RV Educational Institutions ®
RV College of Engineering ®
Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi
Approved by AICTE, New Delhi

Go, change the world

A Project Report on

APPLYING LEARNING TECHNIQUES FOR EFFICIENT RESOURCE ALLOCATION IN HOSPITALS

Submitted in Partial Fulfilment of the Requirement

for the IV Semester MCA Academic Minor Project – I

18MCA46

MASTER OF COMPUTER APPLICATIONS

By

USN	STUDENT NAME
1RV19MCA06	Ambika Badiger
1RV19MCA10	Anusha J

Under the Guidance of

Under the Guidance

of

Ms.ShailaH Koppad

Assistant Professor

Department of Master of Computer Applications
RV College of Engineering®, Mysuru Road
RV Vidyanikethan Post, Bengaluru – 560059

June -2021

RV Educational Institutions ®
RV College of Engineering ®

Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi

Approved by AICTE, New Delhi

Go, change the world

DEPARTMENT OF MASTER OF COMPUTER APPLICATIONS

CERTIFICATE

This is to certify that the project entitled "**APPLYING LEARNING TECHNIQUES FOR EFFICIENT RESOURCE ALLOCATION IN HOSPITALS**" submitted in partial fulfillment of Minor Project-I(18MCA46) of IV Semester MCA is a result of the bonafide work carried out by Ambika Badiger[1RV19MCA06] and Anusha J [1RV19MCA10], during the Academic year 2020-21.

Ms.ShailaH Koppad	Dr. Andhe Dharani
Assistant Professor	Professor and Director
Department of MCA,	Department of MCA,
RV College of Engineering®	RV College of Engineering®

UNDERTAKING BY THE STUDENT

We, Ambika Badiger[1RV19MCA06] and Anusha J[1RV19MCA06] hereby declare that the Minor project-I "APPLYING LEARNING TECHNIQUES FOR EFFICIENT RESOURCE ALLOCATION IN HOSPITALS" is carried out and completed successfully by us and is our original work.

SIGNATURE

Ambika Badiger [1RV19MCA06]

Anusha J [1RV19MA10]

Acknowledgement

The satisfaction and excitement that accompany the successful completion of the task would be incomplete without the mention of the people who made it possible, whose constant guidance and encouragement crowned the efforts with success. We would like to profoundly thank Management of R V College of Engineering for providing such a healthy environment for the successful completion of project. We would like to express our thanks to the Principal, Dr. K N Subramanya for his encouragement that motivated us for the successful completion of Project. It gives me immense pleasure to thank Dr. Andhe Dharani, Professor and Head of Department of MCAfor her constant support and encouragement. We would like to express our deepest sense of gratitude to my internal guide Ms. Shaila Koppad , Associate Professor, MCA Department for her constant support and guidance. Finally, we would like to express my sincere thanks to all staff members of MCA department for their valuable guidance and support.

Ambika Badiger [1RV19MCA06]

Anusha J [1RV19MA10]

Abstract

Allocating resource during emergencies is difficult, especially when all resources are mostly occupied. Considering when a patient needs to be admitted and hospital has to look for available beds for that patient in respected ward. It would be difficult and time consuming using existing system which is manual checking or maintain hand written records. Allocating staffs and maintaining staff shifts is also time consuming by manual methods.

The Resource Allocation system helps is allocating beds for patients in particular wards based on their reports and also allocates shifts and wards to staffs of hospital. The efficient allocations can be carried based on dividing the resources into three modules such as ward/bed allocation, staff allocation and patient module. Ward module will contain the details regarding number of beds available and occupied. Staff module will contain the details of to which ward they are allocated to and shifts in which they are working. The patient module contain the details like reason for admitting to hospital, number for days to be admitted. To handle this allocation problem a system can be developed using Machine learning algorithms and python programming language. The phases involved are Data collection, where the data set is collected from Hospital. Data pre-processing, here missing values are handled. After that specific ML Algorithm is applied for training the model. Lastly evaluating performance of the model will be done.

The system will help hospitals to allocate beds for patients efficiently at emergencies and helps in connecting patient demand prediction to hospital staffing optimization. Hospital can also allocate their staff effectively to particular wards and proper shifts based on rotation and rescheduling shifts of staffs during emergencies. This helps hospital to maintain proper staff shift maintenance as well as beds of particular wards which helps in better way to provide qualified health care for patients.

