DENIAL ANALYSIS APPLICATION

Project Overview

The goal of this project is to support medical billing analysts working in Revenue Cycle Management (RCM) by analyzing medical claims data — specifically focusing on CPT codes, payer performance, and denial trends. The ultimate aim is to reduce denials, recover revenue, and improve operational efficiency in healthcare billing.

Data Input

The Excel file you upload should include the following columns:

- **CPT Code**: Procedure code for the billed service
- **Insurance Company**: Name of the payer
- **Physician Name**: The rendering provider
- **Payment Amount**: Paid amount by payer
- **Balance**: Unpaid balance
- **Denial Reason**

WorkFlow

Step 1: Dataset Upscaling via SMOTE-NC

- Use SMOTE-NC (SMOTE for Nominal and Continuous) to synthetically upsample the dataset to address class imbalance.
- Final dataset is scaled to ~500 records for more effective training and analysis.
- Data is stored In local storage.

Step 2: Streamlit Web Application

A Streamlit dashboard is developed to allow:

- Data ingestion
- Real-time analytics
- ML predictions

Step 3: Excel Data Ingestion and Merging

- New Excel file is uploaded by the user.
- Data is transformed:
- Header alignment
- Currency fields cleaned
- Missing values filled
- Transformed data is appended to an existing master Excel file containing historical records.
- A button to added to run a pre-trained model to classify the inputs to be denied or not.

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Step 4: Streamlit Interface with 3 Main Buttons

- Add Additional Data
- Run Pipeline and Show Results
- Start Over

Step 5: Add Additional Data

i. User uploads an Excel file.

ii. Data is cleaned and validated**:**

- Drop empty rows
- Standardize column headers
- Convert currency fields
- Fill missing values and flag denials

iii. Transformed data is appended to the master file.

Step 6: Run Pipeline and Show Results

Creates 2 main tabs:

Tab 1: ML Model

- Binary classifier: Denied vs Not Denied
- Multiclass classifier: Predicts denial reason

Shows:

- Accuracy
- Classification Report
- Confusion Matrix

Tab 2: Data Analysis

Contains 2 sub-tabs:

Tab 1:Charts

- Denials by CPT Code
- Denial Rate (%)
- Denials by Insurance Provider
- Denials by Physician
- Lost Revenue by CPT

Tab2: Root Cause & Recommendations

- Lists most common causes
- Suggests recommendations per cause

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Step 7: Start Over

Resets the interface to Step 4, allowing the user to upload new data or rerun the pipeline from scratch.

End-to-End Benefit

Automates denial pattern analysis, allows data enrichment, and presents a complete RCM insight tool for healthcare billing analysts.

Result

1. Identify Top Denied CPT Codes

- Rank CPT codes based on the number of denials
- Calculate denial rate per CPT
- Visualize the top denied CPTs

2. Break Down by Payer and Provider

- Show which **insurance companies** are denying claims most often
- Identify **providers** who receive the most denials

3. Root Cause Analysis

- Investigate common denial reasons:
    - Missing Information
    - Charge exceeds fee schedule
    - Non covered service

4. Recommendations

1. Missing information
    - Use complete and correct details.
    - Train staff on payer-specific documentation.

2. Charge exceeds fee schedule
    - Compare charges with payer schedules regularly.
    - Appeal denials with proper justification.
3. Non-covered service
    - Check plan coverage before providing care.
    - Inform patients of potential out-of-pocket costs.

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5. Machine Learning Predictions

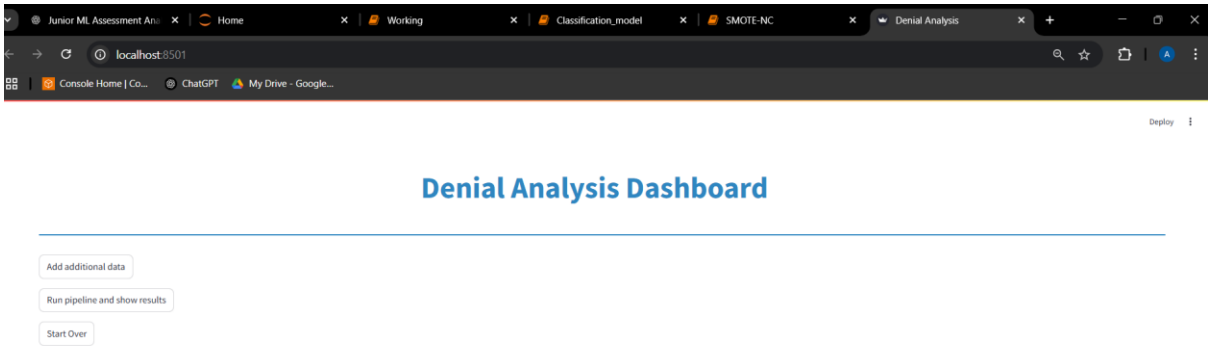
- **Binary Classification**: Predict whether a claim will be denied or not
- **Multiclass Classification**: Predict the specific reason for denial

