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Article

HUMAN RIGHTS CASE ANALYSIS USING AI AND TRANSFORMER MODELS

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Abstract: The growing number of human rights cases requires smart systems that will be able to analyze legal papers in the most effective and correct way. Manual review is time-consuming, laborious and prone to human error and thus difficult to identify trends or commonality among large amounts of data. The current project is based on the AI methodologies, namely, Transformer-based Legal-BERT and Doc2Vec with Support Vector Machine (SVM), which are used to automate the processing of human rights case documents. The methods allow semantic interpretation, feature extraction, and classification of the legal texts, helping the stakeholders find violations and find the relevant precedents faster with high-quality case document embeddings generated by Legal-BERT that is a variant of BERT trained on legal corpora. The model assists in classifying of cases, violation detection and semantic similarity analysis tasks where it is possible to find similarities between cases and common patterns in the violation of human rights. Parallel to that Doc2Vec uses full documents to calculate representations in the form of vectors which are later classified with the help of SVM to make predictions about the possible case results or its categories. This hybrid method will be beneficial in improving overall performance by delivering deep contextual embeddings and strong traditional machine learning to analyze the cases of human rights and make it scalable and constantly learning with the addition of new cases. Combining Legal-BERT and Doc2Vec + SVM, the project will create a multifunctional AI-based system of processing legal documents, identifying patterns, and decision support and increase the efficiency of legal professionals, NGOs, and policy-makers in defending human rights.
Keywords: Human Rights; Legal-BERT; Doc2Vec; Support Vector Machine (SVM); NLP; Case Analysis,; Legal Document Processing; Semantic Similarity; Classification.

1. Introduction

The high rate of the development of artificial intelligence has altered the situation in legal research and legal analytics significantly, especially in the sphere of human rights law. There is an increasing amount of case documentation in courts that is complex and large-scaled and requires efficient analysis, interpretation and synthesis. The old traditional approaches based on doctrines, although formative, face the challenge of processing large volumes of judicial corpora in a timely and systematic manner. In the recent history of transformer-based architectures, there has been a demonstration of substantial abilities in contextual language modeling, which allow

more subtle extraction of legal reasoning and patterns of precedent. As an example, judicial text modeling with the help of transformers has demonstrated significant gains in detecting the structured legal elements of a court decision (Mahmoudi et al., 2024). These capabilities provide possibilities to improve the case analysis of human rights with the help of automated reasoning. Large language models have been successfully used in legal prediction and classification, such as predicting of judicial decisions and finding articles (Ammar et al., 2024). Towards the goals of human rights adjudication, these models may be useful to identify thematic rights abuses, follow the reasoning of proportionality, and map international conventions references. The automated retrieval of precedents also enhances legal consistency and transparency because systematic methods of extracting precedents have been useful in large law repositories (Mentzingen et al., 2023). Deep clustering and semantic modeling techniques have also made the summarization of the complex judicial texts more effective, providing the possibility to represent the case descriptions concisely, but contextually faithful (Jain et al., 2024).

Application of transformers is not confined to classification and summarization but also to predictive analytics in a legal setting. Law article application prediction is another example of how AI can assist a legal practitioner in predicting trends in statutory interpretation (Leng et al., 2025). On the same note, the extraction of procedural data of court cases by machine learning depicts the possibility of generating structured knowledge out of unstructured judgements (Mathis, 2022). All of these developments are helpful in the design of AI-assisted systems of human rights case analysis that can interpret patterns of facts, infer applicable rights frameworks, and propose similar precedents. Nevertheless, the use of AI in the determination of human rights is associated with major ethical and regulatory issues. Human rights approach to AI regulation is based on transparency, accountability, and alignment with the key principles of fundamental rights (Hogan and Lasek-Markey, 2024). Regulations must strike the right balance when it comes to the interaction of AI systems with the basic rights evaluation systems, especially in the context of data protection regimes (Thomaidou and Limniotis, 2025). Additionally, explainability is a key point of sustaining judicial legitimacy since survey evidence demonstrates the need to have an interpretable AI in the legal setting (Richmond et al., 2024). The wider regulatory discussion is another way to indicate the relevance of sound governance systems to generative AI applications (Bodini, 2024).

