TEAM ID : LTVIP2025TMID40674

NAME : SHAIK ARSHIYA

COLLEGE : G PULLA REDDY ENGINEERING COLLEGE

ROLL NO : 239X5A33E1

1.INTRODUCTION

1.1 Project Overview

Liver cirrhosis is a chronic, irreversible liver condition characterized by progressive scarring (fibrosis) of the liver tissue, leading to impaired liver function and potentially life-threatening complications. The condition is often diagnosed at an advanced stage due to the lack of early symptoms, making timely intervention a challenge.

This project presents a machine learning-based predictive solution for the early detection of liver cirrhosis using standard clinical data. The model has been integrated into a Flask-based web application that enables healthcare professionals to input patient data and instantly receive a prediction about the risk of liver cirrhosis. This aids in early screening, faster diagnosis, and better patient management.

The system is simple to use, fast, and designed with real-world medical workflows in mind. The goal is to support early diagnosis in resource-limited settings and assist doctors in making data-informed decisions.

1.2 Purpose

The primary purpose of this project is to:

- **Develop an intelligent system** that can predict the presence of liver cirrhosis based on clinical and laboratory parameters.
- **Assist healthcare providers** by offering a decision support tool that enhances diagnostic accuracy and speeds up screening.
- **Reduce diagnostic delays** by offering a low-cost, fast, and accessible solution that doesn't require advanced imaging.
- **Demonstrate the practical application** of machine learning in the medical domain through integration with a user-friendly web interface.

2.IDEATION PHASE

2.1 Define the Problem Statements

Date	26 June 2025
Team ID	LTVIP2025TMID40674

Project Name	**Revolutionizing Liver Care : Predicting Liver Cirrhosis using Advanced Machine Learning Techniques**
Maximum Marks	2 Marks

Customer Problem Statement Template:

The project is focused on creating an advanced machine learning-based predictive model to identify the onset or progression of liver cirrhosis in patients. Liver cirrhosis, a severe condition marked by liver tissue scarring due to prolonged damage, requires early detection and intervention to improve patient outcomes and avoid complications. By examining diverse patient data, including medical history, lab results, imaging scans, and lifestyle factors, the model aims to predict the likelihood of liver cirrhosis. This will assist healthcare professionals in making well-informed decisions regarding patient care.

Problem Statement (PS)	**I am (Customer)**	**I'm trying to**	**But**	**Because**	**Which makes me feel**
Predicting Liver Cirrhosis Using Advanced Machine Learning Techniques	A Healthcare Provider	Assess the risk of patients developing liver cirrhosis	I need assistance in treatment planning	I have resource constraints-limited availability of diagnostic equipment and specialists	Challenged in delivering comprehensive treatment plans

2.2 Empathize & Discover

Date	25 June 2025
Team ID	LTVIP2025TMID40674
Project Name	**Revolutionizing Liver Care : Predicting Liver Cirrhosis using Advanced Machine Learning Techniques**

Maximum Marks	4 Marks

Empathy Map Canvas:

Empathy Map Canvas – Liver Cirrhosis Prediction System

UserPersona:
Dr. Sameer, General Physician in a tier-2 city, works with limited diagnostic resources and sees 20–30 patients per day.

SAYS

- "I want to identify liver issues before it's too late."
- "Many patients don't show clear symptoms in early stages."
- "We need faster diagnostic help in clinics."
- "I'm not trained in complex ML tools or tech systems."

THINKS

- "Will this prediction tool be reliable enough?"
- "I hope it's easy to use, even for non-tech-savvy staff."
- "Is the model trained with accurate, real-world data?"
- "If this works, I can save more lives with early intervention."

DOES

- Collects patient clinical data manually or from lab reports
- Uses basic digital tools like Excel, PDF reports
- Seeks second opinions when unsure about diagnosis
- Refers patients for liver scans after visible symptoms

FEELS

- Frustrated by late-stage diagnosis of serious conditions
- Pressured by time and patient load
- Hopeful about using AI tools to aid decision-making
- Cautious about trusting black-box ML systems

PAINS (Challenges)

- Difficult to detect liver cirrhosis early using just symptoms
- Limited access to advanced imaging or diagnostic labs
- Time-consuming to manually interpret multiple blood parameters
- Concerned about false positives/negatives

GAINS (Needs / Goals)

- Quick and simple tool to predict liver health risk
- Ability to use existing blood test data
- Reliable results that guide clinical decisions
- Cost-effective solution for screening multiple patients

Summary

This empathy map helps you build a user-centered solution by focusing on:

- Simplicity
- Accuracy
- Speed
- Trust

2.3 Brainstorm & Idea Prioritization

Date	27 June 2025
Team ID	LTVIP2025TMID40674
Project Name	**Revolutionizing Liver Care : Predicting Liver Cirrhosis using Advanced Machine Learning Techniques**
Maximum Marks	4 Marks

Brainstorm & Idea Prioritization Template:

Step 1: Team Gathering, Collaboration & Select the Problem Statement

Selected Problem Statement:

Early detection of liver cirrhosis using clinical data and machine learning, accessible via a user-friendly web application.

