Admissions Discharges Transfers (ADT Modelling)

# Introduction:

ADT (Admission, Discharge, and Transfer) modeling is a fundamental aspect of healthcare analytics, focusing on optimizing patient flow and hospital operations through the critical stages of patient care. It encapsulates the entire patient journey within a healthcare facility, from admission, which marks the initiation of hospital care, through to discharge, indicating the conclusion of a patient's current care episode, and includes any intra-hospital transfers, reflecting the movement of patients between different care units or departments as their treatment needs evolve. Effective ADT modeling leverages data analytics to predict patient loads, streamline bed management, enhance the quality of care, and improve operational efficiency. By meticulously analyzing patterns and trends within these core processes, healthcare providers can forecast demand, allocate resources more efficiently, and ultimately enhance patient outcomes, making ADT modeling a cornerstone of effective healthcare management and planning.

# Dataset Overview:

* **Setup and Parameters:**
  + Defines options for mode of arrival, disposition, and gender.
  + Calculates a scaling factor to adjust the dataset size to a desired total count.
* **Data Generation:**
  + Introduces yearly percentage increases and linear trend factors to simulate growth in admissions over time.
  + Models seasonal fluctuations using a sinusoidal function.
  + Accounts for leap years and simulates internal patient transfers within the hospital system.
* **DataFrame Creation and Analysis:**
  + Assembles the generated data into a Pandas DataFrame with relevant columns.
  + Exports the dataset to a CSV file for further analysis.
  + Converts 'Admission Date' to datetime format and extracts the year for trend analysis.
  + Calculates the percentage increase in yearly admissions, providing insights into trends over time.
* **Key Features and Insights:**
  + Dynamically generates data with realistic variability and complexity for healthcare context.
  + Models trends and seasonality, simulating real-world scenarios like seasonal diseases and population growth.
  + Prepares the dataset for analysis, with properly formatted columns and aggregated data for trend analysis.
  + Provides a foundation for forecasting models and capacity planning studies in healthcare facilities.

# Exploratory Data Analysis (EDA):

different exploratory data analyses (EDAs) performed:

1. **Yearly Admissions Analysis**:
   * Grouping the data by year and counting admissions to understand yearly admission trends.
   * Calculating the percentage increase in yearly admissions to identify growth or decline trends over time.
2. **Trend Analysis**:
   * Incorporating a linear trend factor and percentage increases to simulate growth in admissions over time.
   * Modeling seasonal fluctuations using a sinusoidal function, reflecting typical seasonal variations in hospital admissions.
3. **Seasonal Variation Analysis**:
   * Introducing seasonality through the sinusoidal function to capture variations in admissions across different months of the year.
4. **Transfer Patient Analysis**:
   * Calculating and distributing a subset of patients as transfers within the hospital system.
   * Analyzing the distribution of transfer patients across different months to understand internal patient movements.

# Time Series Analysis:

1. **Trend Analysis**:
   * Introduces a linear trend factor to simulate growth in admissions over time.
   * Adjusts the linear trend factor each year to reflect changes in admission patterns.
2. **Seasonal Variation Analysis**:
   * Models seasonal fluctuations using a sinusoidal function, capturing variations in admissions across different months of the year.
   * Incorporates seasonality to simulate real-world scenarios where hospital admissions may vary due to factors like seasonal diseases or population dynamics.
3. **Autocorrelation Analysis**:
   * Computes autocorrelation and partial autocorrelation functions to identify any autocorrelation in the time series data.
   * Helps in understanding the dependency of current admissions on past admissions, which is crucial for selecting appropriate forecasting models.
4. **ARIMA Modeling**:
   * Utilizes the ARIMA (AutoRegressive Integrated Moving Average) model for forecasting future patient admissions.
   * Fits the ARIMA model to the time series data, possibly testing different configurations or parameters to find the best fit.

# Models & Evaluation Metrics:

1. Admissions Forecast:
   1. ARIMA Model (order: 0,2,2):

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1. Discharge Forecast:
   1. SARIMAX (order: 2,2,1; 3,3,3,12)

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1. Transfer Forecast:
   1. SARIMAX (order: 2,2,2; 2,2,2,12)

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## Pickle Files:

Finally, we serialized the trained ARIMA and SARIMAX models into PKL files, enabling seamless integration into other Python scripts or applications for making predictions on new admission data.

# Automated Insights Generation:

It automates the process of extracting insights from forecasted hospital admission data, saving time and effort for hospital administrators who would otherwise need to manually analyze the data.