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PREDICTIVE AND PRESCRIPTIVE STATISTICAL MODELS FOR INVENTORY MANAGEMENT IN HEALTH CARE

[1]Nilambari A. Jagtap, [2]Tushar D. Kshirsagar, [3]Hrishikesh A. Gujar, [4]Nikhil S. Bhoite

Assistant Professor, Student, Student, Student.

Department of Statistics,

Tuljaram Chaturchand College of Arts, Commerce and Science Baramati, Pune, Maharashtra, India,

Abstract

In this research we have proposed an innovative machine learning model to predict recovery time of patient using predictive and prescriptive analysis. Recently, the healthcare industry has started using inventory management applications to achieve efficiency and effectiveness in its supply chains. There is a rapid growth in the demand of drugs and diagnostic systems within the healthcare industry. The biggest challenge for health care supply chains is to manage inventory efficiently and keep up the satisfactoryservice level at the same time. Our objective of this study is to build a system to manage the inventories in hospital wards using Predictive and Prescriptive Analysis with the help of various machine learning techniques and to conclude which techniques are effective and accurate. A secondary data is collected from four different hospitals named Chaitanya Hospital Baramati, Shripal Hospital Baramati, Bhagat Hospital Baramati, Bhagyajay Hospital Baramati. Modern Machine learning algorithms such as Random Forest, Gradient boosting, Ada boosting, KNN classifier, Decision Tree etc. are used to classify this dataset. The accuracy of the model is calculated and then the one with good accuracy is taken as the model for predicting recovery time. The model we propose makes use of machine learning by taking into consideration both historical usage patterns of the ward's current situation to minimize inventory levels as well as the necessity for emergency.

Index term- Prescriptive Model, Machine learning, Beta Blockers, Abdominal Disease, Random Forest, Decision Tree.

I - Introduction

The Inventory Management System in hospital wards is a process in which, it has a real-time status of all the available beds and the bed occupied, to plan for the efficient use of beds, medicines and medical equipment's. It helps the hospital staff and management by reducing the time of counting and recording the availability of beds. Healthcare inventory management is incredibly important in Hospital wards. Inventory management systems can help hospitals and other medical organizations streamline their processes to save time while providing quality care to patients. After an accident, inconvenient waiting hours in hospital waiting halls due to improper operational capacity planning and control over managing, allotting, and maintaining beds may turn frustrating when emergency care is required. The lack of real-time data analysis provides a disadvantage resulting in patient overcrowding and malefactions in inpatient bed management services during emergencies. Monitoring and managing inpatient-outpatient capacity & patient inflows can be challenging tasks during emergencies. Unplanned inventory, the inability to beds, and other scarce resources may lead to poor operations, and that affects the hospital's goodwill.

Predictive Analysis refers to the use of different statistics and machine learning techniques to make predictions about future events taking present and future data patterns into consideration. Prescriptive Analysis is a process that what actions we have to take to achieve the predicted results, and suggests actions and possible results so we can easily achieve the predicted results. The availability of huge amounts of data is creating new opportunities for decision making under uncertainty, and the renewed attention towards machine learning provides new tools that can be used to generate predictions of quantities that may be of interest for inventory management. In this research we deal with the situation of beds, medical equipment's and medicinal inventories inside a hospital ward.

The main purpose of this study is to explore the different machine learning techniques that will help with the managing the inventories in hospitals. The current study focuses on patients records with their medical history collected from different hospitals. Record contains which type of disease patient diagnosed with, and which kind of treatment was given to them. The record also contains the date of admission and discharge of patient and from that we concluded the recovery time of patient. Our main objective in this study is to propose an efficient model for predicting how much time a patient might requires to recover which helps in managing the inventories in hospital wards. And to correctly predict the output model needs to take some important actions using prescriptive analysis.

II - Methodology:

2.1 Data collection

In this research our interest is to predict recovery time of patients, by taking into consideration their Age, Gender, Medical History, and Diagnosis etc. So, for data collection purpose we have collected data from different hospitals. We collected the data of 2066 patients from Chaitanya Hospital Baramati, Shripal Hospital Baramati, Bhagat Hospital Baramati, Bhagyajay Hospital Baramati, located in Baramati city. Inthis research we have used predictive and prescriptive Analysis for effective management of inventories in hospitals. We have used various machine learning techniques and selected one of best among them with greater accuracy and best precision and applied Input Method on that selected model.

2.2 Data preprocessing

The raw data collected from different hospitals contains some of the columns in categorical format on which machine learning models can't be applied, so we encoded these columns to build machine learning model.

2.3 Type of Disease: In this data there are total of 10 different types of disease. Epidemic Disease, Bacterial Inf ection, Kidney Disease, Neurological Disorder, Long Term Disease, Communicable Disease, Respiratory Disease, Abdominal Disease, Heart Disease, Viral Disease.

2.4 Type of Medicine: These data consist total of 41 various types of Medicines. Antibiotic, Anti-inflammatory , Proton Pump Inhibitor, Antispasmodic, Acid reflux, Antacid, Antiemetic, Anxiolytic, Pain Reliever, Antiba cterial, Drop, Syrup, Antiphrastic, Liquid, Nutritional Supplements, Antiepileptic, Anticoagulant, Corticoste roids, Vasodilators, Antipyretics, Vitamin Booster, Angiotensin receptor blocker, Bronchodilators, Antiplate let, Antifibrinolytics, Beta Blockers, ACE Inhibitors, Antidiabetics, Beta Agonists, Antico, Steroid, Bipyridi ne Inotropic, Antiviral, Insulin, 'Glycogenolytic Agent, Antidiuretic, Antagonist, Antipsychotic, Gall Stone Dissolution Agents, Anticholinergics.