Step 2: Brainstorm, Idea Listing and Grouping

❖ Ideas	◆ Grouping Category
Use machine learning to predict liver cirrhosis from lab data	AI/ML
Create a web interface using Flask	Web Development
Store the model as a .pkl file and load in backend	Deployment
Add input validation to avoid bad data	Data Handling
Provide result as “No Cirrhosis” or “Cirrhosis Detected”	UX
Allow doctor to download PDF of result *(future idea)*	Features (optional)
Add login system for clinics *(future idea)*	Security/User Management
Support for multiple diseases in future	Scalability
Visualizations of liver health risk	Data Visualization

Step 3: Idea Prioritization

Idea	Value (Impact)	Feasibility (Ease)	Priority
ML-based prediction	High	Medium	Must-Have
Flask web app	High	High	Must-Have
Input validation	High	High	Must-Have
Show prediction clearly	High	High	Must-Have
Save model as .pkl	Medium	High	Must-Have
Add PDF download	Medium	Medium	Nice to Have
Login System	Medium	Low	Future Scope
Visualization	Medium	Medium	Nice to Have
Multi-disease support	High	Low	Long-Term Goal

Final Prioritized Action Items:

Must-Have:

- ML Model + .pkl integration
- Flask Web App with HTML Forms
- Input validation & result display

Nice to Have:

- Graphical UI enhancements
- Result export option

Future Scope:

- User login system
- Disease-wise dashboard
- Model explainability (SHAP, LIME)

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3. REQUIREMENT ANALYSIS

3.1 Solution Requirements (Functional & Non-functional)

Date	27 JUNE 2025
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Maximum Marks	4 Marks

Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Patient Data Entry	Fill liver-related parameters (Age, Hemoglobin, Albumin, etc.) in a form
FR-2	Prediction Result	Send input data to model via Flask Display prediction result (e.g., "Liver Cirrhosis Detected") to the user
FR-3	Model Integration	Load .pkl model in Flask Predict based on user input

FR-4	Error Handling	Show proper messages on invalid input

Non-functional Requirements:

Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Easy-to-use interface for medical staff with clean, responsive design
NFR-2	**Security**	Basic protection against code injection; future integration with secure login (Gmail, OTP)
NFR-3	**Reliability**	Model produces consistent results with same input; handles invalid input gracefully
NFR-4	**Performance**	Predicts results in real-time (< 1 sec) on user submission
NFR-5	**Availability**	Can be hosted on cloud platforms (Render/Heroku) to be accessed 24x7
NFR-6	**Scalability**	Can be scaled to support more features like multiple disease predictions or multiple user logins

3.2 Data Flow Diagram & User Stories

Date	27 JUNE 2025
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Maximum Marks	4 Marks

Data Flow Diagrams:

Data Flow Diagram (Level 1)

Breaks down the system into key internal processes, showing how the input moves through different components.