Table of Contents

LIST OF FIGURES

Chapter 1: Introduction

1.1 Project Description

The great demand for hospital care is understandable in view of increased concern for health care on the part of the Indian population. Hospitals continue to face the challenge of providing high-quality patient care in an environment of rising healthcare costs. The allocation process is mostly concerned with limited health resources such as beds per ward and efficient staff allocation. Allocating resources becomes difficult during emergencies or when patient needs to be admitted to hospitals and most of the beds have been occupied. It is difficult to look for beds available to patients in particular wards. Also allocating staffs to particular wards to meet the patients requirements may also get difficult in manual methods

The main purpose of the project is to apply machine learning algorithms to allocate the resources effectively such that it helps patients during emergencies. The system also helps hospital organization to allocate the shifts for staffs effectively. The system will help hospitals to allocate beds for patients efficiently at emergencies and helps in connecting patient demand prediction to hospital staffing optimization. Hospital can also allocate their staff effectively to particular wards and proper shifts based on rotation and rescheduling during emergency.

Chapter 2: Literature Review

2.1 Literature Survey

Sustainability principle necessitates specifying its roles, function and importance in different areas of resource allocation [1]. The Working of the Coordinates-based Resource Allocation Using Machine Learning [2].The detail about optimal branch and bound algorithm used in resource allocation [3]. The use of two quick-response methods within a nurse-scheduling model to help hospitals manage patient demand fluctuations and improve performance [4]. The idea of different levels in which resource allocation in health care system can be designed [5]. The details of three algorithms to build the predictive models : logistic regression, decision trees; and gradient boosted machines (GBM)[6]. The results of a study status that it is help for emergency clinical Physicians and hospital quality management will validly solve clinical medical resource allocation issues and improve medical quality through decision support systems [7]. The study proposes a machine learning framework for resource allocation and discussed how to apply the supervised learning to extract the similarities hidden in a great amount of historical data on scenarios [8]. A multi-objective linear programming model is developed. This study provides a framework for available and limited resources allocation in an emergency healthcare center [9]. According to a study once an aggregative resource allocation model is designed for a hospital, it can be easily modify to fit the unique characteristics of the hospital for application [10].

2.2 Existing and Proposed System

Existing System

The Resources are allocated to patients manually by checking the records. These records are manually updated. The manual method is time consuming and mistakes may occur during allocations. Similarly staff allocation is also done manually. This may result uneven allocation of staffs. During the emergences the bed and ward allocation to patients may get difficult if proper data is not maintained.

Proposed System

The Resource Allocation system can be achieved effectively in allocating beds for patients in particular wards based on their reports and also allocates shifts and wards to staffs of hospital, by applying the Machine Learning algorithm. The system will help hospitals to allocate beds for patients efficiently at emergencies and helps in connecting patient demand prediction to hospital staffing optimization. Hospital can also allocate their staff effectively to particular wards and proper shifts based on rotation and rescheduling shifts of staffs during emergencies

2.3 Tools and Technologies used

Tools : Jupiter notebook, Django

Technologies: Machine Learning Algorithm

2.4 Hardware and Software Requirements

- Hardware Requirements:
  Processor :Intel i3

  Hard Disk : 5GB

  Main Memory : 100MB

  I/O Device : Color monitor, Mouse, Keyboard.

- Software Requirements:
  Methodology to be used : Machine Learning Algorithm

  Programming Language : Python

  Tool : Jupiter Notebook

Chapter 3: Software Requirement Specifications

System Requirements Specifications, often recognized by SRS, has been the expression used to designate the comprehensive overview of the technology platform to be created. This is known to be among the early phases of development. Consider it as a diagram that leads to the final result.

3.1 Introduction

A software requirements specification is a detailed description of a software system to be developed with its functional and non-functional requirements. The software requirement specification document consistent of all necessary requirements required for project development. This document is prepared in order to publish research paper of students and faculties in the institution level. In which students and professors can write and publish the research paper in their interested topic

3.2 Functional Requirement

Three Modules:-

i. Ward/ Bed Resource Allocation Module

Input:- Details regarding available resources

Process:-Analyze using Machine Learning Techniques

Output:- Efficient allocation of resources

ii. Staff Resource Allocation Module

Input:- Details regarding staffs

Process:-Analyze using Machine Learning Techniques

Output:- Efficient allocation of staffs

iii. Patient Module

Input:- Details regarding patients

Process:-Analyze using Machine Learning Techniques

Output:- Efficient allocation to patients

3.3 Non Functional Requirements

- **Speed :** The application responds quickly.
- **Security**: Every user is provided with a particular fixed set of user privileges
- **Reliability:** It is consistently good in quality or performance.
- **Software Quality:** system is adaptable any file containing information of site details can be inserted to the database.
- **Ease of use:** It is not so complicated for user to access this application. User with basic knowledge of using internet can access our application.
- **Portability:** This application is portable and can be used on any system

3.4 Design Constraints

Standard Compliance

- All roles should follow workflow system hierarchy
- Internet connectivity must be established to publish reports and dashboards

Hardware Limitation

- Server storage required to store data
- Need of high-end processor

Chapter 4: System Design

4.1 System Perspective /Architectural Design

Problem Specification

Allocating resource during emergencies is difficult, especially when all resources are mostly occupied. Considering when a patient needs to be admitted and hospital has to look for available beds for that patient in respected ward. It would be difficult and time consuming using existing system which is manual checking or maintain hand written records. Allocating staffs and maintaining staff shifts is also time consuming by manual methods.

