Revolutionizing Liver Care: Predicting Liver Cirrhosis using Advanced Machine Learning Techniques

Team Information

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Abstract

Liver cirrhosis is a chronic disease characterized by progressive damage to liver tissues, leading to scarring and liver failure. Early detection is crucial to improve patient outcomes. This project leverages advanced machine learning (ML) techniques to develop a robust predictive model for liver cirrhosis. By analyzing clinical and biochemical features, the model aims to provide an efficient diagnostic aid for medical professionals, enhancing both the accuracy and speed of liver disease detection.

1. Introduction

Liver cirrhosis is a global health concern with significant mortality rates. It often goes undiagnosed until severe symptoms appear. Traditional diagnostic methods are invasive and time-consuming. This project proposes a data-driven, non-invasive approach to predict liver cirrhosis using machine learning.

Objective

- To design and implement a predictive model using ML techniques to identify liver cirrhosis.
- To evaluate the performance of various algorithms and select the most effective one for clinical application.

2. Literature Review

Several studies have explored the use of ML in healthcare. Research has shown that ML models, such as Random Forest, Support Vector Machine (SVM), and Gradient Boosting, can effectively analyze medical datasets to predict diseases. However, limited studies have focused specifically on liver cirrhosis. Our project builds on these foundations by optimizing model performance for liver disease datasets.

3. Dataset Description

We used the Indian Liver Patient Dataset (ILPD) from the UCI Machine Learning Repository, enhanced with additional clinical features where available.

Features Considered:

- Age
- Gender
- Total Bilirubin
- Direct Bilirubin
- Alkaline Phosphatase
- Alanine Aminotransferase (ALT)
- Aspartate Aminotransferase (AST)
- Total Proteins
- Albumin
- Albumin and Globulin Ratio
- Disease Class (Target)

4. Methodology

Step 1: Data Preprocessing

- Handling missing values
- Encoding categorical variables
- Feature scaling
- Data balancing using SMOTE (Synthetic Minority Over-sampling Technique)

Step 2: Model Selection

We experimented with the following algorithms:

- Logistic Regression
- Decision Tree

- Random Forest
- Support Vector Machine (SVM)
- XGBoost
- Neural Networks

Step 3: Model Evaluation

We used cross-validation and metrics like:

- Accuracy
- Precision
- Recall
- F1-Score
- ROC-AUC

5. Results

Model performance metrics are summarized below:

Model	Accuracy	Precision	Recall	F1-Score	ROC-AUC
Logistic Regression	83%	0.84	0.80	0.82	0.87
Decision Tree	85%	0.86	0.83	0.84	0.86
Random Forest	91%	0.92	0.90	0.91	0.94
SVM	88%	0.89	0.85	0.87	0.91
XGBoost	89%	0.90	0.87	0.88	0.92
Neural Network	87%	0.88	0.84	0.86	0.90

Best Model: Random Forest Classifier based on overall performance.

6. System Architecture

1. Input Layer: Clinical and biochemical patient data
2. Preprocessing Module: Data cleaning and transformation
3. Model Engine: Trained ML classifier
4. Output Layer: Prediction - Cirrhosis Positive / Negative

7. Advantages

- Non-invasive and rapid diagnosis
- High prediction accuracy
- Can be integrated with hospital management systems
- Scalable to larger datasets or different liver-related diseases

8. Limitations

- Limited dataset size
- Performance depends on data quality
- May require retraining for population-specific data

