Artificial Intelligence & machine Learning

1 Introduction

1.1 Project Title

Revolutionizing Liver Care: predicting Liver Cirrhosis Using Advanced Machine Learning

1.2 Team Members

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2 Project Overview

2.1 Purpose

The Cirrhosis Prediction App is designed to predict the likelihood of liver cirrhosis in patients based on clinical data using a pre-trained Random Forest machine learning model. The app aims to assist healthcare professionals and individuals with a quick, data-driven risk assessment tool.

2.2 Features

- User-friendly web interface for inputting patient data.
- Prediction of cirrhosis risk based on 18 clinical features (e.g., Age, Bilirubin, Status).
- Display of prediction results with interpretation (Cirrhosis or No Cirrhosis).
- Informative pages for Home, About, and Contact.
- Error handling for invalid inputs or model failures.

3 Architecture

3.1 Frontend

The frontend is built using HTML5 and CSS, with placeholder CSS files (index.css, home.css, about.css, contact.css, result.css, error.css). It includes:

- home.html: Landing page with a call-to-action.
- index.html: Prediction form with JavaScript for age conversion (years to days).
- about.html: Project information.
- contact.html: Contact details.
- result.html: Prediction output.
- error.html: Error display page.

3.2 Backend

The backend is developed using Flask, a lightweight Python web framework. It:

- Handles routing for all pages (/, /about, /contact, /form, /predict).

- Processes form data, applies normalization, and uses a Random Forest model for predictions.
- Implements logging for debugging and error tracking.

3.3 Machine Learning Models

The app uses pre-trained models:

- random_forest_model.pkl: Random Forest classifier.
- normalizer.pkl: Data normalizer.

Input features include 18 clinical parameters (e.g., N_Days, Status, Bilirubin), with categorical features encoded using predefined mappings. Models are loaded using pickle and joblib.

4 Setup Instructions

4.1 Prerequisites

- Python 3.8+
- Flask (pip install flask)
- Pandas (pip install pandas)
- Joblib (pip install joblib)
- Pickle (included in Python standard library)
- Web browser (e.g., Chrome, Firefox)
- Model files: random_forest_model.pkl, normalizer.pkl

4.2 Installation

1. Clone the repository:

```
git clone <repository-url> cd cirrhosis-prediction-app
```

2. Create a virtual environment:

```
python -m venv venv
source venv/bin/activate % On Windows: venv\Scripts\activate
```

3. Install dependencies:

```
pip install flask pandas joblib
```

4. Ensure random_forest_model.pkl and normalizer.pkl are in the project root.
5. Create a static/css directory and add CSS files (e.g., index.css).
6. Create a templates directory and place HTML files (home.html, index.html, about.html, contact.html, result.html, error.html).
7. Set up environment variables (optional):
   - FLASK_ENV=development
   - FLASK_APP=app.py

5 Folder Structure

5.1 Client (Frontend)

```
templates/ home.html
                        % Landing page
  index.html            % Prediction form
  about.html            % Project information
  contact.html          % Contact details
  result.html           % Prediction results
  error.html            % Error display page
static/
  css/
```

```
index.css  % Styles for index.html (placeholder) home.css  % Styles for home.html
(placeholder) about.css          % Styles for about.html (placeholder) contact.css %
Styles for contact.html (placeholder) result.css      % Styles for result.html (placeholder)
error.css  % Styles for error.html (placeholder)
```

5.2 Server (Backend)

```
.
app.py                                  % Main Flask application
random_forest_model.pkl % Pre-trained Random Forest model normalizer.pkl          %          Pre-trained
normalizer
```

6 Running the Application

6.1 Frontend

The frontend is served by Flask's template rendering, so no separate frontend server is needed.

6.2 Backend

Run the Flask server:

```
cd <project-directory> source venv/bin/activate % On Windows: venv\Scripts\activate python
app.py
```

Access the app at http://127.0.0.1:5000.

7 API Documentation

The application exposes the following endpoints:

- **GET /**
  - *Description*: Renders the home page.
  - *Response*: HTML (home.html).
- **GET /about**
  - *Description*: Renders the about page.
  - *Response*: HTML (about.html).