Block Diagram

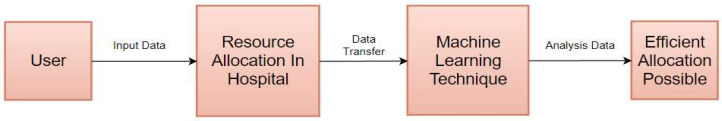

Fig 4.1 : Block Diagram

Module specification

Three modules :

Ward/bed resource module will contain the details regarding number of beds available and occupied.

Staff resource module will contain the details of to which ward they are allocated to and shifts in which they are working.

The patient module contain the details like reason for admitting to hospital, number for day to be admitted.

Chapter 5: Detailed Design

5.1System Design

Dynamic modelling

Activity Diagram

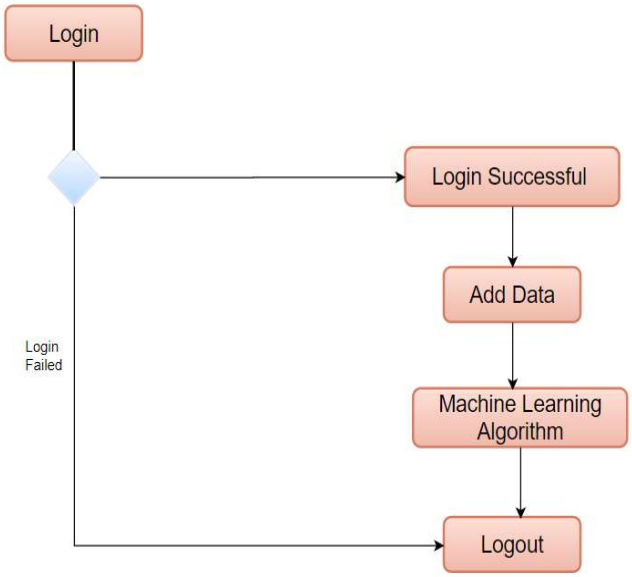

Fig 5.1.1: Activity Diagram

Sequence Diagram

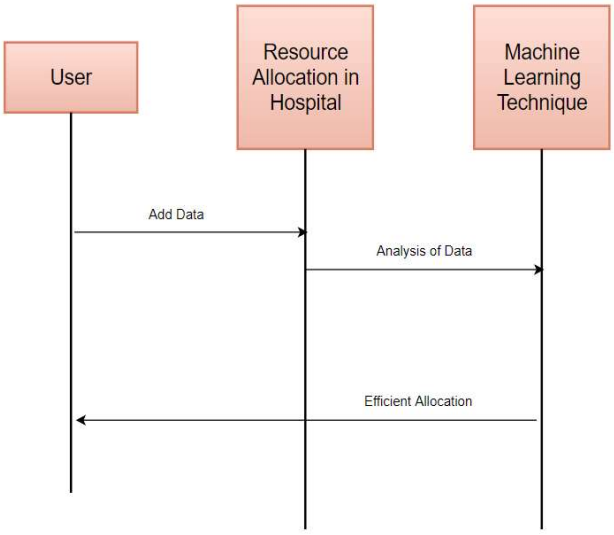

Fig 5.1.2: Sequence Diagram

Functional Modelling

Data Flow Diagrams

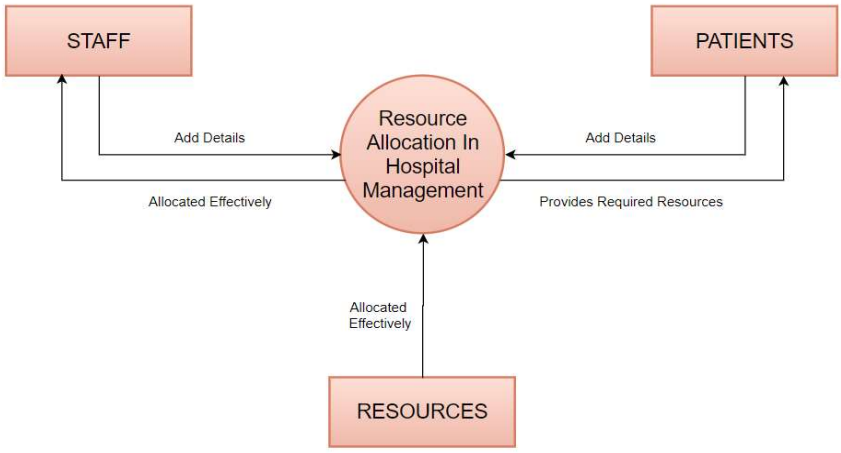

Fig 5.1.3: Data Flow Diagram

Database Design (ER Diagram / Conceptual Scheme)