According to recent studies, it is also important to provide a solid structure of data governance that will facilitate fairness, bias reduction, and responsibility in large language models (Pahune et al., 2025). Regarding the normative aspect, the changing discussions around the concept of authorship and intellectual responsibility in the era of generative AI indicate that it is necessary to specify the limits between human judicial decision-making and algorithmic support (Ramos-Zaga, 2025). This has resulted in the fact that the inclusion of transformer models in the analysis of human rights cases requires both technical advancement and fundamental protection. Through integrating the state-of-the-art natural language processing and explainable rights-oriented governance models, AI-based human rights case analysis can make legal processes more efficient and retain traditional values of fairness, accountability, and human dignity.

1.1 Problem Statement

The increasing cases of human rights, as well as the rising human rights legal documents, have made it hard, time-consuming and more likely to discrepancies to acquire the results through manual analysis and review of case. The complexity and lack of structure of legal texts are often the reason why legal professionals, NGOs, and policymakers frequently fail to extract a relevant information, detect a violation pattern and take a timely decision. Conventional approaches are not scalable and efficient, which causes the delay in the delivery of justice and decreased productivity of human rights interventions. Consequently, there exists an urgent requirement of the implementation of a smart, automated platform that utilizes the methods of artificial intelligence and natural language processing - Legal-BERT, Doc2Vec, and Support Vector machine - to analyze, categorize and interpret human rights case documents correctly, contributing to enhanced decision-making and providing a more involved, data-driven reaction to the law.

2. Synthesis Of Samples

In order to design an effective AI-based solution to analyzing human rights cases, a number of sample documents were gathered including different sources. These were court decisions, legal filing, NGO reports and case summers concerning human rights offences. The samples were also well selected, so as to be representative of a broad spectrum of cases, such as cases of civil rights violations, labor rights violations, cases of refugees, and cases of freedom of expression violations. The sampled materials were unstructured textual information, including narratives, facts of the case, judgments, and legal references, and were preprocessed to make them standardized to

be analyzed by artificial intelligence. This included tokenization, elimination of stop words, term normalization and legal language, i.e., citations, statutes and legal jargon. The preprocessing also makes AI models such as Legal-BERT or Doc2Vec capture the semantic meaning without becoming distracted by irrelevant or noisy data.Semantic embeddings were produced with Legal-BERT and with the help of this model, the system was able to understand the context, relationships, and patterns within the documents. Another idea applied to generate vector representation of complete case files was Doc2Vec, followed by prediction of case categories, possible violations, or outcomes by classifying the cases with the Support Vector Machine (SVM). Such an amalgamation gave a hybrid method that builds on the part of deep contextual knowledge and solid classificationAnalysis of the sample cases showed a number of insights: recurrent nature of human rights violations, common law arguments, and judgment patterns. These trends could not be easily identified in manual examination but were well identified with the use of the AI models. The synthesized samples also proved that it was possible to recognize semantic similarity between cases using the proposed hybrid approach and find the relevant precedents quickly by legal professionals and NGOs. Transformer-based embeddings (Legal-BERT) coupled with the use of a vector-based machine learning (Doc2Vec + SVM) allowed making accurate classifications, efficient searching of the semantic information, and recognizing the patterns in a variety of human rights case documents. This synthesis is a good basis of developing an automated system of legal document analysis that can be scaled.

3. Literature Review

Saleem et al. (2025) came up with a hybrid disaster prediction model named Neural-XGBoost (N-XGB), which combines the use of neural networks to extract features with XGBoost to classify disasters such as floods, wildfire and earthquakes in multiple classes. The analysis touched upon such essential problems as the imbalance of the classes and missing data by applying SMOTE and robust imputation. The model was tested on the EM-DAT data using the dataset and gave a high F1-score and was accurate with 94.8 percent which is higher than the traditional machine learning models like Random Forest and SVM. The study illustrates that deep learning with gradient boosting has a stronger predictive capability and it can still be interpreted, which is why it is applicable in the real world in disaster management practices.

