**Project Proposal**

**Topic: Patient Flow Model for Hospital Admission Analysis**

**Chapter 1:**

**1.1: Project Overview**

The issue of hospital overcrowding has been a recurring issue, leading to long waiting hours and delayed admissions to intensive care wards. This has been identified as a major challenge facing hospitals globally [1]. Overcrowding occurs when the healthcare is forced to operate beyond its capacity due to a shortage of medical staff and an excessive number of patients seeking medical treatment [2]. Hospital overcrowding is primarily caused by factors such as unnecessary patient visits, lack of inpatient beds, and prolonged waiting times for available beds in wards. Research indicates that unnecessary visits often stem from inadequate standard procedures, while a shortage of inpatient beds exacerbates delays in emergency departments (EDs) and contributes to increased mortality rates among vulnerable populations, such as chronic kidney disease patients [3]. To mitigate these effects, healthcare systems can implement several strategies. Enhancing bed management and fostering departments can streamline patient flow and reduce boarding times [4]. Additionally, optimizing staffing levels in outpatient departments and employing queuing models to manage patient arrivals can significantly decrease wait times and improve overall operational effectiveness [3]. These measures can help alleviate overcrowding and enhance patient care quality.

Patient flow plays a critical role in hospital overcrowding, as inefficient management of patient movement can lead to significant delays and negative outcomes. Research indicates that effective patient flow management, including the use of artificial intelligence (AI) tools, can enhance the forecasting and monitoring of patient admissions, transfers, and discharges, thereby alleviating overcrowding in hospitals [5]. For instance, the implementation of discharge lounges has been shown to improve patient flow by increasing discharge rates and reducing turnaround times, which directly correlates with decreased overcrowding [6]. Additionally, systematic reviews highlight that managing patient flows across various hospital departments is essential, as disruptions in one area can impact the entire system. Factors such as prolonged waiting times and inadequate staffing in emergency departments exacerbate overcrowding, underscoring the need for targeted interventions to streamline patient flow [7]. Overall, optimizing patient flow is vital for improving hospital efficiency and patient care quality. The emerging technique of Artificial Intelligence (AI) has made it possible to manage overcrowding in emergency departments hence getting more attention in community.

This project proposes k-Nearest Neighbor (KNN) model of Machine Learning to be employed and trained using hospital admission data encompassing attributes such as diagnosis, consultancy episodes, number of admission and demography. The model will identify patterns and trends to predict which diagnosis requires the patient to have longer hospital stays or readmissions to help stakeholders to prioritize resource allocation accordingly. Apart from that, this project also emphasizes on data visualization as it is essential for understanding and addressing the relationship between diagnosis and overcrowding in hospitals. It can help identify patterns, bottlenecks, and trends in the data, offering actionable insights for improving patient throughput and resource management. Data visualization using Python with libraries such as Matplotlib, Seaborn, and Plotly is a powerful approach to transforming raw data into meaningful insights through graphical representation.

**1.2 Problem Statement**

1. Insufficient Understanding of Diagnosis-Specific Flow Patterns: The absence of data visualized of how specific diagnoses contribute to patient flow dynamics creates challenges in identifying which medical conditions are most closely associated with overcrowding at different times.
2. Difficulty in Integrating Historical Data for Predictions: Hospitals face challenges in integrating historical patient diagnosis data to create accurate prediction models, limiting their ability to anticipate and mitigate future overcrowding effectively.
3. Lack of Explainability in Prediction Models: Stakeholders struggle with interpreting and understanding the predictive models used for anticipating overcrowding. The absence of explainability makes it difficult for healthcare professionals to trust and act upon the predictions, which limits the effectiveness of these models in decision-making and patient flow management.

**1.3 Objectives**

1. To conduct data visualization of diagnosis-specific flow patterns in order to identify which medical conditions are most closely associated with overcrowding during different times. This will aid in targeted resource allocation and improve patient flow management.
2. To develop robust methods for integrating historical patient diagnosis data into predictive models, enhancing the hospital's ability to accurately forecast diagnosed patient influx and manage future overcrowding proactively.
3. To improve the explainability of predictive models used for forecasting patient flow and overcrowding, ensuring that healthcare professionals can trust and comprehend the outputs, leading to better-informed decisions and improved management of hospital resources.

**1.4 Methodology**

Python’s extensive set of libraries enables users to craft a wide variety of visual representations that can help uncover insights and communicate data patterns effectively. Some of the libraries for data visualization in Python will be used including Matplotlib, Seaborn, Plotly, and Bokeh.

KNN will be used to predict periods of overcrowding by looking at the diagnosis flow. If similar patterns in diagnoses (such as an influx of certain conditions) have previously led to overcrowding, the model could be used to flag potential future overcrowding when these patterns emerge again.

LIME (Local Interpretable Model — Agnostic Explanations) LIME can be adapted for time series data by generating explanations for specific predictions. For instance, it can help explain why the ARIMA model predicts a price spike at a particular time by approximating the model’s behavior locally around that prediction.

**1.5 Literature Review**

1) Data Visualization

รูปภาพประกอบด้วย ข้อความ, ภาพหน้าจอ, พล็อต, แผนภาพ

คำอธิบายที่สร้างโดยอัตโนมัติThis visualization illustrates the top 10 diseases with the highest number of patients based on hospital admissions data. The X-axis represents the disease codes, while the Y-axis shows the total number of patients diagnosed with each disease.

Fig. 1 Top10 diagnoses by Total number of patients.

Figure 1. To see the top ten diagnoses with the largest number of cases. J18 has a significantly higher hit rate than any other.

Figure3. illustrates the number of patients by age group. By choosing to show only pneumonia, which is the most common disease. The X-axis represents the number of patients, and the Y-axis shows the age range.

2) ML techniques to manage overcrowding

Predictive Modeling

Classification

Clustering

3) Explainable AI

LIME

SHAP

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