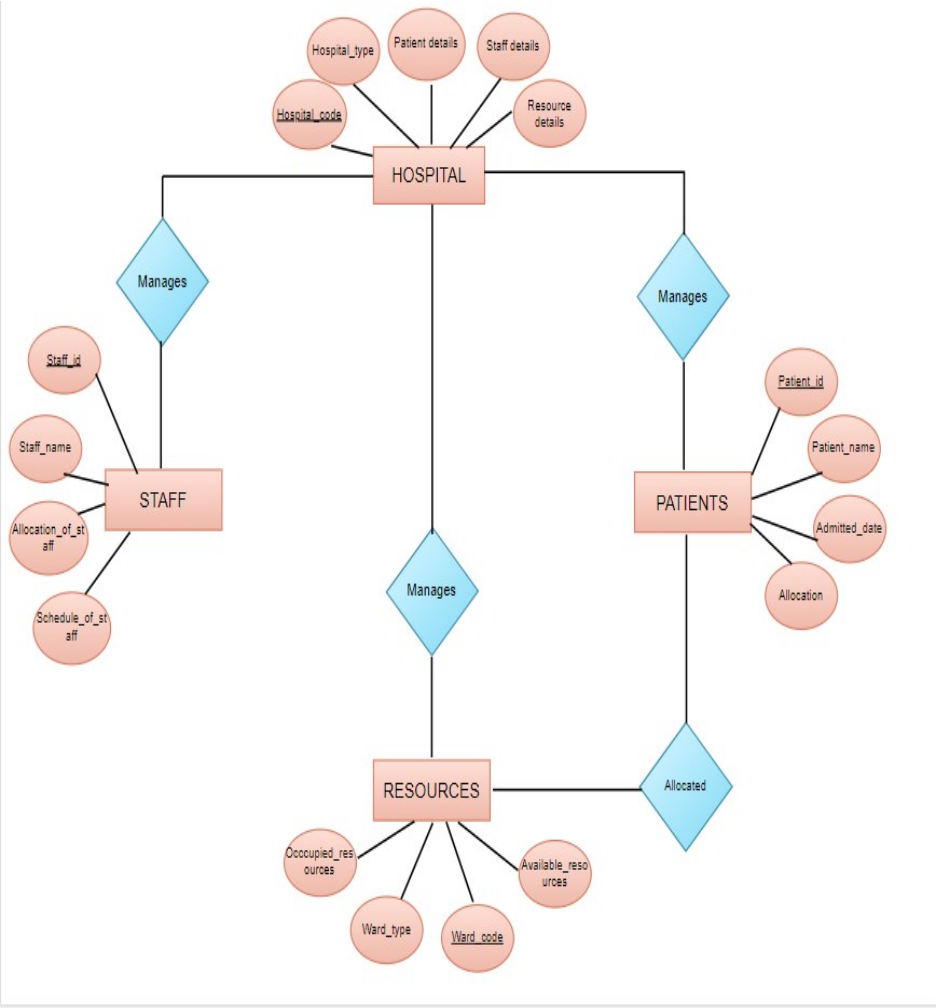

Fig 5.1.4: E R Diagram

5.2Detailed design

Ward/ Bed Resource Allocation Module

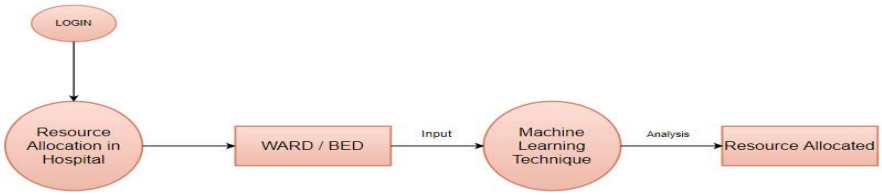

Fig 5.2.1: DFD Diagram for Ward/ Bed Resource Allocation Module

Staff Resource Allocation Module

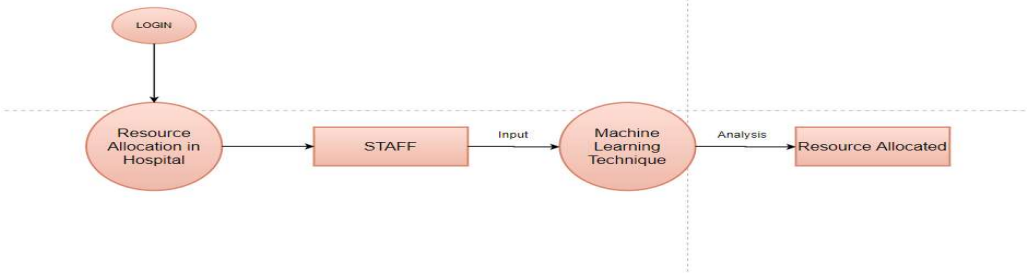

Fig 5.2.2: DFD Diagram for Staff Resource Allocation Module

Patient Module

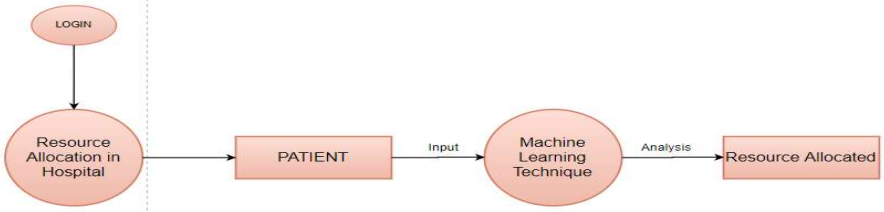

Fig 5.2.3: DFD Diagram for Patient Module

Chapter 6 Implementation

6.1 Code Snippets

```
In [34]: sns.countplot(train['Type of Admission'],hue=train['Department'],palette='rainbow')
Out[34]: <matplotlib.axes._subplots.AxesSubplot at 0x24880ec3f40>
```

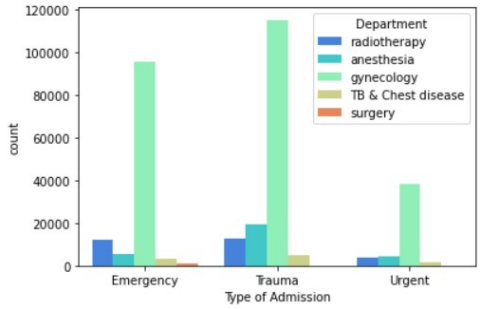

Fig 6.1.1: Graph for Type of Admission

In the above graph Most of the patients who were admitted for either in the emergency or trauma or Urgent category had an appointment in gynecology department .There were very few admissions for surgery.

```
In [35]: train['Age'].hist(bins=20,figsize=(10,4))
Out[35]: <matplotlib.axes._subplots.AxesSubplot at 0x24880ad3d30>
```