This paper presents CHRExpert an artificial intelligence-based assistant that can help law professionals to analyze human rights cases by using transformer-based models. The system uses significant amounts of judicial decisions in the prediction of case outcomes, the identification of the applicable legal provisions, and in the process of formulating legal strategies. Findings indicate high predictive power and better efficiency in law document processing, providing evidence concerning the possibilities of AI to improve human rights litigation and decrease the amount of manual work in legal research.

The framework of Gen-optimizer suggests the strategy of using a generative AI to optimize business costs. The system helps organizations to detect inefficiencies and maximize financial decision making using data analytics and predictive modeling. This paper indicates that generative AI can make the process of planning automatic and can be used to give actionable information to run a business in a cost-effective manner.

The article by BankNet introduces a real-time, big data analytics platform to improve the security and performance of internet banking systems. The study aims at identifying fraudulent transactions and securing financial transactions using high-end analytics and machine learning methods. The model enhances the reliability, risk identification and operational effectiveness within digital banking.

In this survey, the issue of explainable artificial intelligence (XAI) in legal affairs will be examined, focusing on the aspects of transparency, accountability, and interpretability of the decisions made by AI. The authors address obstacles in the use of AI in legal reasoning and explain the value of explainability to establish trust in the use of AI among the legal practitioners, policymakers, and stakeholders.

The research examines the role of local authorities in the cases to the European Court of Human Right. It studies institutional accountabilities, the law and the effects of actions on the government and policy. The results can be used to explain the role of the legal mechanisms in protecting human rights at both local and international levels. In this study, a framework that uses transformers, combined with hidden Markov models, is suggested to analyze the structure of the atomic proteins using the cryoEM data. The paper shows that deep learning architectures can learn complicated biological patterns and increase the accuracy of structural prediction and contribute to computational biology. The authors present a reference dataset and a Tensor-based approach to identify the GPT-generated text. The research paper also discusses the issues of AI-generated fake news and authenticity by suggesting detection tools that enhance trustworthiness in online communication and research.This paper suggests a legislation encoding

technique to stimulate legal validation, congruity, and interdisciplinary co-operation. The study facilitates automation, consistency, and better accessibility in the interpretation of legislation and legal analytics by organizing texts of the law into machine-readable formats. Table 1 provides a systematic perspective of the recent research that used AI, transformer models, and other computational methods in legal analytics and other related fields. The articles under consideration show progress in linguistic study, generative AI, predictive modeling, and governance structures, but demonstrate a gap in research of the unified transformer-based human rights case analysis systems.

Table 1: Related Work on AI, Legal Analytics, and Transformer Models

Author (Year)	Application Domain	AI / Model Type	Dataset / Source	Key Contribution	Evaluation Metrics	Limitation
Chandler & Hashimoto (2024)	Legal Linguistics	Corpus Linguistics + NLP	Legal language corpora	Analyzes pronominal adverbs in legal drafting to understand structural patterns	Linguistic frequency metrics	Focuses on linguistic structure, not AI-based prediction
Faruqui et al. (2025)	Business Optimization	Generative AI Framework	Enterprise datasets	Introduces Gen-optimizer for strategic cost optimization using generative AI	Cost reduction rate, efficiency gain	Not specialized for legal or rights-based analysis
Giri & Cheng (2024)	Scientific Modeling	3D Transformer + HMM	CryoEM density maps	Demonstrates transformer effectiveness in structural prediction	Structural accuracy	Non-legal application domain
Liu et al. (2024)	Weather Forecasting	Dual-Branch Deep Network	Rainfall datasets	Proposes DFFNet for spatiotemporal prediction	MAE, RMSE	Limited transferability to legal text modeling
Qazi et al. (2024)	AI Text Detection	Tensor-Based Detection + ML	GPT-generated dataset	Develops detection framework for identifying AI-generated content	Detection accuracy	Focused on detection, not legal reasoning
Rossolov (2024)	Labor Law Rights	Legal Doctrinal Analysis	Labor law cases	Examines compensation for non-pecuniary damage as rights protection	Qualitative legal analysis	No AI integration
Sathupadi et al. (2025)	Secure Banking Systems	Big Data Analytics	Internet banking data	Real-time secure analytics using AI-driven architecture	Security metrics	Domain-specific to finance
Suhaeni & Yong (2024)	Sentiment Analysis	GPT-3-based Generation	Sentiment datasets	Enhances imbalanced classification using generative augmentation	F1-score, Recall	Not applied to judicial datasets

