advanced AI models. As a result, case predictions will be more precise. 2. Ethical AI Development: AI systems' biases and ethical dilemmas will be heavily addressed. To make sure that AI models are making impartial predictions and choices, we will be working to make them more open and equitable. Thirdly, AI systems will evolve to become more specialized, meeting the needs of certain areas of law or kinds of cases. More precise and personalized forecasts for many areas of law will be made possible by this specialty. 4. Deeper Integration in Legal businesses: Artificial intelligence (AI) technologies will be used more and more by legal businesses to improve efficiency and productivity in case prediction, legal research, contract analysis, and other areas. 5. AI and Legal experts Working Together: It's probable that in the future, AI and legal experts will work together in harmony. Instead than replacing attorneys, AI will work alongside them to help make better, faster decisions.

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