Legal Judgment Prediction Using Fine-Tuned LegalBERT: A Transformer-Based Approach

Aryan Jangde (230084), Prabhat Kumar (230130), Mahendra Parihar (230140)

***Abstract*—This paper presents a transformer-based legal judgment prediction model using LegalBERT, a domain-adapted variant of BERT trained on legal corpora. The model performs binary classification to predict outcomes of legal cases. The dataset is split into training, development, and test sets. To mitigate class imbalance, oversampling and class-weighted loss functions were used. The model was fine-tuned using HuggingFace Transformers and PyTorch, and evaluated with Accuracy, Precision, Recall, and F1 Score. The final system also includes a FastAPI deployment pipeline with automated summarization and explainability features. Results show that LegalBERT significantly improves performance on legal prediction tasks compared to general models.**

I. Introduction

Legal judgments contain complex structures and domain-specific terminology, making automated prediction challenging. Transformer-based architectures such as BERT have revolutionized natural language processing, but general-purpose versions often underperform on legal texts.

LegalBERT, pre-trained on millions of legal documents, offers improved semantic interpretation for tasks like legal judgment prediction. This research focuses on fine-tuning LegalBERT for binary classification while addressing challenges such as imbalanced datasets and deployment requirements.

II. Related Work

Prior studies show traditional ML, CNN, and RNN models struggle with long legal texts. Transformer-based models outperform them but lack legal specialization. LegalBERT and similar domain-adapted models offer improved vocabulary and context comprehension. However, few works integrate explainability and deployment, which this research addresses.

III. Dataset Description

The dataset contains three key columns: *text*, *label*, and *split*. Labels are binary (0 or 1), and splits include training, development, and testing sets. Missing records were removed and text sequences were capped at 512 tokens as required by LegalBERT. Large class imbalance required correction.

IV. Methodology

A. LegalBERT Model

LegalBERT is a transformer model trained on legal case documents, statutes, and judicial opinions. Its architecture includes a multi-layer bidirectional encoder and a classification head outputting logits for two classes.

B. Handling Class Imbalance

Two techniques were applied:

- **Oversampling:** Positive class samples were replicated 3x.
- **Class-weighted loss:** Inverse frequency weights were applied in a custom WeightedTrainer based on the CrossEntropy loss function.

C. Training Configuration

The training used:

- Learning rate: $2e^{-5}$
- Batch size: 8
- Epochs: 3
- Weight decay: 0.01
- Mixed precision: FP16

A custom trainer allowed computing weighted loss, and the best model was chosen using F1 score.

V. Experimental Setup

Experiments were performed in a GPU environment using PyTorch and HuggingFace Transformers. Evaluation metrics included Accuracy, Precision, Recall, and F1 Score. F1 score was chosen as the primary metric due to class imbalance.

VI. Results & Discussion

Fine-tuning LegalBERT significantly improved classification performance. Oversampling enhanced minority-class representation, while class-weighted loss improved Recall. The model outperformed baseline BERT architectures. The final trained model was saved as `legal-case-predictor-model` for later deployment.

VII. Deployment

A. FastAPI Service

A REST API was implemented using FastAPI and Uvicorn. Key endpoints include:

- **GET /health:** Returns system and GPU status.
- **POST /predict:** Accepts legal text and returns predicted judgment.
- **GET /:** Web-based interface.

B. Advanced Features

Automated Summarization: Using BART-large-cnn, long legal texts are summarized into 60–200 word segments.

Explainable AI: Integrated Gradients highlights influential tokens and extracts key reasoning sentences. Outputs include:

- Verdict
- Confidence score
- Reasoning explanation

VIII. Conclusion

This research successfully fine-tunes LegalBERT for predicting legal judgments. Class imbalance was addressed using oversampling and weighted loss. The final deployed model provides explainability and summarization, making it suitable for real-world applications. LegalBERT proves highly effective for domain-specific NLP.

IX. Future Work

Future enhancements include:

- Multi-class classification
- Incorporating larger regional legal datasets
- Retrieval-augmented generation for reasoning
- Citation prediction
- Model compression for on-device deployment

X. References

References

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