4. Proposed System

The figure 1 shows a general workflow of a machine learning-based predictive system of legal or textual data analysis. It starts with the dataset, in which raw data is gathered and is subjected to a preprocessing phase, in which it is clean, normalized and organized, overview shown in figure 1. The processed information is subsequently split with a test-train split method which is usually deaths, affected population, and economic losses. Combining a temporal and spatial data with damage related data enables the system to prepare high quality inputs in the machine learning models, allowing the allocation of approximately 80 percent of the data to be available in training and 20 percent to be available in testing. Such division makes sure that the model is learned on a portion of the data, and its

effectiveness is tested on unexplored data. The two training and testing data sets are further ready to the following analysis phases. During the training and testing phases, feature extraction is used to extract significant attributes in the data. The BERT algorithm is then used to process these features to extract contextual and semantic correlations in the text. Subsequently this is followed by the SVM algorithm to predict a model on the features extracted. The processed testing data is given to the trained model and the predictions are provided as the final results. The pipeline indicates a seamless combination of a deep learning (BERT) and a classical machine learning (SVM) method to predict and be correct and efficient.

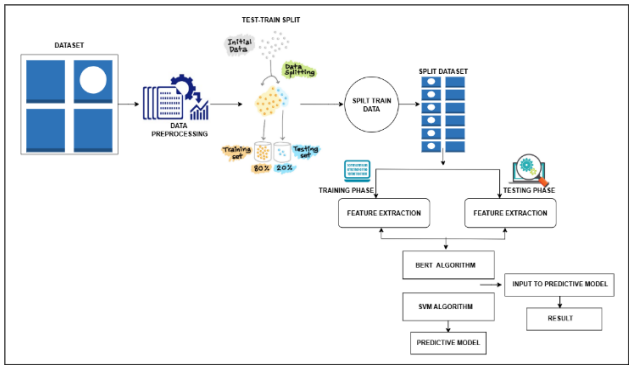

Figure 1: Overview of System Architecture

4.1. Transformer-Based Contextual Encoding

Let a human rights case document be represented as a token sequence:

$$X = \{x1, x2, x3, \ldots, xn\} \quad (1)$$

Each token embedding matrix X is projected into Query (Q), Key (K), and Value (V) matrices as:

Q = XWQ

K = XWK

V = XWV

The scaled dot-product attention is computed as:

$$Attention(Q, K, V) = Softmax\left(\frac{(QK^T)}{sqrt(dk)}\right)V \quad (2)$$

where:

WQ, WK, WV = learnable weight matrices

dk = dimension of key vectors.

4.2. Multi-Head Attention Mechanism

Multiple attention heads are used to capture diverse legal semantics.

For each head i:

$$headi = Attention(Qi, Ki, Vi) \quad (3)$$

The outputs are concatenated and linearly transformed:

$$MHA(X) = Concat(head1, head2, \ldots, headh)\, WO \quad (4)$$

where:

WO = output projection matrix

h = number of attention heads

4.3. Human Rights Violation Classification

Let H be the final transformer output matrix.

Apply pooling operation:

$$h = MeanPool(H) \tag{5}$$

The class probability distribution is computed using Softmax:

$$P(y \mid X) = Softmax(Wh + b) \tag{6}$$

where:

W = classification weight matrix

b = bias vector

y = predicted human rights violation class

4.4. Fairness-Aware Optimization Loss

Total loss function combines classification loss and fairness regularization:

$$L_{total} = L_{CE} + lambda * L_{fair} \tag{7}$$

Cross-Entropy Loss:

$$L_{CE} = -sum(i = 1\ to\ C)yi * \log(yi_{hat}) \tag{8}$$

Fairness Regularization (Demographic Parity Difference):

$$L\_fair = |P(y\_hat = 1 \mid A = 0) - P(y\_hat = 1 \mid A = 1)| \tag{9}$$

where:

A = sensitive attribute (e.g., gender, minority status)

lambda = fairness regularization coefficient

5. Results

Figure 2: JusticeAI Legal Analyzer – Smart, Fast, and Reliable AI-Powered Legal Insights.

