**Makerere University**

# Design of a machine learning based system for pharmaceutical purchases

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A Report submitted in partial fulfillment of the requirements for the
**Degree of Bachelor of Science in Telecommunications Engineering**
at Makerere University.

# Declaration

Add your declaration here.

# Dedication

I dedicate this to my parents who have been there for me in this entire study period both emotionally and financially .

# Acknowledgments

Add acknowledgments.

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Abstract

Using a univariate time series analysis, we were able to validate different methods and approaches related to time series data preparation, analysis and forecast with an aim to facilitate recommending sales and marketing strategies based on trend/seasonality effects and forecasting sales of top five selling pharmaceutical products with diverse characteristics, such as stationarity, seasonality, amount of residuals and sales data variance. These drugs are Amoxicillin caps, Ampicloxa, Ceftriaxone Inj, Ciprofloxacin, Cotrimoxazole. ......

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# List of Abbreviations

| | |
|---|---|
| ARIMA | Auto Regression Integrated Moving Average |
| LSTM | Long Short Term Memory |

# Chapter 1

# Introduction

## 1.1 Background

One of the responsibilities of pharmacies in Uganda is being required to have a minimum stock of medicines to ensure the patients can have it when prescribed.

In addition to this, pharmacies need to get a good forecast of the medication needs due to the short term validity of many medicines and the need to control stock levels in order to avoid excessive costs and loss of customers due to stock outages.

A good sales forecast is usually associated with striking a balance between stock costs and adequate satisfaction of customer demand.To specific case of pharmacies in Uganda, the problem is of particular importance due to the short cycle life of many products and the importance of quality which is in turn strongly linked to public health.

People act on the basis of forecasting models whether they are on paper or in their heads. You are better off quantifying these estimations so you can discuss them rationally as opposed to making them based on intuition. For pharmaceutical distribution companies, it is essential to get good estimates of drugs due to the short shelf life of many medicines, the need to control stock levels and to avoid excessive inventory costs while guaranteeing customer demand satisfaction.This decreases the possibility of loss of customers due to stock outages.

Before digital technology dominated the world, the forecasting process was done manually by experienced individuals in the domain. This intuition required a lot of experience and was prone to error. Such a multifaceted problem started to realize the need for automating the pharmacy sales forecasting process. Research has been carried out with statistical, machine learning, deep learning and ensemble techniques to achieve more accurate sales forecasts. [1]

## 1.2 Aims and Objectives

The main aim of the research project was to precisely predict sales of drugs and medical supplies.

The specific objectives were:

- To collect datasets of previous sales and purchases from Soteria Pharmacy.
- To train and validate datasets with ARIMA and LSTM models.
- To optimize the best model algorithm for accurate performance.

## 1.3 Contributions of the Project

The following major contributions have been accomplished during the course of this research:

1. Developed a robust neural network model that could accurately predict future sales for a period of 50 days using a 2 year period worth of sales and purchases information.
2. Performed a data cleaning task, analysis and training with the various Machine learning models and came up with a graphical output.
3. Proposed a multivariate input approach with other characteristics such as precipitational weather information and promotional sales.

## 1.4 Organization of the Report

This report has 3 chapters.

- Introduction
- Analysis and Findings
- Conclusion

# Chapter 2

# Heading of Chapter 2

## 2.1 Introduction

## 2.2 ....

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## 2.3 Summary

# Chapter 3

# Add another Chapter

## 3.1 Introduction

## 3.2 Mathematical Preliminaries

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# Chapter 4

# Numerical Results

Table 4.1: Simulation Parameters

| Parameters | Values |
|---|---|
| Network size | $A = 5\,\mathrm{km} \times 5\,\mathrm{km}$ |
| Total BS bandwidth | $\mathcal{B} = 20\,\mathrm{MHz}$ |
| BS and user densities | $\lambda_b = 1.6 \times 10^{-5}\ \mathrm{m}^2$, $\lambda_u = 2\lambda_b$ |
| Transmit power | $P_t = 21\,\mathrm{dBm}$ |
| Pathloss parameters | $L = -33\,\mathrm{dB}$, $\alpha = 4$ |
| Power parameters | $\mathcal{N}_b = 2$, $P_0 = 6.8\,\mathrm{W}$, $\Delta = 4$, $P_{sl} = 4.3$ |
| Additive noise parameters | $F = 10$, $T_a = 300\,\mathrm{K}$ |

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# Chapter 5

# Conclusions and Future Works

## 5.1 Conclusions

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## 5.2 Ideas for Future Work

# References

[1] M. Jayasinghe S. H. Perera, N. Jihan and Srinath. Sales forecasting using multivariate long short term memory network models. *PeerJ PrePrints*, 7:e27712, 2019.

# Appendix A

# Appendix

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