CS 411 Stage 1: Detailed Project Description

Flight Delay Prediction System

Project Summary

The **Flight Delay Prediction System** is a web application designed to predict and analyze flight delays by combining historical flight data with real-time weather conditions. It integrates a robust database infrastructure, specifically MongoDB, to store and query large datasets, such as flight schedules, delays, cancellations, and weather data. The system utilizes machine learning algorithms to generate accurate delay predictions while offering insights into potential disruptions across the air travel network, accounting for factors like weather, hub congestion, and aircraft rotation patterns.

By integrating APIs for real-time weather (OpenWeatherMap), flight status (Aviation Stack), and notifications (Twilio, SendGrid), the system provides proactive alerts to users via SMS and email. The project emphasizes a database-driven approach, utilizing MongoDB to efficiently manage unstructured data and enhance prediction accuracy, setting it apart from existing flight tracking applications by offering predictive analytics based on complex, interconnected factors affecting flight operations.

Project Description

The primary goal of our project is to develop a sophisticated flight delay prediction system that addresses the critical need for accurate and timely information about potential flight disruptions. Air travel delays significantly impact both passengers and airlines, with cascading effects throughout the transportation network. Our application aims to solve this problem by providing proactive delay predictions and actionable insights for better travel planning and resource allocation.

Creative Component

Our application's creative component leverages multiple APIs and data integration techniques to provide comprehensive flight delay predictions:

1. OpenWeatherMap API integration for real-time weather conditions at airports

2. Aviation Stack API for current flight status and scheduling information
3. Twilio API integration for SMS notifications about predicted delays
4. Google Maps Geocoding API to provide airport location data and basic route visualization
5. Custom algorithm combining weather severity scores with historical delay patterns
6. Email notification system using SendGrid API for delay alerts

Usefulness

The Flight Delay Prediction System offers unique value by providing:

- SMS and email notifications for predicted delays
- Real-time weather impact assessment on flights
- Personalized alert system for specific routes
- Historical delay patterns for better travel planning
- Simple, user-friendly interface for quick information access

While existing flight tracking applications like FlightAware and FlightRadar24 provide current flight status, our system differentiates itself by offering predictive analytics and comprehensive delay risk assessment. The application considers complex interconnected factors that affect flight operations, providing a more nuanced and accurate prediction system. This helps the user to get an idea of whether they can expect delays or not, helping them plan their travel better.

Realness

Our application will utilize two primary datasets:

https://www.kaggle.com/datasets/patrickzel/flight-delay-and-cancellation-dataset-2019-2023

https://www.kaggle.com/datasets/sobhanmoosavi/us-weather-events

1. Flight Delay and Cancellation Dataset (2019-2023)
    - Format: CSV
    - Size: Multiple GB of data covering 5 years
    - Information: Flight numbers, departure/arrival times, delay durations, cancellations
    - Source: Kaggle (US Bureau of Transportation Statistics)

2. US Weather Events Dataset
    - Format: CSV
    - Size: Comprehensive weather data covering major US airports
    - Information: Weather conditions, severity, duration, location
    - Source: Kaggle (US Weather Service)

Functionality

The website will offer the following key features:

User Interactions (CRUD Operations)

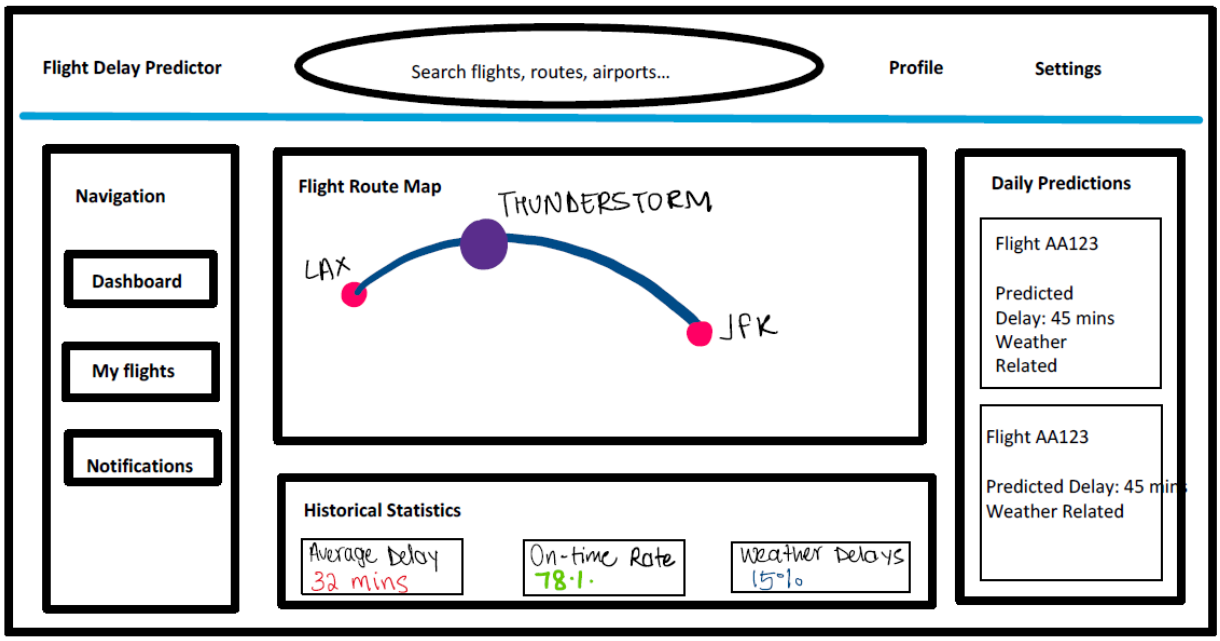
- Create: Users can create custom alert profiles for specific routes or airports
- Read: Access real-time delay predictions and historical delay patterns
- Update: Modify alert preferences and notification settings
- Delete: Remove saved routes and alert profiles
- Search: Look up specific flights, routes, or airports for delay predictions

Additional Features

- Interactive delay prediction dashboard
- Custom alert system for specific routes
- Historical delay pattern analysis
- Weather impact visualization
- Resource optimization recommend

UI Mockup

[A basic wireframe sketch showing the main dashboard layout with the following components:]



- Top navigation bar with search functionality
- Main map display showing flight routes and weather overlay
- Sidebar with delay predictions and alerts
- Bottom panel with detailed statistics and historical data
- Modal windows for creating and editing alert profiles

Project Work Distribution

Frontend Development

- Bhavika: User interface and main dashboard
- Anitej: Interactive visualizations and maps
- Tanmay and Naina: Search functionality and filters

Backend Development

- Tanmay: Database design and management (MongoDB)
- Naina: API development and integration

- Anitej, Bhavika: Prediction Algorithm and Weather data processing

Data Processing

- Naina : Flight data ETL pipeline
- Tanmay: Weather data processing
- Anitej : Machine learning model development
- Bhavika: Testing and optimization

Each team member will be responsible for both frontend and backend components of their assigned features, ensuring full-stack development experience across the team.