Design of A Machine Learning Based System for Pharmaceutical Purchases

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Using a univariate time series analysis, we 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.All these analyses and forecasts are made on a small scale, for an individual pharmacy located in Luweero District-Uganda.

Introduction

One of the responsibilities of pharmacies in Uganda is to have a minimum stock of medicines.This ensures 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.This avoids 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.

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.

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.

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]

During our research study of Soteria Pharmacy procurement process with an interview of Ms.Brenda the incharge of this, we realised she uses personal judgement of current stock levels athand and the rate at which people come in to ask for a ceratin drug then determine how much more stock should be purchased.Given her difficulties in accurately predicting the future sales,this report explores the product sales forecast at the indiviual level of this Pharmacy.I made a forecast for 5 sold drugs.The forecast was based on analysis of historical data for a period of 24 months and future results analyses of 50 days determined.ARIMA and LSTM methods were used in the sales forecast of which the best model was recommended including a conclusive way of improving our results.

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$$A = \pi r^2. \tag{1}$$

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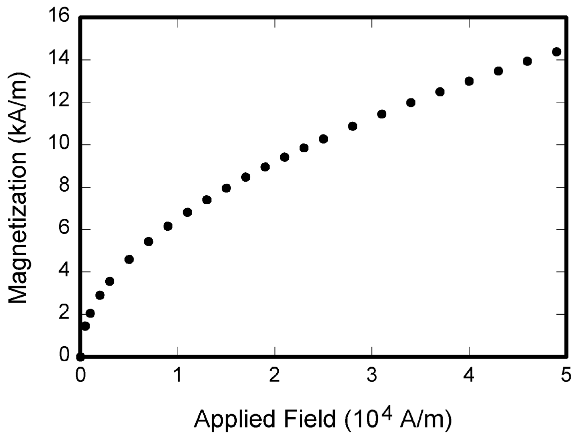

Figure 1 Note that "Figure" is spelled out. There is no period after the figure number, followed by one space. It is good practice to briefly explain the significance of the figure in the caption. (Used, with permission, from [4].)

Table 1 Units for Magnetic Properties

Symbol	Quantity	Conversion from Gaussian and CGS EMU to SI[a]
Φ	Magnetic flux	1 Mx $\rightarrow 10^{-8}$ Wb $= 10^{-8}$ V $\cdot$ s
B	Magnetic flux density, magnetic induction	1 G $\rightarrow 10^{-4}$ T $= 10^{-4}$ Wb/m^2
H	Magnetic field strength	1 Oe $\rightarrow 10^{-3}/(4\pi)$ A/m
m	Magnetic moment	1 erg/G = 1 emu $\rightarrow 10^{-3}$ A $\cdot$ m$^2 = 10^{-3}$ J/T
M	Magnetization	1 erg/(G $\cdot$ cm^3) = 1 emu/cm$^3 \rightarrow 10^{-3}$ A/m
$4\pi M$	Magnetization	1 G $\rightarrow 10^{-3}/(4\pi)$ A/m
σ	Specific magnetization	1 erg/(G $\cdot$ g) = 1 emu/g $\rightarrow$ 1 A $\cdot$ m^2/kg
j	Magnetic dipole moment	1 erg/G = 1 emu $\rightarrow 4\pi \times 10^{-10}$ Wb $\cdot$ m
J	Magnetic polarization	1 erg/(G $\cdot$ cm^3) = 1 emu/cm$^3 \rightarrow 4\pi \times 10^{-4}$ T
χ, κ	Susceptibility	$1 \rightarrow 4\pi$
χ_ρ	Mass susceptibility	1 cm^3/g $\rightarrow 4\pi \times 10^{-3}$ m^3/kg
μ	Permeability	$1 \rightarrow 4\pi \times 10^{-7}$ H/m $= 4\pi \times 10^{-7}$ Wb/(A $\cdot$ m)
μ_r	Relative permeability	$\mu \rightarrow \mu_r$
w, W	Energy density	1 erg/cm$^3 \rightarrow 10^{-1}$ J/m^3
N, D	Demagnetizing factor	$1 \rightarrow 1/(4\pi)$

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[a]Gaussian units are the same as cg emu for magnetostatics; Mx = maxwell, G = gauss, Oe = oersted; Wb = weber, V = volt, s = second, T = tesla, m = meter, A = ampere, J = joule, kg = kilogram, H = henry.

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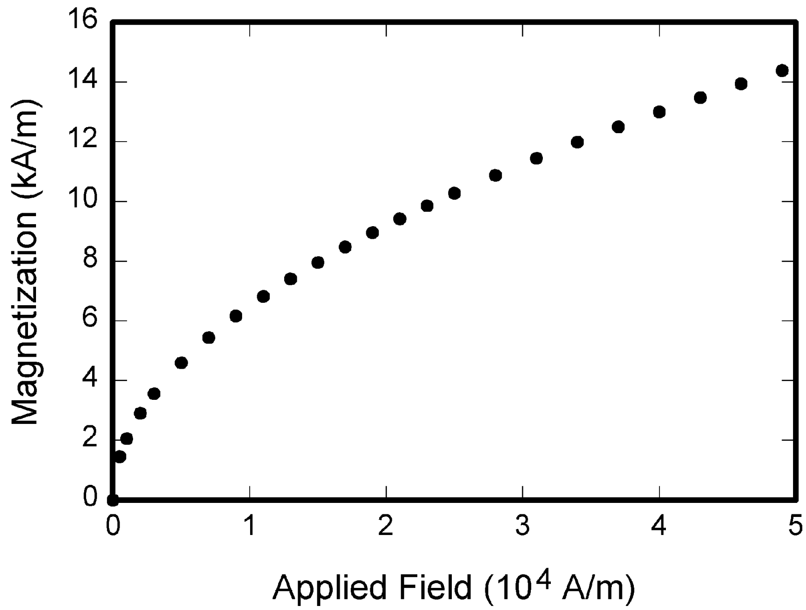

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Acknowledgment

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