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

Project Report

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Team ID: LTVIP2025TMID59416
Project Name: Revolutionizing Liver Care: Predicting Liver Cirrhosis using Advanced Machine Learning Techniques

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1. INTRODUCTION

1.1 Project Overview

The Revolutionizing Liver Care project is a comprehensive full-stack Python application designed to predict liver cirrhosis in patients using advanced machine learning algorithms. The project utilizes state-of-the-art classification models such as Random Forest, Logistic Regression, Support Vector Machine, and XGBoost to assess patient health based on clinical and biochemical indicators. The system is deployed as a Flask-based web application, enabling users (patients or doctors) to enter data and receive real-time liver health assessments with high predictive accuracy

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1.2 Purpose

The main objective of this project is to combat the rising global health concern of undiagnosed liver cirrhosis by leveraging predictive analytics. This automated solution aims to:-

- Facilitate early detection of liver cirrhosis using data-driven techniques

- Reduce dependency on expensive diagnostic imaging and lab testing

- Support doctors and health workers with a fast, accessible screening tool

- Minimize health risks and improve patient outcomes through early intervention

- Demonstrate practical application of machine learning in healthcare diagnostics

- Provide a scalable and cost-effective liver disease screening tool for all demographics

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2.1 Problem Statement –

Customer Problem Template

1. I am a General Physician, trying to quickly identify signs of liver cirrhosis in patients but tests like FibroScan and biopsy are not always available or affordable, because patients often seek help only when symptoms are severe, which makes me feel frustrated and worried about late detection.
2. I am a Rural Health Worker, trying to screen patients for liver problems during field visits, but lack tools to analyze patient symptoms quantitatively, because remote areas have no access to diagnostic labs, which makes me feel helpless and limited by infrastructure
3. I am a Patient at Risk, trying to understand my liver health from basic medical reports, but I don't know how to interpret test results or when to consult a doctor, because of fear of being too late in getting treatment, which makes me feel anxious and unsure.

2.2 Empathy Map Canvas

Target User: Healthcare Professionals and At-Risk Patients

SAYS:

- "We need faster ways to screen for liver disease."

- "I wish we had an easy tool to understand test results."

THINKS:

- Concerned about missing early signs of cirrhosis.
- Worried about treatment delays due to diagnosis bottlenecks.

DOES:

- Orders liver function tests.
- Reviews patient symptoms manually.
- Refers patients for imaging or specialist diagnosis.

FEELS:

- Frustrated by limited early-stage detection tools.
- Anxious about patient outcomes.
- Interested in tech-assisted diagnosis tools.

Pain Points

- Delayed diagnosis of liver cirrhosis
- High cost of conventional testing
- Limited access to diagnostic labs in rural areas
- Patients unaware of early symptoms

Gain Points

- Automated early detection using ML
- Cost-effective solution
- Accessible web-based tool
- Improved decision-making for doctors

2.3 Brainstorming - Idea Prioritization

Step 1: Problem Selection

Selected Problem: Early prediction of liver cirrhosis using clinical and biochemical data

Step 2: Idea Listing

- Traditional statistical models

- Machine Learning classification models

- Deep learning with clinical datasets

- Web-based diagnostic tools

Step 3: Prioritization

Idea: ML + Flask Web App

Feasibility: High

Impact: High

Resources: Medium

Priority: 1 (Selected)

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3. REQUIREMENT ANALYSIS

3.1 Customer Journey Map

Scenario: Patient visits a primary care doctor with symptoms like fatigue or jaundice

1. Doctor records clinical and lab data

2. Enters data into the web app

3. ML model evaluates the input and gives prediction

4. Doctor uses the result to decide further treatment or testing

3.2 Solution Requirements - Functional Requirements

- User form for inputting patient clinical values (age, bilirubin, protein, etc.)

- Backend model to process and classify

- Confidence score output

- Display prediction result: 'Likely Cirrhosis' or 'Unlikely

3.3 Data Flow Diagram

[User] --> [Web Interface] --> [Flask Backend] --> [Input Preprocessing]

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[Prediction Result] <-- [ML Model] <-- [Preprocessed Input]

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[User Display] <-- [Result Processing] <-- [Confidence Calculation]

3.4 Technology Stack

Frontend: HTML, CSS, Bootstrap

Backend: Flask

ML Libraries: Scikit-learn, XGBoost, Pandas, NumPy

Deployment: Localhost or Cloud (optional)

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4. PROJECT DESIGN

4.1 Problem-Solution Fit

Customer Segments: General practitioners, rural health workers, hospitals, at-risk patients

Jobs-to-be-Done:

- Early screening of liver disease

- Aid in decision making

- Low-cost assessment tools

Constraints:

- Limited access to labs

- Need for simple tools

Available Solutions:

- Blood tests, biopsy, FibroScan

Our Solution:

- ML-based liver health predictor with a web interface

4.2 Proposed Solution

1. Problem: Lack of accessible, early-stage liver cirrhosis detection tools

2. Idea: A Flask-based web app using ML models trained on liver datasets

3. Uniqueness: Data-driven, affordable, accurate (>90%), web-based, real-time

4. Impact: Better diagnosis, less hospital burden, early treatment initiation

5. Business Model: Freemium model for doctors; open use for NGOs
6. Scalability: Support for other liver diseases, regional language interface

4.3 Solution Architecture

Presentation Layer: Web UI

Application Layer: Flask backend for data processing and routing

Model Layer: Trained ML models (Random Forest, XGBoost)

Storage Layer: Pickled model files and test datasets

5.PROJECT PLANNING & SCHEDULING

Sprint-1: UI Design and Dataset Cleaning (01-07 July)

Sprint-2: Model Training and Evaluation (08-14 July)

Sprint-3: Integration and Testing (15-21 July)

Velocity: 11 story points per sprint

6. FUNCTIONAL AND PERFORMANCE TESTING

Accuracy: >92% (XGBoost best model)

Validation Method: Train-test split (80-20)

Metrics Used: Accuracy, Precision, Recall, AUC Score

Model Response Time:<2 seconds

7. RESULTS

- Achieved >92% prediction accuracy
- Successfully integrated with web app
- Tested with anonymized patient samples
- Demostrated usability by doctor

8. ADVANTAGES & DISADVANTAGES

Early detection of liver cirrhosis

Accurate and low-cost tool

Simple web interface

Time-saving for doctors

Accuracy depends on dataset diversity

Needs regular updates with new data

Limited to binary classification

9. CONCLUSION

The project showcases the power of machine learning in transforming liver healthcare. By offering a predictive tool that is both accurate and accessible, this solution addresses a major gap in liver disease diagnosis. It empowers doctors, especially in

underserved areas, to take proactive steps in managing patient liver health.

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10. FUTURE SCOPE

- Multi-class prediction (fibrosis stages)
- Integration with EHR systems
- Mobile app version
- Expansion to other liver conditions like hepatitis or fatty liver
- Support for regional language