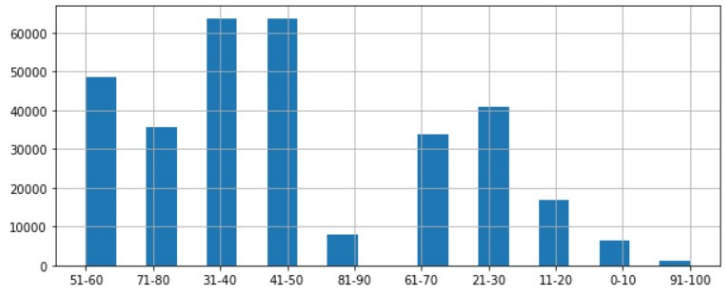

Fig 6.1.2: Graph for No of patients as per the particular age

Cluster of number of patients could be seen in the interval between 31-40 .There were fewer (outliers)patients admitted of age 91-100.

```
In [36]: def change1(ch):
             if(ch=='Extreme'):
                 return 0
             elif(ch=='Minor'):
                 return 1
             elif(ch=='Moderate'):
                 return 2

In [37]: train['Severity of Illness'] = train['Severity of Illness'].apply(change1)

In [38]: sns.countplot(train['Severity of Illness'],hue=train['Department'],palette='rainbow')
Out[38]: <matplotlib.axes._subplots.AxesSubplot at 0x24880f55ca0>
```

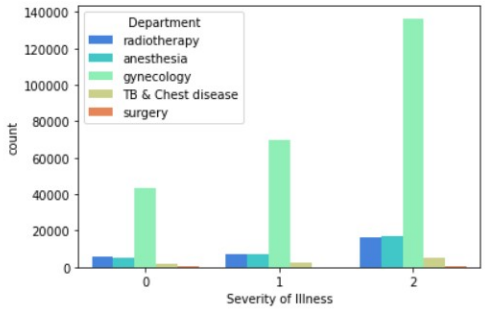

Fig 6.1.3: Graph of Severity of illness

There were good number of serious cases in radiotherapy department .Even though there were more number of admissions in gynec department most of them were moderate and only a few were of extreme and minor cases.

```
In [24]: train['Stay'].hist(bins=20,figsize=(10,4))
Out[24]: <matplotlib.axes._subplots.AxesSubplot at 0x24880a0a8b0>
```