- **GET /contact**
  - *Description*: Renders the contact page.
  - *Response*: HTML (contact.html).
- **GET /form**
  - *Description*: Renders the prediction form.
  - *Response*: HTML (index.html).
- **POST /predict**
  - *Description*: Processes patient data and returns a prediction.
  - *Parameters* (Form Data):
    - N_Days: Number (days since registration).
    - Status: Enum (C, CL, D).
    - Drug: Enum (D-penicillamine, Placebo, Other).
    - Age: Number (age in years, converted to days).
    - Sex: Enum (M, F).
    - Ascites: Enum (N, Y).
    - Hepatomegaly: Enum (N, Y).
    - Spiders: Enum (N, Y).
    - Edema: Enum (N, Y, S).
    - Bilirubin, Cholesterol, Albumin, Copper, Alk_Phos, SGOT, Tryglicerides, Platelets, Prothrombin: Numbers.
  - *Example Request* (Form Data):

```
N_Days=400 Status=C
Drug=D-penicillamine
Age=50
Sex=F
Ascites=N
Hepatomegaly=Y Spiders=N
Edema=N
Bilirubin=1.2
Cholesterol=200 Albumin=3.5
Copper=50
Alk_Phos=1000
SGOT=80
Tryglicerides=120
Platelets=250 Prothrombin=10.5
```

  - *Example Response* (Success): HTML (result.html) with:
    - prediction: 1 (Cirrhosis) or 0 (No Cirrhosis).
    - interpretation: “Cirrhosis” or “No Cirrhosis (Stage 0)”.
  - *Example Response* (Error): HTML (error.html) with:

 error_message: e.g., “Normalizer is not loaded”.

8 Authentication

Current Implementation: The app does not implement authentication or authorization, as it is designed for open access.

Future Consideration: Authentication could be added using Flask-Login or JWT to restrict access to authorized users (e.g., healthcare professionals). User sessions could be managed with Flask’s session handling.

9 User Interface

The UI consists of:

- **Home Page**: Welcomes users with a call-to-action button.
- **Prediction Form**: Inputs for 18 clinical parameters, with dropdowns for categorical features.
- **Result Page**: Displays prediction outcome with a retry option.
- **About Page**: Provides project context.
- **Contact Page**: Lists contact information.
- **Error Page**: Displays error messages with a retry link.

Screenshots: To be added by the developer, as CSS styling is not provided.

10 Testing

Testing Strategy:

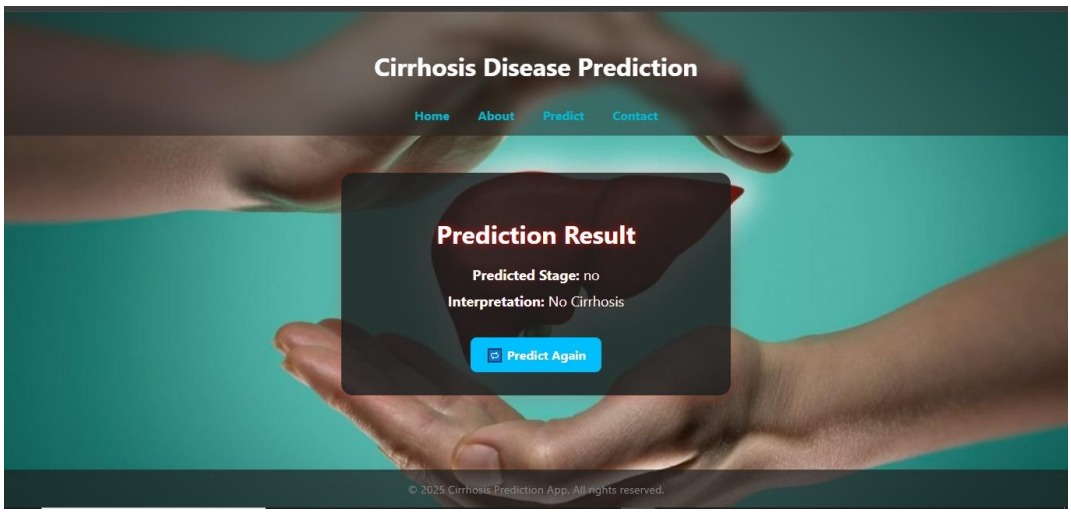
- *Unit Testing*: Test Flask routes and prediction logic using unittest or pytest.
- *Integration Testing*: Verify form submission and prediction pipeline.
- *Model Validation*: Ensure model files produce expected outputs.

Tools:

- pytest for unit tests.
- Manual testing via browser for UI.
- Logging (in app.py) for debugging.

Current Status: No automated tests implemented. Manual testing recommended.

11. Screenshots



12 Known Issues

- Missing CSS files may result in unstyled pages.
- error.html was not initially provided but is referenced.
- Invalid numerical inputs default to 0.0, potentially skewing predictions.
- No client-side form validation beyond HTML5 required attributes.
- No authentication, making the app openly accessible.
- Model loading errors cause prediction failures.

13 Future Enhancements

- Implement client-side form validation using JavaScript.
- Add CSS styling for improved UI/UX.
- Introduce authentication (e.g., Flask-Login or JWT).
- Develop automated tests using pytest.

- Add a MongoDB database for prediction history (transition to MERN if desired).
- Deploy to a cloud platform (e.g., Heroku, AWS).
- Enhance the model with real-time retraining or additional features.