2.5 Recovery Time of patients: The target attribute consists of, in how much time a patient recovered.in this variable there are three classes of recovery time.
0 to 48 Hours: - "0"
48 to 72 Hours: - "1"
More than 72 Hours: - "2"

2.6 Arthritis: Arthritis means joint inflammation. Arthritis is a medical condition in which the patient feels swelling and pain in their joints. Among adults aged 18 to 44. 7.1% ever reported having diagnosed with arthritis, and adults aged 45 to 64 29% reported having diagnosed with arthritis.

Yes: - "1"

No: - "0"

2.7 Breathing Problem: In this attribute we have taken two classes on the basis of patients having breathingproblem or not.

Yes: - "1"

No:-"0"

III - Predictive statistical model:

3.1 Splitting Train & Test Set:

Taking randomly 80% dataset as train dataset which is used to train the machine learning model and 20% dataset as test dataset which is used for evaluation of model's performance purpose.

3.2 Model building

Machine Learning models are built based on training data. Random Forest Classifier has greater accuracy than the other models. So Random Forest does best amongst the models to be the most accurate.

Model Comparison:

Model	Accuracy	Sensitivity	Specificity	F1 score
Decision Tree	82%	82%	83%	82%
Random Forest	83%	84%	83%	84%
Ada boost	82%	82%	82%	82%

Table 1

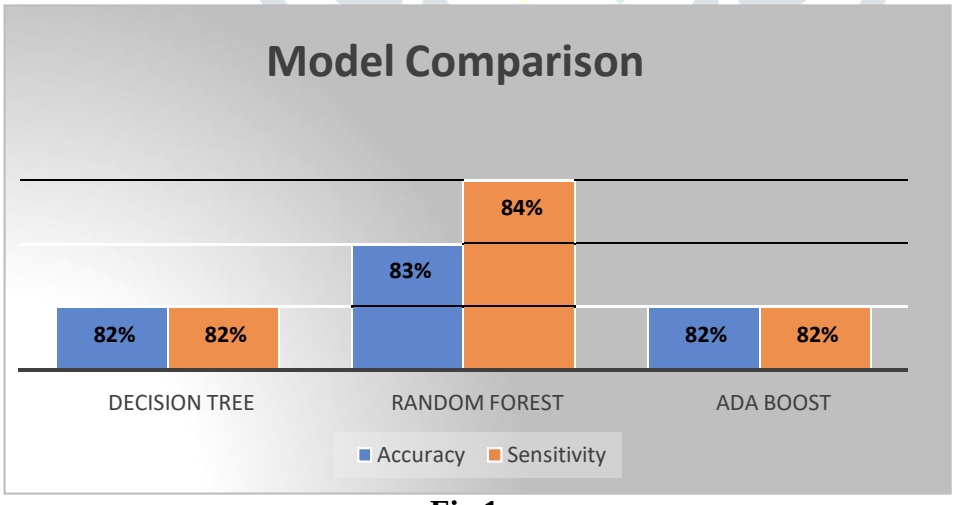

Fig 1

Fig 1 also shows that Random Forest Model performs best among all the other models, with greater accurac y and precision.

IV - Prescriptive statistical analysis:

4.1 Working of Model: -

To build this model we have used machine learning technique called input method. Model works on Random Forest Classifier. The model contains patients' medical history like blood pressure, blood glucose, sugar, arthritis etc. Their age, gender, what type of disease they are suffering from and their locality. We have to provide these inputs to the model, and the output will show how much time patient might need to recover. Output is in the terms of hours. In how may hours patient will recover. So, the hospital staff will getan idea about how to manage the beds and inventory and all the necessary equipment's needed for this patient to recover.

4.2 Demonstration: -

Suppose a medical case of a female patient from rural area having **age 25**, with medical history i.e**., Blood Pressure: 90, Hemoglobin: 12.5, Blood Glucose: 121, sugar level: Normal "1", Arthritis: No "0", Breathing Problem: No "0"** suffering from **Gastrointestinal Infection** Which belongs to class of **Abdominal Disease "5",** arises at a hospital for treatment. The hospital staff will provide these inputs to the machine learning model, then model will predict how long will it take for a patient to recover.

Model will predict Recovery Time of patient as one of the following:

- Patient might recover within 48 hours.
- Patient might recover within 72 hours.
- Patient might take more than 72 hours to recover.

By taking output given by the model into consideration the hospital staff will get an idea about how to manage the bed and other necessary equipment's or inventories required for the recovery of patient. This prescriptive model will help hospitals to avoid improper capacity planning of inventories, will also help to control over managing, allotting, and maintaining beds.

V - Discussion and conclusion: -

We have proposed an innovative machine leaning model to manage beds, medical equipment's and drugs in hospitals on daily basis using predictive and prescriptive statistical model. The engagement of beds, medical equipment's and drugs is correlated with recovery time of patients which depends on patient's age, gender, medical history and type of diseases. To build this predictive machine learning model we have used different machine learning algorithms such as Random Forest, Decision Tree and Ada boost. These models were built on training data to check which one this model performs best to predict recovery time of patients. Random Forest Classifier has greater accuracy and precision than the other models and it does best amongst the models to be the most accurate. The accuracy of Random Forest Model on test set is 83%.

VI - REFERNCES

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