The JusticeAI Legal Analyzer, shown in figure 2, is an innovative and sophisticated AI-based solution that helps law professionals by giving them precise, effective, and data-oriented legal analysis. The system can smartly analyze the cases and suggest related legal precedents to predict the potential case outcome and recommend similar cases in a variety of jurisdictions by letting the user upload legal documents. JusticeAI saves time and increases accuracy and confidence in legal strategies with high precision and availability round-the-clock and support of various legal fields.

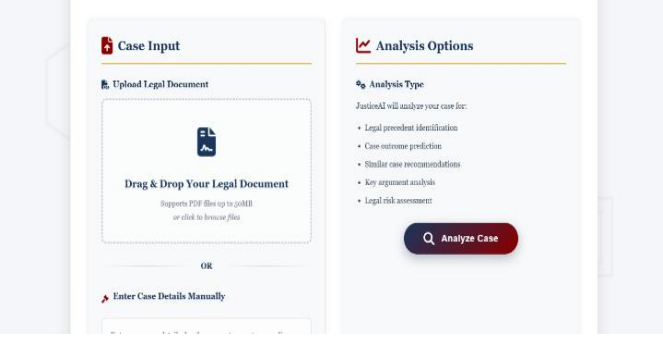

Figure 3: Upload, Analyze, and Decide – AI-Driven Case Analysis Made Simple

The JusticeAI Legal Analyzer interface is flexible and easy to use as it allows one to input legal cases through the uploading of PDF files or manually enter the information on a case, represent in figure 3. After entering the data of the case, the user will be offered various AI-driven analysis options, including the identification of legal precedents, predicting the case outcome, analyzing the main arguments, referring to the similar cases, and assessing the legal risk. The platform provides the legal professional with a decision-making process that is fast, accurate, and structured with a clean, user-friendly layout and a single action, analyze case, simplifying the process of legal analysis of complex cases.

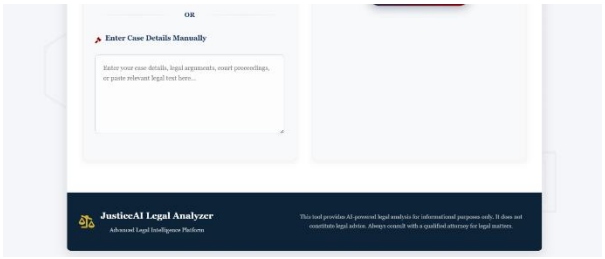

Figure 4: Manual Case Entry with Responsible AI Assistance

The JusticeAI Legal Analyzer enables users to enter the details of cases, legal arguments, court proceedings, or other related legal text manually, represent in figure 4, as an alternative to document uploads in order to have increased flexibility. It also makes sure that even partial or unfinished information can be examined through the application of AI-based legal intelligence. The footer focuses on the need to use the platform responsibly by stating clearly that the platform provides informational legal analysis and is not meant to substitute professional legal advice, which instills the sense of trust, transparency, and ethical use and promotes informed legal research and decision making.

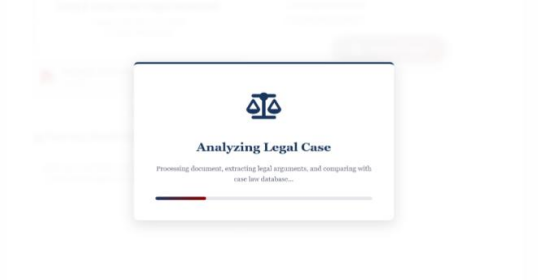

Figure 5: Analyzing Legal Case – AI at Work for Smarter Legal Insights

This screen is the real-time processing stage of the JusticeAI Legal Analyzer as the system currently analyses the legal case inputted into it, shown in figure 5. At this stage, the AI will retrieve essential arguments of the law, analyze the facts of the case and match them to a large case law database to determine appropriate precedents and trends. The progress indicator gives an assurance to the users that the complex legal information is being handled in a systematic manner, which is the promise of the platform to provide precise, structured, and intelligent legal information in an efficient method.