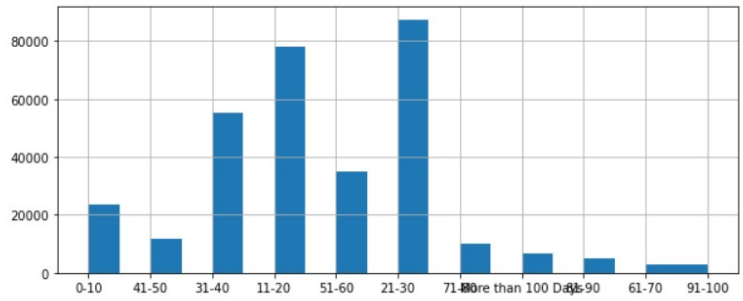

Fig 6.1.4: No of Patients at a particular age who stays for longer period

Many patients stayed for about 21-30 days .There were only few patients who stayed more than 100 days

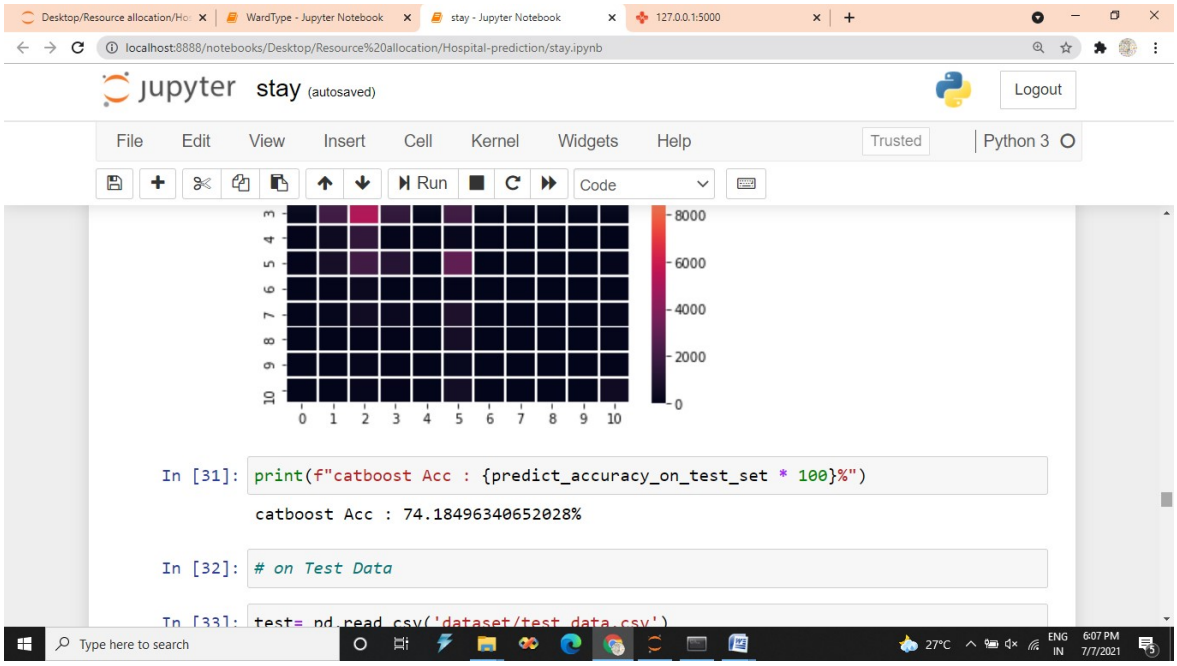

Fig 6.1.5: Catboost Algorithm gives 74.18% Accuracy.

Accuracy of train data is about : 74.18 percentage. For number of days patients to be stayed in hospital.