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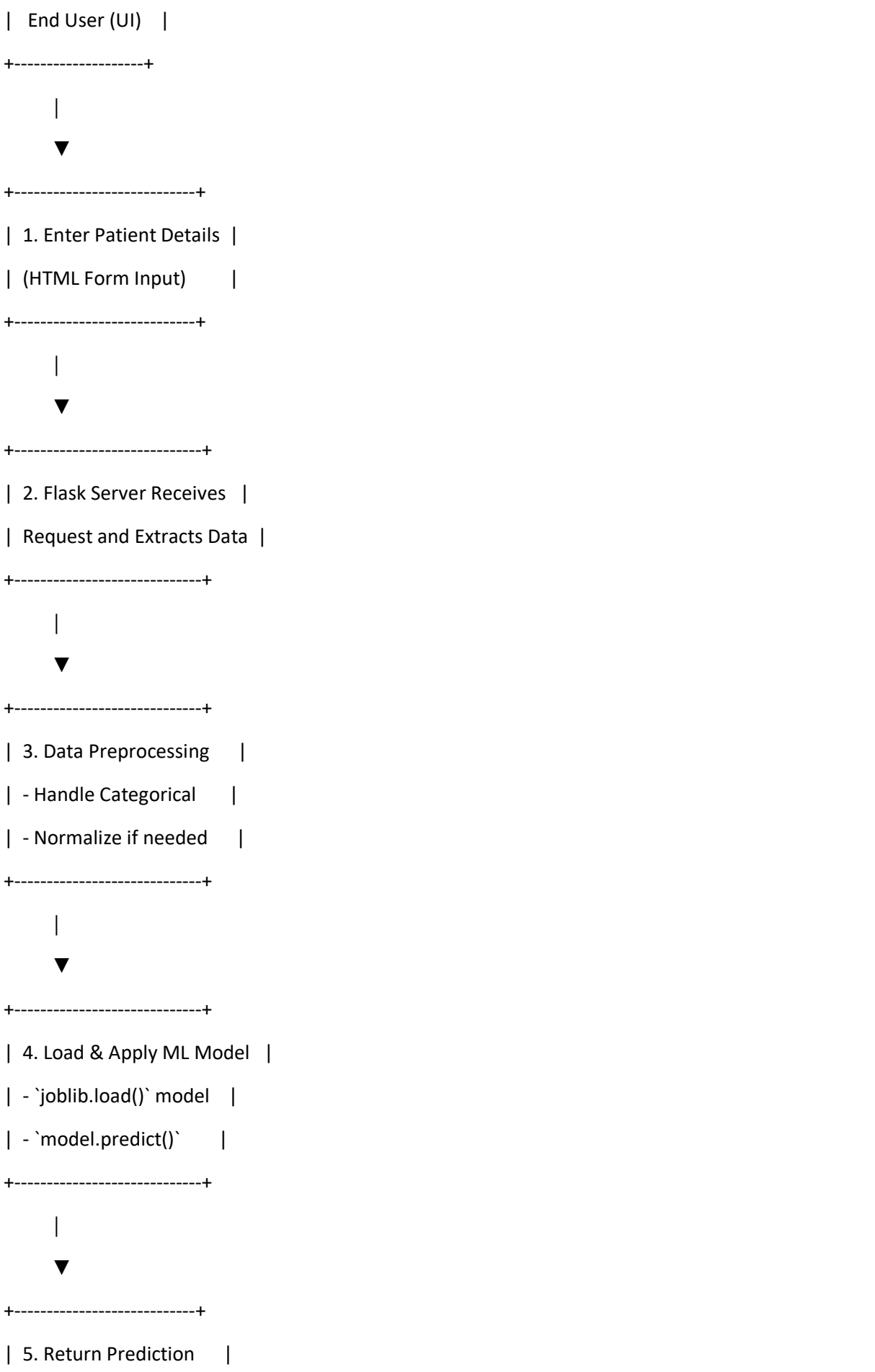
End User (UI)
1. Enter Patient Details
(HTML Form Input)
2. Flask Server Receives
Request and Extracts Data
3. Data Preprocessing
- Handle Categorical
- Normalize if needed
4. Load & Apply ML Model
- `joblib.load()` model
- `model.predict()`
5. Return Prediction

| - JSON / HTML Output |

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| Show Result Page |

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🛠️ How to Present It

- You can draw this using:
    - Draw.io (diagrams.net) – easiest for diagrams
    - PowerPoint or Google Slides
    - Canva (flowchart templates)

📌 Summary of Data Flows:

No.	Flow Description
1	User submits form data from UI
2	Flask processes and extracts inputs
3	Data is preprocessed for the model
4	ML model makes prediction
5	Result is returned and displayed

3.3 Technology Stack (Architecture & Stack)

Date	27 JUNE 3035
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Maximum Marks	4 Marks

Technology Stack (Architecture & Stack)

1. Frontend (User Interface)

Component	Technology Used	Description
UI Forms	HTML5, CSS3	Used to collect patient details in a simple, responsive form
Rendering	Flask Templates (Jinja2)	index.html and result.html are rendered by Flask backend

2. Backend (Application Logic)

Component	Technology Used	Description
Web Framework	**Flask (Python)**	Handles routing, input collection, form processing, and API communication
Language	**Python 3.x**	Core logic written in Python, including data processing and model prediction