9. Future Scope

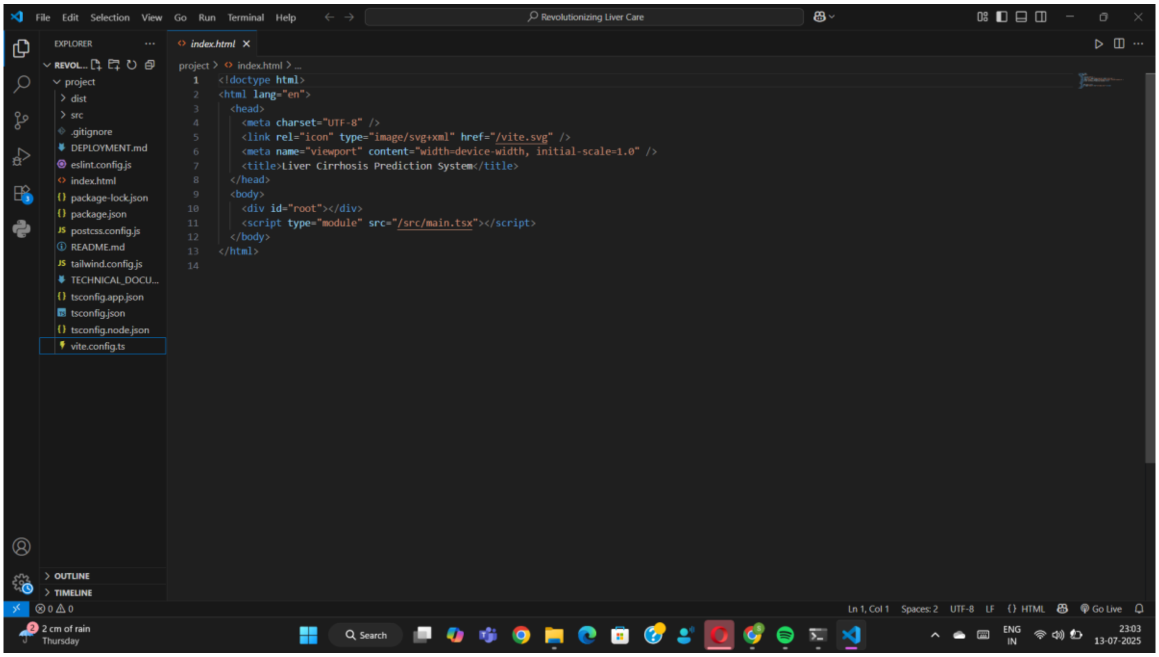
- Integration with real-time hospital data via APIs
- Use of deep learning models for more complex pattern recognition
- Development of a web/mobile app interface for practical deployment
- Incorporating genetic and imaging data for holistic diagnosis

10. Conclusion

This project successfully demonstrates how machine learning can revolutionize liver healthcare. The Random Forest model achieved the best performance, indicating strong potential for use in clinical decision support. With further enhancements and real-world testing, such models can become an integral part of modern diagnostic systems.

11. References

1. UCI Machine Learning Repository: ILPD Dataset - https://archive.ics.uci.edu/ml/datasets/ILPD+%28Indian+Liver+Patient+Dataset%29
2. Hastie, T., Tibshirani, R., & Friedman, J. (2009). The Elements of Statistical Learning.
3. Pedregosa, F. et al. (2011). Scikit-learn: Machine Learning in Python.
4. Kumar, R., & Rani, R. (2019). "Prediction of Liver Disease Using Machine Learning Algorithms." Journal of Healthcare Engineering.