6. Visual Reporting

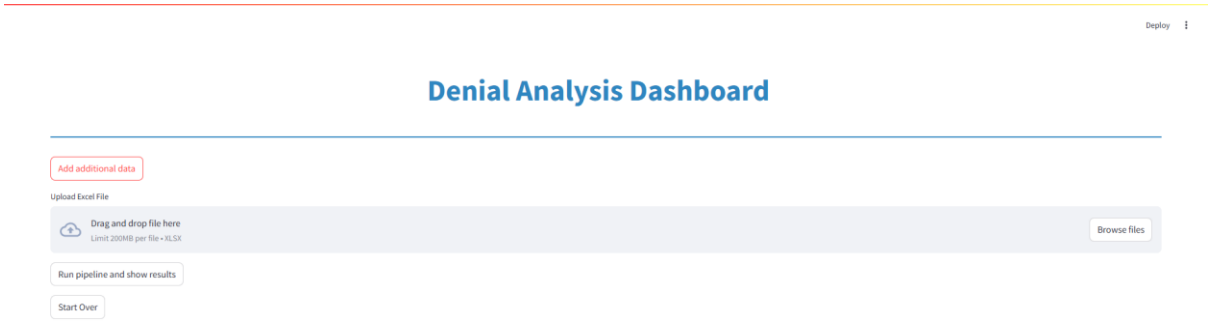
- Bar plots for:
    - Denials by CPT, payer, and provider
    - Lost revenue by CPT
    - Denial rate comparisons
- Displayed directly in a Streamlit dashboard

Output:

The preview of Application developed using streamlit,along with the button enabled.



Upon clicking into “add additional data”.



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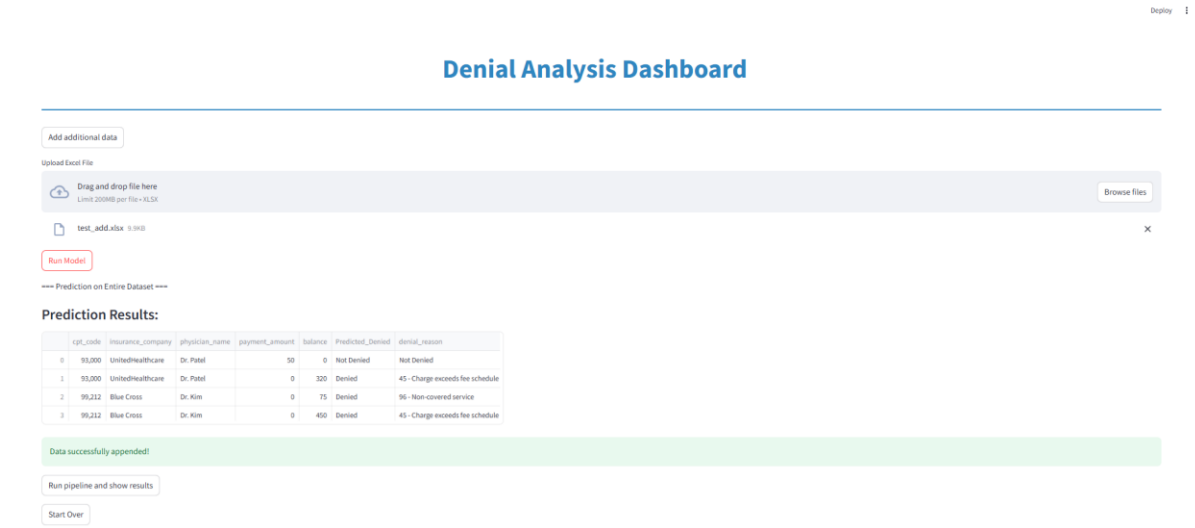
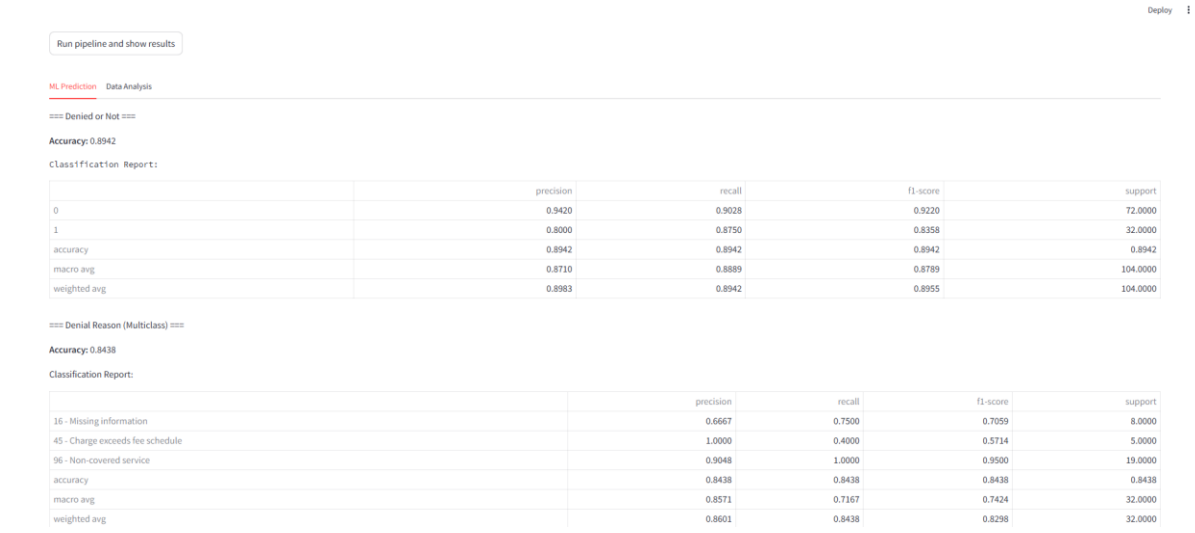
A button is visualized after adding the excel file to “Run Model” which runs a classification model to classify whether the input is denied or not.