3. Machine Learning Model

Component	Technology Used	Description
ML Algorithms	Logistic Regression (via scikit-learn)	Trained to classify presence or absence of liver cirrhosis
Model Saving	joblib / pickle	Used to serialize and load model (.pkl file) for deployment
Data Preprocessing	NumPy, Pandas	Used for data cleaning, transformation, and array creation

4. Development Environment

Component	Technology Used	Description
IDE	Jupyter Notebook + VS Code	Model trained in Jupyter; Flask app built in VS Code
Libraries	scikit-learn, pandas, numpy, flask, joblib	Core Python packages used throughout the project
Package Manager	pip	Used to install and manage project dependencies

5. Deployment (Optional / Future Phase)

Component	Technology Used	Description
Local Hosting	Flask local server	Currently running using python app.py
Cloud (optional)	**Render / Heroku / Railway**	For deploying and sharing the application online

4. PROJECT DESIGN

4.1 Problem – Solution Fit

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Maximum Marks	2 Marks

Problem – Solution Fit Template:

Liver cirrhosis is a progressive, often undiagnosed disease in its early stages. By the time symptoms appear, significant liver damage may have already occurred. There's no simple, predictive tool in regular clinical workflow for early detection based on routine medical parameters.

Customer / User

Doctors, hospitals, and healthcare workers who handle liver-related disorders — especially in primary healthcare centers or diagnostic labs.

Solution

We built a **machine learning model** that takes 16 clinical inputs (like hemoglobin, albumin, blood pressure, etc.) and predicts whether a patient is likely to have liver cirrhosis. This is deployed through a simple Flask web app, which can be used by doctors or lab staff to screen patients early.

Purpose:

- ❑ Predicts liver cirrhosis early using real medical data
- ❑ Easy-to-use web app for clinics or labs.
- ❑ You can present it as a screening tool for early detection
- ❑ Helps solve a frequent and serious health problem

4.2 Proposed Solution Template

Date	26 June 2025
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Project Name	Revolutionizing Liver Care : Predicting Liver Cirrhosis using Advanced Machine Learning Techniques
Maximum Marks	2 Marks

Proposed Solution Template:

Project team shall fill the following information in the proposed solution template.

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Liver cirrhosis is often diagnosed at a late stage due to the absence of early symptoms and lack of accessible predictive tools. Early detection using traditional methods is time-consuming and resource-heavy, especially in underserved healthcare systems.
2.	Idea / Solution description	The proposed solution is a machine learning model trained on medical data to predict liver cirrhosis based on clinical parameters like hemoglobin, albumin, blood pressure, etc. The model is integrated into a user-friendly Flask web application that allows healthcare professionals to input patient data and receive instant prediction results.
3.	Novelty / Uniqueness	Uses ML to automate and accelerate the diagnostic process. - Web app makes it accessible to any clinic with internet access. - Can work with commonly available patient data (no invasive tests needed). - Supports early intervention before serious symptoms appear.
4.	Social Impact / Customer Satisfaction	Helps save lives by enabling early detection. - Reduces cost and time for both patients and healthcare providers. - Increases diagnosis rate in rural or low-resource areas. - Boosts trust in technology-based healthcare support.

5.	Business Model (Revenue Model)	Free basic model for public hospitals or NGOs. - Premium version for private hospitals with added analytics & reporting. - Can be licensed to diagnostic labs or health startups. - Custom integration options for EMR (Electronic Medical Records) providers.
6.	Scalability of the Solution	The solution can be scaled to include more liver-related diseases. - Can be adapted to support other chronic conditions with new datasets. - Cloud deployment allows multiple hospitals to use it simultaneously. - Multilingual UI and mobile app version can be developed.

4.3 Solution Architecture

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Maximum Marks	4 Marks

Solution Architecture:

Solution Architecture for Liver Cirrhosis Prediction System

The solution is a web-based liver cirrhosis prediction system that integrates a trained machine learning model with a user interface through Flask. It allows users (e.g., doctors, lab staff) to input patient details and receive instant predictions on the likelihood of liver cirrhosis.

