Emergency Medical Service Demand Prediction and Optimization

Leveraging historical 911 call data to predict high-risk zones, optimize resource allocation, and improve emergency response times through advanced analytics and machine learning.

The Critical Challenge

Uneven Demand Patterns

Emergency services face unpredictable call volumes that create resource bottlenecks during peak periods and waste capacity during quiet hours.

Response Time Delays

Poor resource positioning leads to delayed responses when every second counts for patient outcomes and community safety.

Resource Misallocation

Without data-driven insights, ambulances and staff are positioned based on intuition rather than statistical evidence of need.

Our Data-Driven Solution

Pattern Detection

Analyze historical emergency call data to identify temporal patterns, geographic hotspots, and seasonal trends that drive demand fluctuations.

Risk Prediction

Forecast high-risk zones and time periods using advanced machine learning models to anticipate emergency incidents before they occur.

Resource Optimization

Generate optimal deployment recommendations for ambulances and staff based on predicted demand patterns and historical response data.

Comprehensive Feature Set

1 Historical Data Analysis

Deep dive into emergency call patterns by time, location, and incident type to identify peak demand periods and high-risk geographical areas.

2 Interactive Heatmap Visualization

Dynamic geographic visualization of emergency call hotspots with filtering capabilities for different time periods and emergency types.

3 Predictive Modeling Engine

Machine learning models that forecast emergency types and call volumes, enabling proactive resource planning and deployment strategies.

4 Real-time Simulation Platform

Live simulation environment for testing resource allocation strategies and visualizing the impact of deployment decisions on response times.

Advanced Technology Stack

Data Processing

Robust data pipeline using pandas and numpy for efficient processing of large-scale emergency call datasets with complex temporal and geographic attributes.

Machine Learning

Advanced predictive models leveraging scikit-learn, Prophet, and XGBoost for accurate forecasting of emergency incidents and demand patterns.

Geographic Analysis

Sophisticated spatial analysis using Folium and GeoPandas for precise location-based insights and interactive mapping capabilities.

Interactive Dashboard

User-friendly Streamlit interface providing real-time access to analytics, predictions, and optimization recommendations for operational decision-making.

Rich Dataset Foundation

Our analysis utilizes the comprehensive Montgomery County, PA 911 Emergency Calls dataset, providing a robust foundation for pattern recognition and predictive modeling.

Key Data Elements

- Precise timestamps for temporal analysis
- Geographic coordinates for spatial modeling
- Emergency classification types
- Detailed location information including townships and addresses

This rich dataset enables sophisticated analysis of demand patterns across multiple dimensions, supporting accurate predictions and optimization strategies.

Comprehensive Dashboard Experience

01

Overview & Statistics

General project information with comprehensive dataset statistics and key performance indicators for emergency services operations.

02

Historical Pattern Analysis

Rich visualizations revealing historical emergency call trends, seasonal patterns, and demand fluctuations across different time periods.

03

Geographic Heatmap

Interactive mapping showing geographic distribution of emergency calls with drill-down capabilities for detailed location analysis.

04

Predictive Analytics

Advanced forecasting tools for emergency type prediction and call volume estimation to support strategic planning decisions.

05

Real-time Simulation

Dynamic simulation environment for testing resource allocation scenarios and optimizing emergency response strategies.

Future Enhancement Roadmap

Real-time Traffic Integration

Incorporate live traffic data for more precise response time estimation and dynamic route optimization.

Enhanced ML Models

Deploy deep learning algorithms for superior prediction accuracy and automated pattern recognition capabilities.

Mobile Field Application

Develop responsive mobile interface for field responders with real-time updates and communication features.

Hospital Capacity Integration

Connect with hospital systems for optimal patient routing and comprehensive resource management coordination.

Thank You