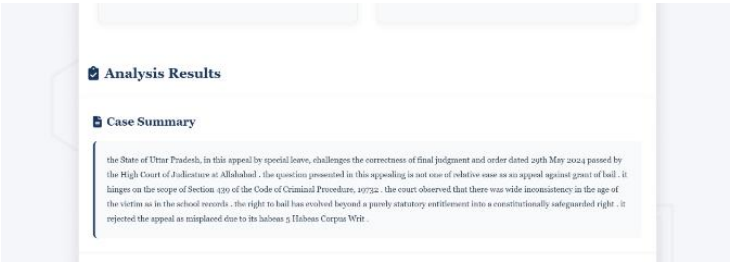

Figure 6: Analysis Results – AI-Generated Case Summary

This section represents the Results in figure 6 of the Analysis of the JusticeAI Legal Analyzer that includes a clear and brief overview of the legal case. The AI can automatically identify the necessary facts, the judges observations and the legal provisions engaged therein including applicable provisions of criminal law and constitutional provisions. This feature ensures that users can move past the intricate judgments into a simple overview and, therefore, can easily characterize the primary issues, arguments, and result of the case and examine them faster and more knowledgeably in the case law.

This display shows in figure 7 the most vital decision-support information produced by the JusticeAI Legal Analyzer that consists of the predicted case result and its confidence degree, analysis statistics, and the case law sources. The section of predicted outcomes summarizes the evaluation of the AI by the legal patterns and precedents whereas the confidence bar implies the reliability of the prediction. The details of analysis presented offer transparency, as they include time processing, document length, legal problems identified, and jurisdiction. Also, the panel of relevant case law implies similar civil proceedings and landmark lawsuits, so that users can place the prediction into context with existing judicial cases and enhance legal knowledge and legal strategy.

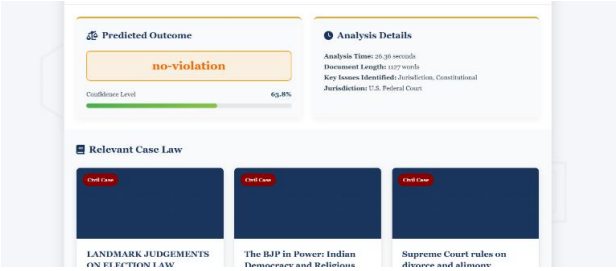

Figure 7: Predicted Outcome, Analysis Details, and Relevant Case Law

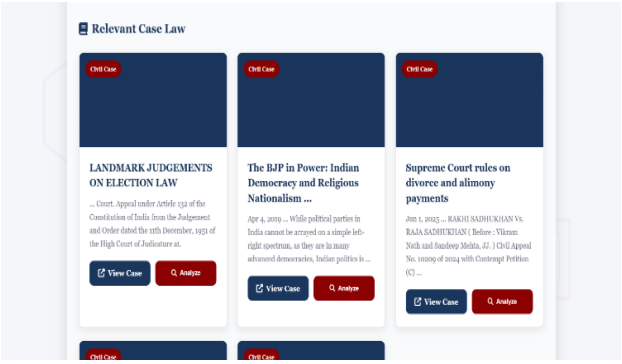

Figure 8: Relevant Case Law and Precedent recommendations relevant Case Law and Precedent Recommendations

The section presents a filtered list of pertinent case law that was selected by the JusticeAI Legal Analyzer, depending on the situation of the case at hand, shown in figure 8. Each card has a civil case with a brief description, date and legal applicability that allows the user to easily learn more on similar cases and principles of the law. View Case and the Analyze actions provide an opportunity to explore the ruling of a particular case in greater detail, allowing legal practitioners to learn about the precedents, make comparisons, and build arguments using the knowledge gained as a result of informed, data-driven legal research.