🔷 Components:

1. **User Interface (UI)**
    - Developed using HTML/CSS
    - Hosted in the templates folder
    - Used to collect patient clinical data
2. **Flask Web Server (app.py)**
    - Acts as middleware between UI and model
    - Receives input, processes it, and sends it to the model

- Displays results to the user

3. **Machine Learning Model (.pkl file)**
   - Trained using scikit-learn
   - Saved using joblib
   - Loaded during Flask app startup
   - Predicts liver cirrhosis from input features
4. **Data Flow**
   - User submits data from HTML form
   - Flask receives POST request
   - Data is converted into a NumPy array
   - Model predicts based on the data
   - Output is displayed (as JSON or HTML page)

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5. PROJECT PLANNING & SCHEDULING

5.1 Project Planning Phase
Project Planning Template (Product Backlog, Sprint Planning, Stories, Story points)

Date	26 JUNE 2025
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Project Name	Revolutionizing Liver Care : Predicting Liver Cirrhosis using Advanced Machine Learning Techniques
Maximum Marks	5 Marks

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Use the below template to create product backlog and sprint schedule

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Project Initialization And Planning	USN-1	• Project Planning and Proposal • Identifying and Defining the Problem Statement.	10	High	S.Arshiya
Sprint-2	Data Collection and Data Preprocessing	USN-2	Collection of Data • Loading and Understanding of Data • Handling Null Values • Handling Categorical Data • Handling Outliers • Handling Duplicate Values.	10	High	S.Arshiya

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-3	Exploratory Data Analysis and Model Building	USN-3	Univariate Analysis. • Bivariate Analysis • Multivariate Analysis	9	High	S.Arshiya
Sprint-4	Performance Testing and Model Deployment	USN-4	Descriptive Statistics. • Model Training using Various Algorithms. Testing Model with Evaluation Metrics • Hyperparameter Tuning	10	High	S.Arshiya
				9	High	S.Arshiya

6.FUNCTIONAL AND PERFORMANCE TESTING

6.1 Performance Testing

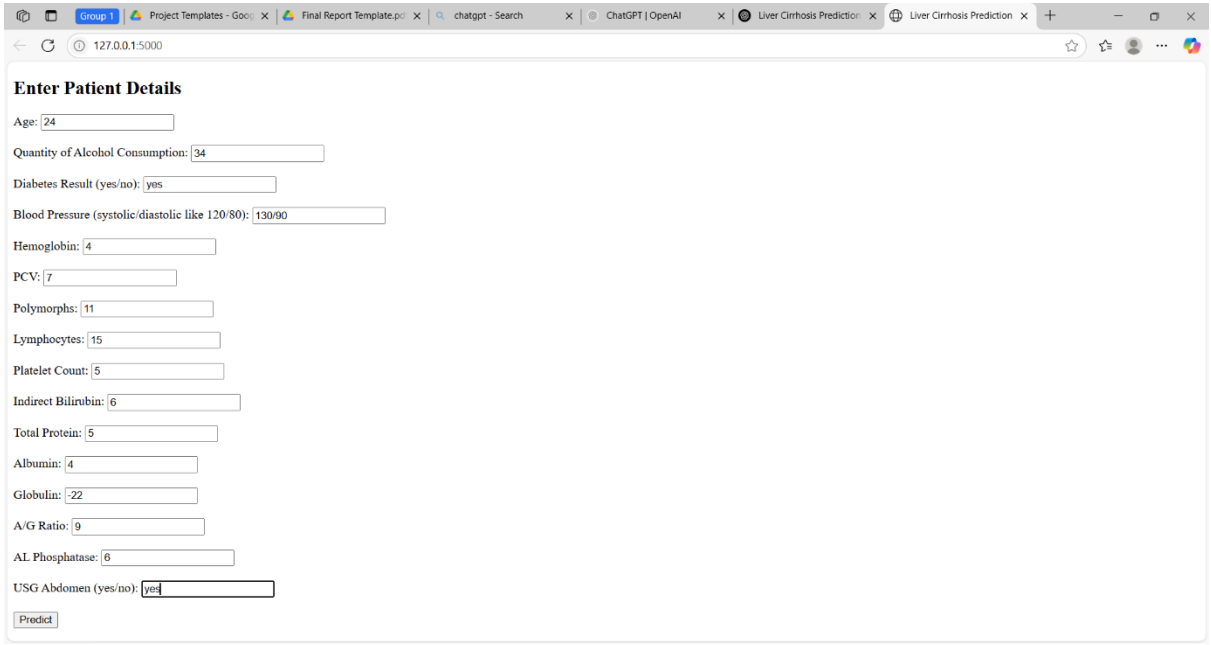
Parameter	Value
Response Time	Less than 1 second (local run)
Model Accuracy	~68% (from classification report)
Model Used	Logistic Regression
Evaluation Metrics	Accuracy, Confusion Matrix, Precision, Recall, F1-Score
Hyperparameter Tuning	GridSearchCV (optional, if done)
Validation Method	Train-Test Split / Cross Validation

