FORECASTING HOSPITAL ADMISSIONS USING MATLAB TIME SERIES ANALYSIS

1. Overview

Client:

A regional public hospital network in the United Kingdom managing five general hospitals and two emergency units

Objective:

To develop a predictive model for weekly hospital admissions to support staff scheduling and resource allocation, especially during seasonal spikes.

2. Background

The client maintained three years of historical data on weekly admissions. Although basic trend charts existed, there was no statistical model in place for forecasting. The hospital administrators wanted to pre-empt bed shortages and overloads, especially during winter months and flu season.

3. Data Summary

Dataset:

Weekly admission data from Jan 2020 to Dec 2022 (156 weeks)

Key Variables:

Variable	Type	Description
Week_Number	Integer	Sequential week ID
Admission_Count	Integer	Total weekly inpatient admissions
Hospital_ID	Categorical	H1 to H7
Flu_Alert_Level	Ordinal	Low, Medium, High (external NHS feed)
Avg_Temperature	Continuous	Weekly mean °C from Met Office
Holiday_Week	Binary	1 = Major holiday week, 0 = Otherwise

4. Methodology

Software Used:

MATLAB R2023b with Econometrics Toolbox

Workflow:

1. **Data Aggregation & Cleaning:**
    - Grouped data using groupsummary() by week across hospitals
    - Missing weather data filled using linear interpolation
    - Created time series object with timeseries() and datetime() formatting
2. **Exploratory Analysis:**
    - Used plot() and seasonplot() to detect seasonal peaks
    - Applied movmean() and detrend() to assess long-term and short-term trends
3. **Forecasting Model Development:**
    - Evaluated ACF and PACF plots using autocorr() and parcorr()
    - Built and tuned **Seasonal ARIMA (SARIMA)** model with estimate()
    - Included exogenous variables: temperature and flu alert level
4. **Model Evaluation:**
    - Used 80% data for training, 20% for testing
    - Measured forecast accuracy using RMSE, MAPE, and out-of-sample prediction plots

5. Key Results

Metric	**Value**
RMSE (Test Set)	32.5 admissions
Mean Absolute Percentage Error (MAPE)	8.3%
Forecast Horizon	6 weeks ahead
Best-Fit Model	SARIMA(1,1,1)(1,0,1)[52]
Forecast Accuracy	92% (within CI bounds)

High-Demand Period Identified:

- Weeks 49–2 consistently showed peak admissions
- Coincided with colder temperatures and ‘High’ flu alert levels

6. Visual Outputs (MATLAB):

- Weekly admissions time series plot with forecast overlay
- ACF/PACF diagnostics
- Seasonal decomposition: trend, seasonal, and residual
- 6-week forecast with prediction intervals using forecast()

7. Deliverables

- .m scripts for time series preprocessing, modeling, and visualization
- Forecast model saved as .mat for reuse
- Final analytical report (13 pages):
    - Model assumptions and diagnostics
    - Forecast summary and confidence intervals
    - Visual charts and heatmaps
- Slide brief (3 slides):
    - Predicted weekly demand
    - Recommendations for staff planning
    - Visuals to communicate forecasting reliability

8. Application & Outcome

- Hospital scheduling system integrated the forecast model for winter surge planning
- Beds and staff allocation adjusted for predicted spikes
- Reduced emergency overflow events by 19% in Q1 2023
- Enabled early warning alerts for flu-induced demand surges

9. Strategic Value Delivered

- Provided **reliable admission forecasts with seasonal insight**
- Enabled **data-driven hospital operations**
- Delivered **reusable and scalable MATLAB scripts** for continued forecasting
- Reduced guesswork in staff allocation and emergency preparedness