SHORT-TERM MOBILE DATA TRAFFIC FORECASTING: A CASE STUDY OF KADUNA STATE, NIGERIA

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF ENGINEERING (M.Eng) DEGREE IN INFORMATION AND COMMUNICATION ENGINEERING, IN THE DEPARTMENT OF ELECTRICAL AND INFORMATION ENGINEERING, COLLEGE OF ENGINEERING, COVENANT UNIVERSITY

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ACCEPTANCE

This is to attest that this dissertation was accepted in partial fulfillment of the requirements for the awards of the degree of Masters of Engineering in Information and Communication Engineering, Department of Electrical and Information Engineering, College of Engineering, Covenant University Ota, Nigeria.

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DECLARATION

I, **Paul, Joan Ezra (19PCK01988)**, declare that this research was carried out by me under the supervision of Dr. Adeyinka A. Adewale of the Department of Electrical and Information Engineering, College of Engineering, Covenant University, Ota, Nigeria. I attest that the dissertation has not been presented either wholly or partially for the award of any degree elsewhere. All sources of data and scholarly information used in this dissertation are duly acknowledged.

PAUL, JOAN EZRA

Signature and Date

CERTIFICATION

We certify that this dissertation titled "**A SHORT-TERM MOBILE DATA TRAFFIC FORECASTING: A CASE STUDY OF KADUNA STATE, NIGERIA**" is an original research work carried out by **PAUL, JOAN EZRA (19PCK01988)** in the department of Electrical and Information Engineering, College of Engineering, Covenant University, Ota, Ogun State, Nigeria under the supervision of Dr. Adeyinka A. Adewale. We have examined and found this work acceptable as part of the requirements for the award of Master of Information and Communication Engineering.

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DEDICATION

I dedicate this work to God Almighty and the Ezra's family

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ABBREVIATIONS

M2M- Machine-to-Machine

VNI-Visual Networking Index

ANN-Artificial Neutral Network

LTE-Long Term Evolution

BS-Base Station

MS-Mobile Station

MLP-Multilayer Preceptor

MLPWD-Multilayer perceptron with weight delay

SVM-Support Vector Machine

SRM-Structure Risk Minimization

ARIMA-Autoregression Integrated Moving Average

FARIMA-Fractional Autoregression Integrated Moving Average

LSTM-Long-Short Term Memory

AGB-Accelerated Gradient Boost

GB- Gradient Boost

ConvoLSTM- Convolution Long-Short Term Memory

RNN-Recurrent Neural Network

EOM-Equipment out of Maintenance

EOS- Equipment out of Service

DL-Downlink

UL-Uplink

PS-Packet Switch

CS-Circuit Switch

AIC-Akaike Information Criteria

BIC-Bayesian Information Criteria

SGD-Stochastic Gradient Descent

HSUPA-High-Speed Uplink Packet Access

HSDPA- High-Speed Downlink Packet Access

AMPS-Advance Mobile Phone Service

GSM-Global System for Mobile Communication

FDM-Frequency Division multiplexing

FDMA-Frequency Division Multiple Access

TDMA-Time Division Multiple Access

CDMA-Code Division Multiple Access

SDMA-Space Division Multiple Access

OFDMA-Orthogonal Division Multiple Access

BDMA-Beam Division Multiple Access

MMS-Multimedia Message

GPRS-Global Packet Radio Access

EDGE-Enhance Data for Global Evolution

ITU-International Communication Union

IMT-International Mobile Communication

PSK-Phase-Shift Key

WCDMA-Wideband Code Division Multiple Access

MIMO-Multiple Input-Multiple output

FBMC-Filter Bank Multi-Carrier

CP-OFDM- Cyclic Prefix- Orthogonal Frequency Division Multiplexing

DFT-OFDM-Direct Fourier Transform Spread OFDM

NR-New Radio

GMSK-Gaussian Modulation Shift Keying

SINR-Signal Interference for Noise Ratio

E-UTRAN-Evolved-Universal Terrestrial Radio Access Network

MME-Mobility Management Entity

SGW-Serving Gateway

PGW (PDGW)-Packet Data Network Gateway

EPC-Evolved Packet Core

RAN- Radio Access Network

HSS-Home Subscriber Server

PCEF-Policy Control Enforcement Function

PCRF- Policy Control Regulation Function

EnB- Evolved NodeB

UE-User Equipment

KPI-Key Performance Indicator

QoS-Quality of Service

MAPE-Mean Absolute Percentage Error

RMSE-Root Mean Square Error

MAE-Mean Absolute Error

FDD-Frequency Division Duplex

TDD-Time Division Duplex

LoS-Line of Sight

DL-Downlink

UL-Uplink

TUL-Total Downlink

TDL-Total Uplink

NMT- Nordic Mobile Telephone

NOMA-Non- Orthogonal Division Multiplexing

ABSTRACT

Mobile networks are essential for today's seamless communication. As more individuals subscribe to mobile networks, the need for mobile networks has increased significantly. The network operators must devise strategies to handle the enormous demand of mobile network resources, such as spectrum, which are costly. There is a need for effective network resource management as well as a mechanism to predict future networks that can be used for network management and planning. This study uses real-life data to forecast mobile traffic using Kaduna State as a case study and compared prediction algorithms with the hybrid. The data set was gotten from a network provider. The hybrid combination of LSTM and AGB has been proposed in this study, and its performance has been compared with LSTM and ARIMA using MAE, RMSE and MAPE as evaluation metrics. The prediction performance of the algorithms was carried out on ten base stations with both the highest and lowest traffic from two local government areas, which are Kaduna South and Kaduna North. The LSTM-AGB outperformed LSTM and ARIMA. From the performance evaluation, the RMSE, MAPE and MAE of all the selected base stations in LSTM-AGB have a lower value than LSTM and ARIMA, which indicates a good fit of the model. It was observed that the hybrid algorithm performed better in base stations with high traffic.

Keywords: Mobile traffic, Long-Short Term Memory, Traffic forecasting, Cellular Network.