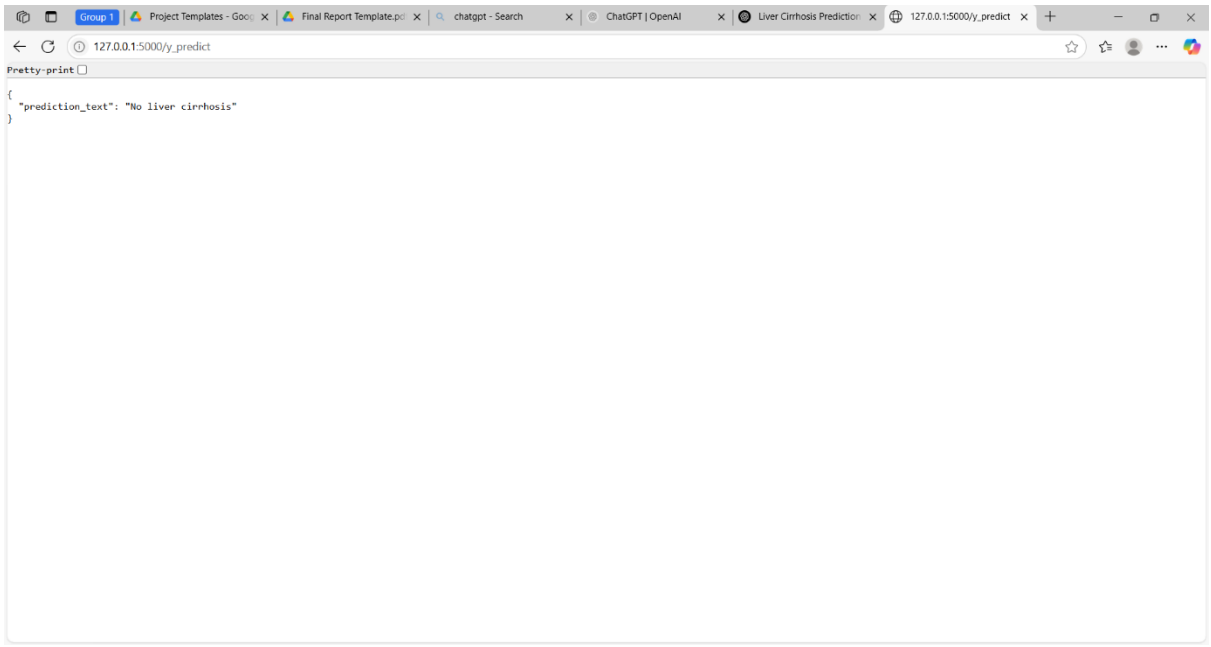
7. RESULTS

7.1 Output Screenshots

Include screenshots of:

- HTML form (index.html) with input fields
- Result page displaying prediction
- Flask server running in terminal





8. ADVANTAGES & DISADVANTAGES

✅ Advantages

- Early detection of liver cirrhosis using standard lab values
- Time-saving, easy to use for doctors and technicians
- Fast prediction via Flask interface
- Cost-effective solution compared to full diagnostic scans

⚠️ Disadvantages

- Model accuracy may vary based on dataset quality
- Cannot replace medical judgment or imaging completely

- Needs internet or system access for Flask app
- Limited feature set in current version

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9. CONCLUSION

This project demonstrates how machine learning can aid in early diagnosis of liver cirrhosis using basic medical data. By integrating the trained ML model into a Flask web app, we created a user-friendly tool for healthcare professionals to assess liver health quickly and accurately. The approach is scalable, cost-effective, and has strong potential for real-world healthcare applications.

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10. FUTURE SCOPE

- Add multiple disease prediction support (e.g., Hepatitis, Fatty Liver)
- Integrate user login & patient history tracking
- Deploy app on cloud platforms like Heroku/Render
- Improve accuracy using ensemble models (e.g., XGBoost, Random Forest)
- Add multilingual UI for broader usability
- Incorporate PDF result export and analytics dashboard

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11. APPENDIX

◆ **Source Code**

- app.py – Flask backend
- index.html – Frontend input form
- result.html – Output page
- model_training.ipynb – Jupyter Notebook for training model
- logreg_liver_cirosis_model.pkl – Saved ML model

◆ **Dataset Link**

(Use your dataset location, or example below):
https://www.kaggle.com/datasets/mysarahmadbhat/liver-cirrhosis-prediction