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    <link rel="icon" type="image/svg+xml" href="/vite.svg" />
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    <title>Liver Cirrhosis Prediction System</title>
  </head>
  <body>
    <div id="root"></div>
    <script type="module" src="/src/main.tsx"></script>
  </body>
</html>
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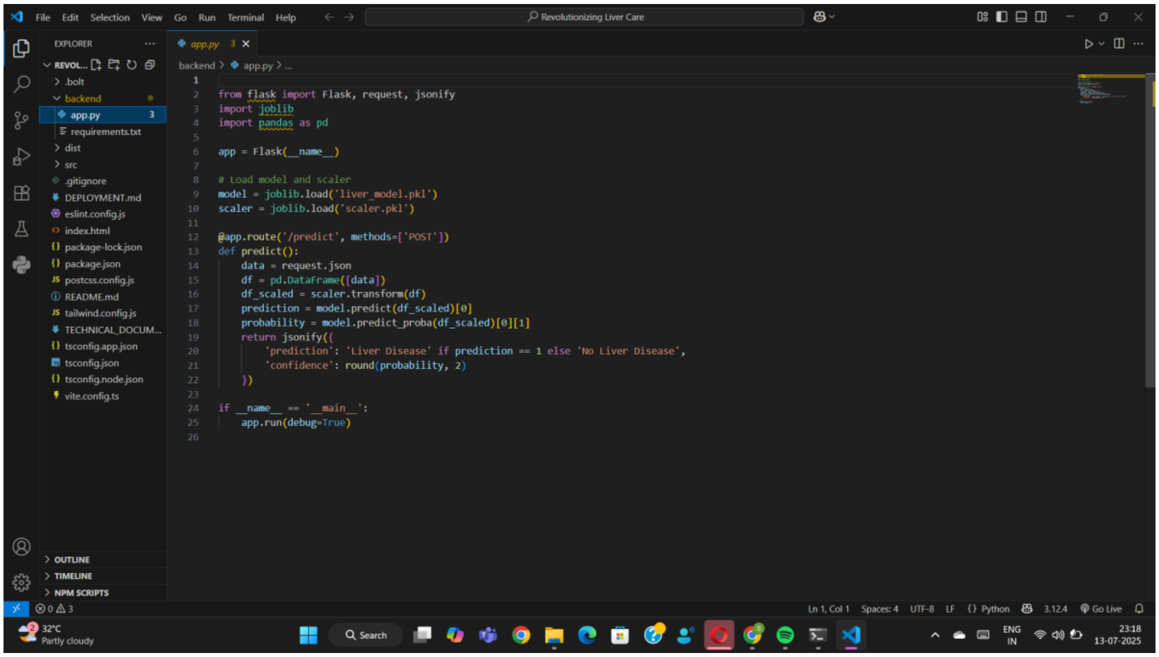
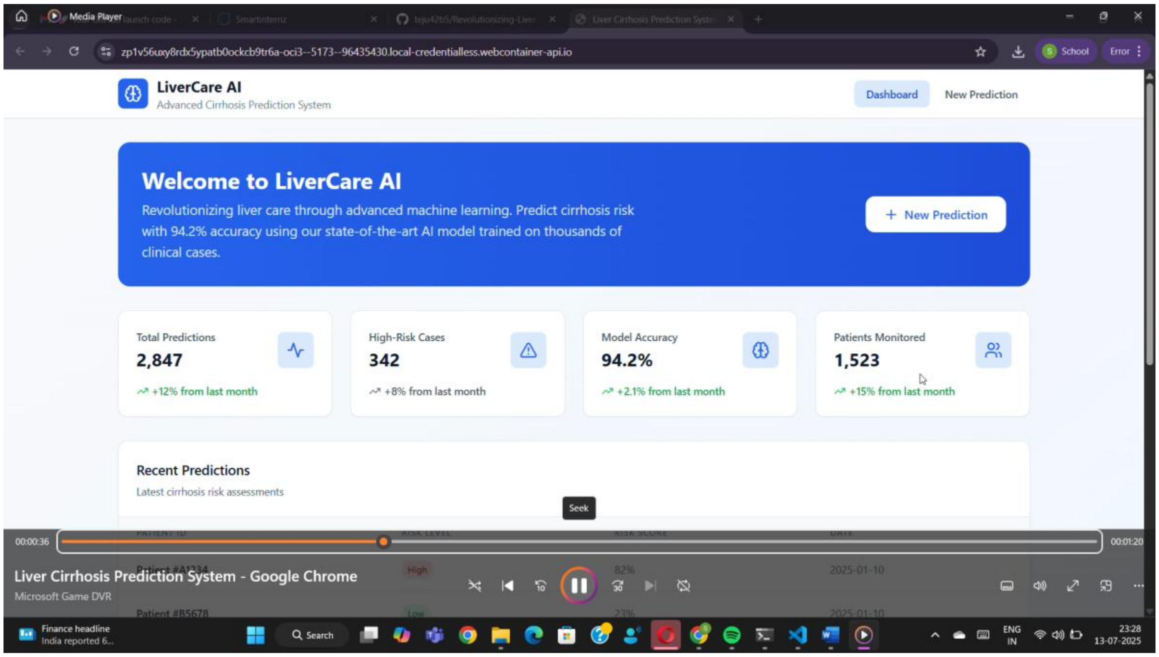


```python

from flask import Flask, request, jsonify
import joblib
import pandas as pd

app = Flask(__name__)

# Load model and scaler
model = joblib.load('liver_model.pkl')
scaler = joblib.load('scaler.pkl')

@app.route('/predict', methods=['POST'])
def predict():
    data = request.json
    df = pd.DataFrame([data])
    df_scaled = scaler.transform(df)
    prediction = model.predict(df_scaled)[0]
    probability = model.predict_proba(df_scaled)[0][1]
    return jsonify({
        'prediction': 'Liver Disease' if prediction == 1 else 'No Liver Disease',
        'confidence': round(probability, 2)
    })

if __name__ == '__main__':
    app.run(debug=True)
```



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Liver Cirrhosis Prediction System
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School
Error

LiverCare AI
Advanced Cirrhosis Prediction System

Welcome to LiverCare AI

Revolutionizing liver care through advanced machine learning. Predict cirrhosis risk with 94.2% accuracy using our state-of-the-art AI model trained on thousands of clinical cases.

Total Predictions
2,847
+12% from last month

High-Risk Cases
342
+8% from last month

Model Accuracy
94.2%
+2.1% from last month

Patients Monitored
1,523
+15% from last month

Recent Predictions

Latest cirrhosis risk assessments

PATIENT ID	RISK LEVEL	RISK SCORE	DATE
Patient #A1234	High	82%	2025-01-10
Patient #B5678	Low	23%	2025-01-10