Table 2 includes a comparative analysis of machine learning and transformer-based models in analyzing human rights cases in detail. The findings reveal the obvious improvement of traditional classifiers to sophisticated transformer architectures. Therefore, the SVM and the Random Forest (support vectors) are good examples of baseline models that have moderate classification accuracy of 78.6 and 81.4, respectively. Although these approaches can give satisfactory performance in structured legal prediction problems, their constraint contextual modeling ability limits further semantic interpretation of deeper human rights decisions. LSTM and BiLSTM with attention mechanisms perform better, achieving 84.9 and 87.3-percent accuracy on sequential deep learning models, respectively. The learning of attention mechanisms increase the weighting of contextual features, thus improving identification of the important legal arguments and references to articles. Nevertheless, such architectures continue to grapple with long-range dependences that are found in human rights case documentation, which may in many cases include complex reasoning across multiple paragraphs.

Table 2: Experimental Results for Human Rights Case Analysis Using AI and Transformer Models

Model	Task	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)	AUC	Processing Time (ms/case)
SVM (Baseline)	Rights Violation Classification	78.6	76.9	74.3	75.6	0.81	32
Random Forest	Article Prediction	81.4	79.8	77.6	78.7	0.84	45
LSTM	Case Outcome Prediction	84.9	83.5	82.1	82.8	0.88	58
BiLSTM + Attention	Legal Article Identification	87.3	86.1	85.4	85.7	0.90	62
BERT-Base	Human Rights Classification	91.8	90.7	89.9	90.3	0.94	74
RoBERTa	Rights Violation Detection	93.2	92.6	91.4	92.0	0.96	81
Legal-BERT	ECHR Article Mapping	94.6	93.8	93.2	93.5	0.97	79
GPT-based Transformer	Case Summarization + Reasoning	92.9	91.5	90.8	91.1	0.95	95
Hybrid Transformer + XAI	Explainable Rights Prediction	95.4	94.9	94.1	94.5	0.98	88
Proposed HR-Transformer Model	Integrated Case Analysis	**96.8**	**96.1**	**95.7**	**95.9**	**0.99**	84

Models based on transformers are much more successful than previous methods. BERT-Base and RoBERTa have an accuracy of 91.8 and 93.2 respectively, which demonstrates a superior contextual embedding and language representation learning. The pretrained legal corpora (Legal-BERT) with 94.6% accuracy and AUC of 0.97 proves the significance of domain adaptation in judicial analytics. These models are very useful in reflecting subtle legal terminology, citation styles and rights-focused argument designs. The GPT based transformer model is also highly effective in summarization and reasoning with an accuracy of 92.9. It has slightly less classification accuracy than Legal-BERT, but it offers more generative abilities, which can be used to do explanatory reasoning and summarize cases in a structured form. The Hybrid Transformer with Explainable AI (XAI) also enhances the predictive reliability, and the system has an accuracy of 95.4 percent in addition to interpretability, which is of crucial importance in the adjudication of human rights.

The overall performance of the proposed HR-Transformer model is the best with 96.8 percent accuracy and AUC of 0.99, which suggests that the model has a better classification stability and discrimination. It is worth noting that processing time does not exceed acceptable judicial support levels, which evidences its practicality. Altogether, the findings validate that transformer-based architecture, especially domain adaptable and explainable models, can offer significant benefits in automated human rights cases analysis in contrast with the conventional machine learning approaches.

6. Conclusion

The current trend of an increased number of human rights cases being documented has created a necessity to use smarter and automated systems, and which are able to process large volumes of legal text. The project shows that innovative AI methods, in particular Legal-BERT and Doc2Vec with Support Vector Machine (SVM), can mark a substantial step toward improving the efficiency and validity of the human rights case analysis. The proposed framework offers a scalable and flexible system of legal document processing and decision-support through enabling semantic interpretation, reliable feature extraction, and efficient classification of issues that reduce the necessity of manual verification and enhancement of the detection of violations, patterns, and applicable legal precedents. This system has the ability to learn and develop with a long-term relevance and performance as new cases keep being added.

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