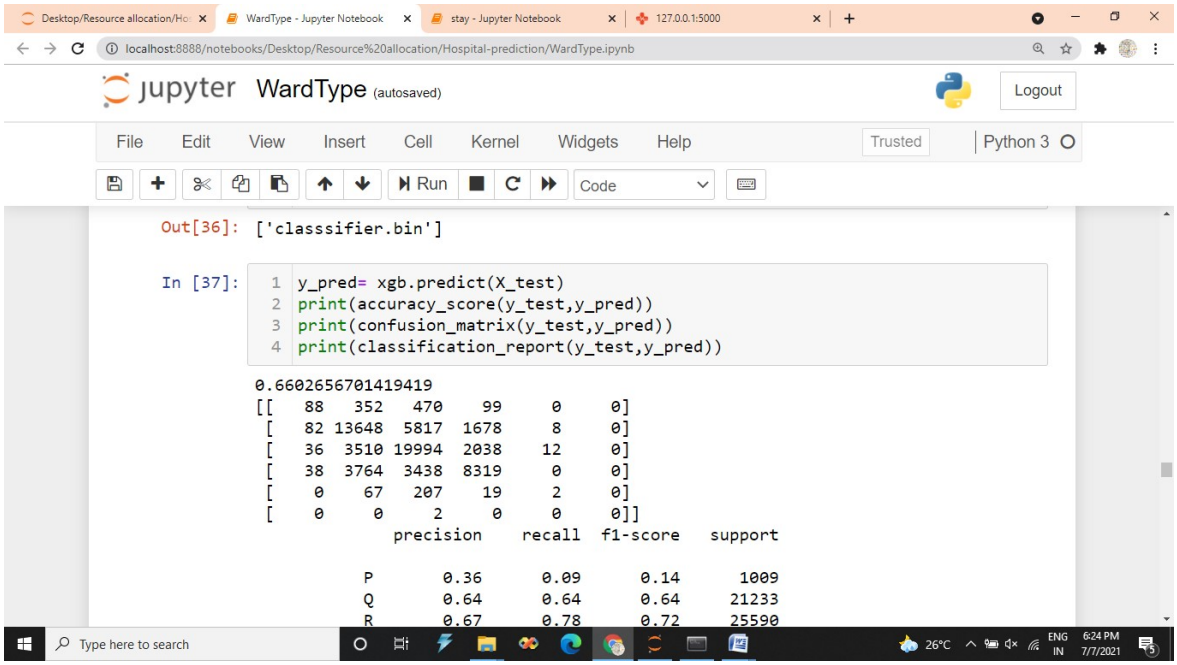

Fig 6.1.6: xgboost Algorithm gives 66.02% Accuracy.

Accuracy of train data is about : 66.02 percentage. For ward type for patients in hospital.