Upon successfully adding the dataset we get a poppedup message of “Data successfully appended” and by clicking the “Run pipeline and show results” button we get the ML results of the existing data by default in tab1,



And in tab2 we have the analysis part where we get to find 2 more subtabls of Analysis part and Solution and Root cause tabs respectively,

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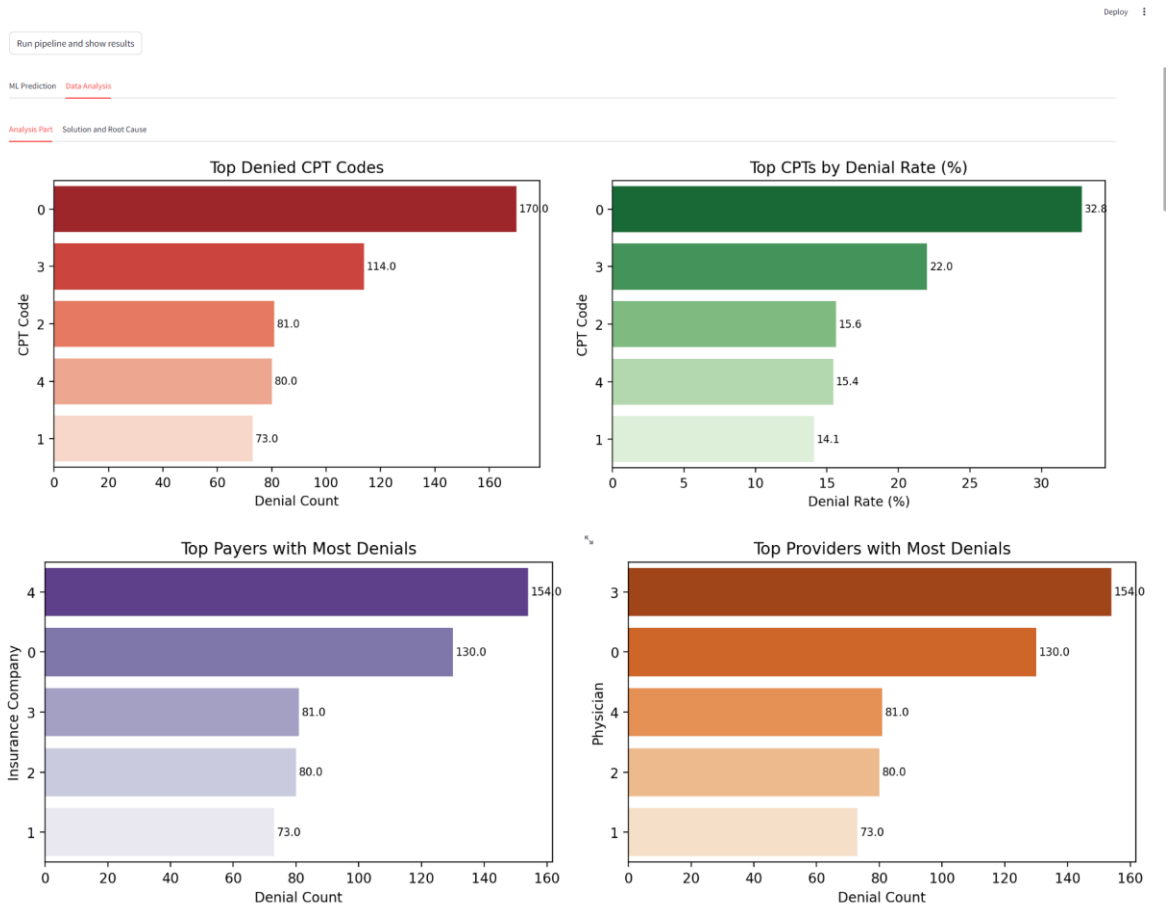
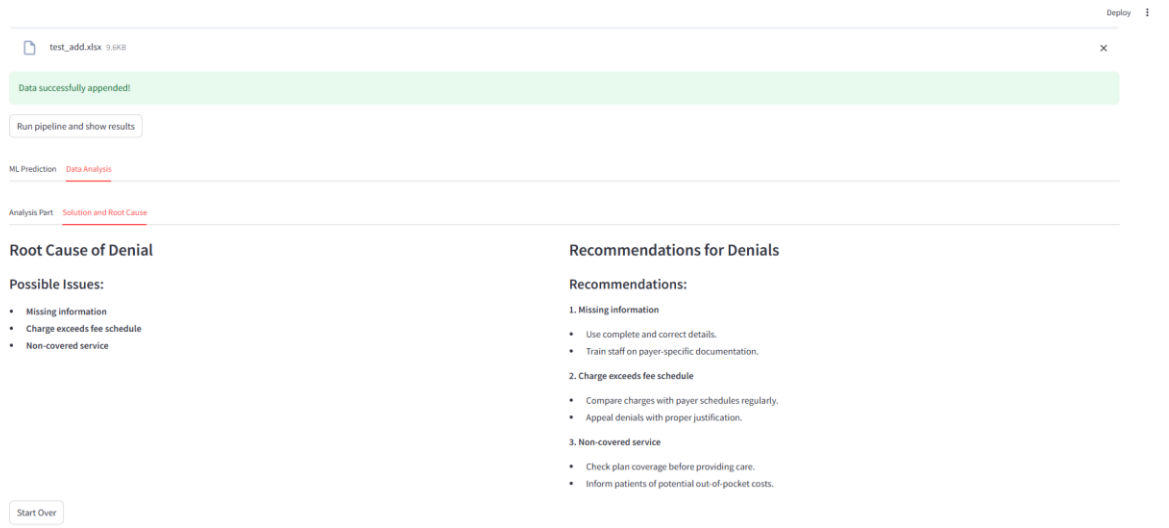
we have 5 barchars to be noted,



By clicking into the section subtab we can find the hardcoded rootcause and recommendation parts



