Abstract:

Real-Time Air Quality Monitoring and Intelligent Health Advisory System

Air pollution has become one of the most pressing environmental concerns of the modern world, posing severe risks to human health and urban sustainability. With the rapid pace of industrialization and urban growth, monitoring air quality and providing timely health guidance have become critical. This project, titled **"Real-Time Air Quality Monitoring and Intelligent Health Advisory System,"** is designed to continuously process air quality data derived from structured CSV datasets, enabling smart decision-making without the need for physical sensor hardware.

The proposed system employs a data-driven pipeline that integrates various stages of data engineering — including ingestion, cleaning, transformation, and visualization. The collected dataset contains vital air pollutant parameters such as **PM2.5, PM10, CO, NO_2, O_3, and SO_2**, which are processed to compute the **Air Quality Index (AQI)** based on standard environmental formulas. The system continuously monitors changes in pollutant levels and automatically detects **pollution spikes** that exceed safety thresholds. Upon detecting unhealthy air conditions, it generates **real-time alerts** for both citizens and local authorities.

What makes this project unique is its **AI-powered health advisory module**, which goes beyond simple AQI monitoring. This intelligent component provides **personalized health recommendations** based on user-specific attributes such as age, medical conditions, and lifestyle habits. For instance, the system can suggest avoiding outdoor activities for users with asthma or heart conditions when AQI levels exceed safe limits. Additionally, the project integrates **predictive analytics** to forecast near-future AQI trends using past data, allowing proactive decision-making rather than reactive responses.

A **Streamlit-based interactive dashboard** serves as the front-end interface, visualizing real-time AQI data, pollutant distribution, and alert status through dynamic charts, graphs, and maps. The dashboard enables users to filter information by location, pollutant type, and time range. Furthermore, an **anomaly detection module** identifies unusual or abrupt pollution events that may indicate fire outbreaks, industrial emissions, or traffic surges.

Overall, the system effectively demonstrates how principles of **data engineering, analytics, and artificial intelligence** can be applied to address real-world environmental challenges. By combining continuous data processing, predictive modeling, and health-oriented insights, this project transforms traditional monitoring into a **proactive, intelligent, and user-centric air quality management solution**. The proposed model not only contributes to environmental awareness but also supports public health safety and sustainable urban development.

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