The Open University of Sri Lanka
இலங்கை திறந்த பல்கலைக்கழகம்
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THE OPEN UNIVERSITY OF SRI LANKA
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
BACHELOR OF SOFTWARE ENGINEERING

EEX5362 – Performance Modeling

Deliverable 01 – Mini Project

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1. High-Level Problem Description

Hospitals in Sri Lanka often face difficulties in managing patient flow, especially during busy hours in the Outpatient Department (OPD). Many patients have to wait a long time to meet a doctor, do tests, or get follow-up care. This causes frustration among patients, extra pressure on doctors and nurses, and poor use of hospital resources.

The Smart Queue Management System (SQMS) helps to organize and control patient movement in the OPD. It keeps track of when patients arrive, which doctors are available, and how long each service takes. By using real-time data, the system can find delays and balance the workload among doctors.

Stakeholders:

- **Patients:** Expect shorter waiting times and clear updates about their place in the queue.
- **Doctors and Nurses:** Experience better workload balance and reduced stress.
- **Hospital Administrators:** Get useful information about performance, waiting times, and staff utilization.
- **System Engineers / Developers:** Build, monitor, and improve the system's performance.

By studying and analyzing hospital data, the SQMS aims to reduce waiting time, increase patient throughput, and make sure doctors' time is used effectively — helping the hospital run more smoothly.

2. Dataset Description

The dataset represents a synthetic one-week record of hospital outpatient operations. Each entry corresponds to a single patient visit, including timestamps for registration, consultation, and tests.

Fields Included:

Field	Description
patient_id	Unique identifier for each patient
arrival_time	Time the patient arrives at the hospital
registration_time_seconds	Time taken for registration (in seconds)
doctor_assigned	Assigned doctor ID
consultation_start	Actual start time of consultation
consultation_duration_seconds	Duration of consultation (in seconds)
test_required	Boolean (1 if test required, 0 otherwise)
test_duration_seconds	Duration of diagnostic test (if applicable)
total_wait_seconds	Total waiting time (arrival → end of services)
doctor_schedule	Doctor's available working hours

How the dataset was generated:

- The dataset was synthetically generated using a Python script (generate_hospital_data.py).
- It simulates 1000 patient records over a 7-day period.
- Doctors D1–D4 were randomly assigned to patients.
- Consultation and test durations follow realistic time ranges (5–30 minutes).
- 25% of patients were assigned additional diagnostic tests.

3. Performance Objectives

The main aim of this study is to understand how well the hospital queue system performs and find ways to improve it. The focus is to reduce waiting times, improve doctor usage, and identify any process delays.

Objectives:

1. **Reduce average waiting time**
    - Goal: Make sure patients don't wait too long before seeing a doctor or doing tests.
    - **Performance Metric:** Average waiting time (in minutes)
    - **Target:** 20 minutes or less
2. **Use doctors' time effectively**
    - Goal: Keep doctors busy but not overloaded, to improve service quality.
    - **Performance Metric:** Doctor utilization rate (%)
    - **Target:** 80% or higher
3. **Increase patient throughput**
    - Goal: Serve more patients in a day by managing time and resources better.
    - **Performance Metric:** Patients served per hour
    - **Target:** At least 8 patients per hour
4. **Maintain balanced queues**
    - Goal: Avoid some doctors being overloaded while others are idle.
    - **Performance Metric:** Queue length variance
    - **Target:** Not more than 10% difference between doctors' queues
5. **Find performance bottlenecks**

- Goal: Identify which stages (registration, consultation, or testing) cause the most delay.
- **Performance Metric:** Stage delay ratio
- **Target:** Less than 0.3

4. Tools and Techniques

This section explains what technologies, software, and methods you used to create or analyze your system.
It shows how you built or evaluated the system.

Tools Used:

- **Python 3** – for generating synthetic dataset and analysis
- **Pandas, NumPy** – for data handling and performance calculation
- **Matplotlib / Seaborn** – for creating performance graphs
- **Excel** – for viewing and validating data
- **GitHub** – for version control and project repository
- **Jupyter Notebook / VS Code** – for running analysis scripts

Techniques Used:

- Data simulation using random time generation
- Queue modeling and performance measurement
- Descriptive analysis (average waiting time, utilization rate)
- Bottleneck identification and optimization techniques

5. Expected Outcome

This section explains **what results or benefits** you expect after analyzing or implementing the system.
It shows **why** your system is valuable.

Example:

- The system will help identify **bottlenecks** in hospital queues.
- Expected **reduction in average waiting time** for patients.
- **Better utilization** of doctors and other staff.
- **Higher patient satisfaction** due to reduced delays.
- Useful **reports and charts** for hospital management to plan resources.
- A **reliable dataset** that can be used for further performance testing or simulation.