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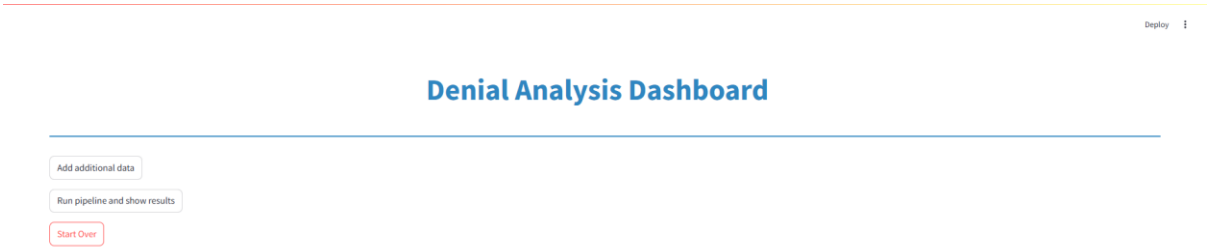
Upon clicking in the Start over button we get to clear the cache and begin a walk through from start.



Observation

This project addresses a critical need in healthcare revenue cycle management: identifying and understanding the reasons behind claim denials. The workflow is thoughtfully structured and incorporates data augmentation, machine learning, and user interactivity.The key strengths of the project includes Robust Data Preparation,Scalable DataIntegration,Dual-Purpose Output and Actionable Business Value.