**SkySentinel AI - Phase 1**

**An AI-Powered Real-Time Flight Anomaly Detection System**

**Executive Summary**

The aviation industry faces a critical challenge: managing the ever-increasing complexity of air traffic while ensuring safety and efficiency. Existing air traffic management systems are reactive, struggle with scalability, and lack predictive capabilities.

SkySentinel AI is a revolutionary project that leverages live flight data, cutting-edge machine learning, and real-time streaming technologies to predict and mitigate airspace risks. This system integrates data from Flightradar24, processes it using Apache Kafka, and applies advanced AI models to identify anomalies in flight patterns. Designed to scale globally, SkySentinel AI lays the foundation for a new era of proactive airspace safety and traffic management.

**Project Objectives**

1. **Proactive Anomaly Detection**:
   * Identify unusual flight behaviors, including trajectory deviations, altitude anomalies, and speed irregularities, in real time.
2. **Real-Time Insights**:
   * Build a live data streaming pipeline to process flight information continuously and provide actionable insights.
3. **Scalable Architecture**:
   * Design a modular system capable of scaling to handle global air traffic data efficiently.
4. **Long-Term Vision**:
   * Enable seamless integration of emerging airspace technologies like Urban Air Mobility (UAM) and autonomous drones.

**Key Challenges Addressed**

1. **Inefficiency in Air Traffic Monitoring**:
   * Current systems rely on manual monitoring and post-event analysis.
   * SkySentinel AI introduces automated, predictive capabilities.
2. **Rising Airspace Complexity**:
   * The growing diversity of airspace users (planes, drones, eVTOLs) requires advanced solutions.
   * SkySentinel AI adapts to multi-vehicle scenarios.
3. **Scalability Limitations**:
   * Existing solutions cannot process global flight data in real time.
   * Apache Kafka and AWS services ensure scalability and low-latency processing.

**Core Features**

1. **Real-Time Data Streaming**:
   * Live flight data ingestion using Apache Kafka.
   * Scalable data processing pipeline to handle millions of data points per minute.
2. **Anomaly Detection**:
   * Machine learning models (e.g., Isolation Forest, Autoencoders) trained to flag flight anomalies.
   * Predictive insights delivered with high accuracy.
3. **Interactive Visualization**:
   * User-friendly dashboard for visualizing live airspace status and anomalies.
   * Alerts and recommendations for air traffic controllers.
4. **Future-Ready Design**:
   * Modular architecture to integrate weather data, satellite feeds, and regulatory compliance modules.

**Tools and Technologies**

* **Data Streaming**: Apache Kafka for real-time ingestion and processing.
* **Machine Learning**: Scikit-learn for anomaly detection; TensorFlow for advanced modeling.
* **Cloud Infrastructure**: AWS MSK (Kafka), Lambda, SageMaker for scalable deployments.
* **Visualization**: Flask backend with Dash or Streamlit for real-time dashboards.

**Expected Outcomes**

1. **Proactive Safety Monitoring**:
   * Real-time alerts on flight anomalies, enabling faster response times.
2. **Operational Efficiency**:
   * Enhanced air traffic flow and reduced congestion through predictive insights.
3. **Scalable Architecture**:
   * Capable of handling global data streams with minimal latency.

**Metrics for Success**

* **Anomaly Detection Accuracy**: 95% or higher.
* **Latency**: Predictions delivered within 1 second of data ingestion.
* **Scalability**: System processes up to 1 million flight data records per minute.

**Authors**

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**Conclusion**

SkySentinel AI represents the future of air traffic management, blending real-time data with cutting-edge AI to ensure safer skies. This project is a critical step toward proactive airspace safety, paving the way for future innovations in autonomous air traffic control and integrated airspace management.