6.2 Screenshots

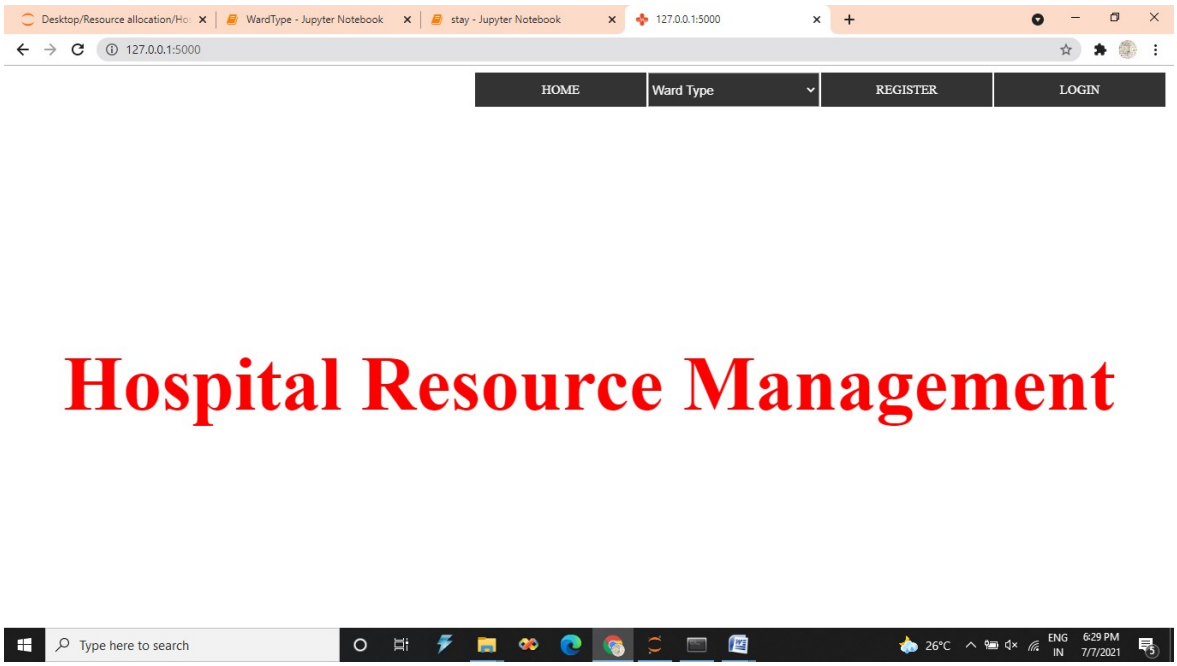

Fig 6.2.1 Home page

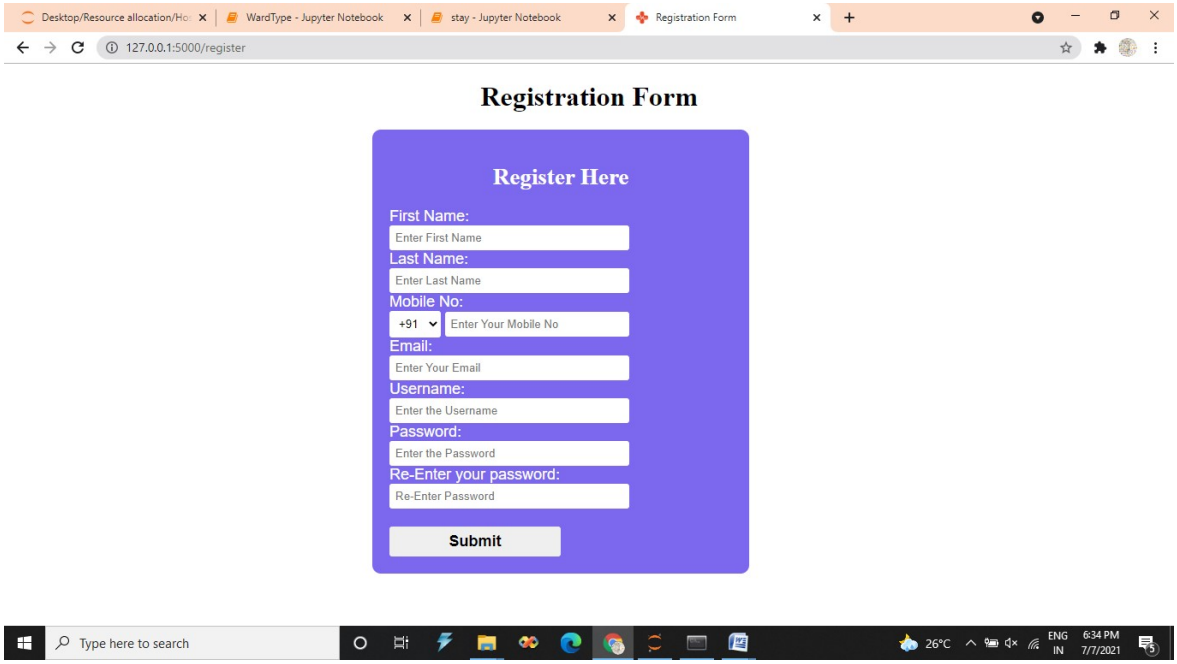

Fig 6.2.2 Registration form

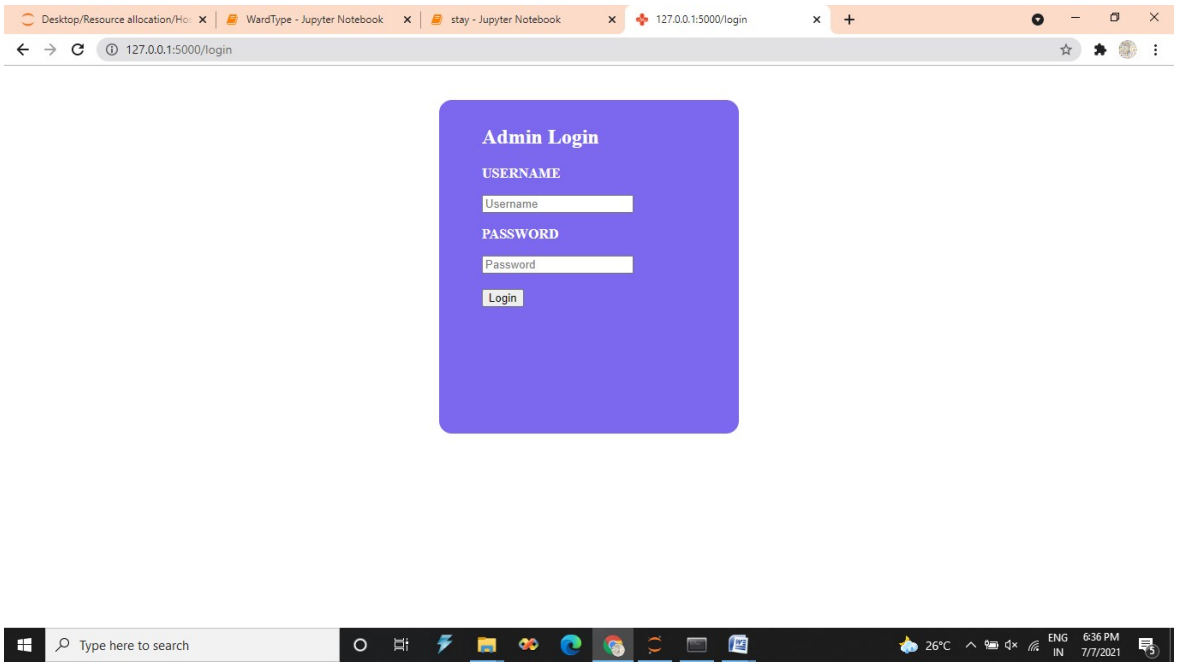

Fig 6.2.3 Login Page

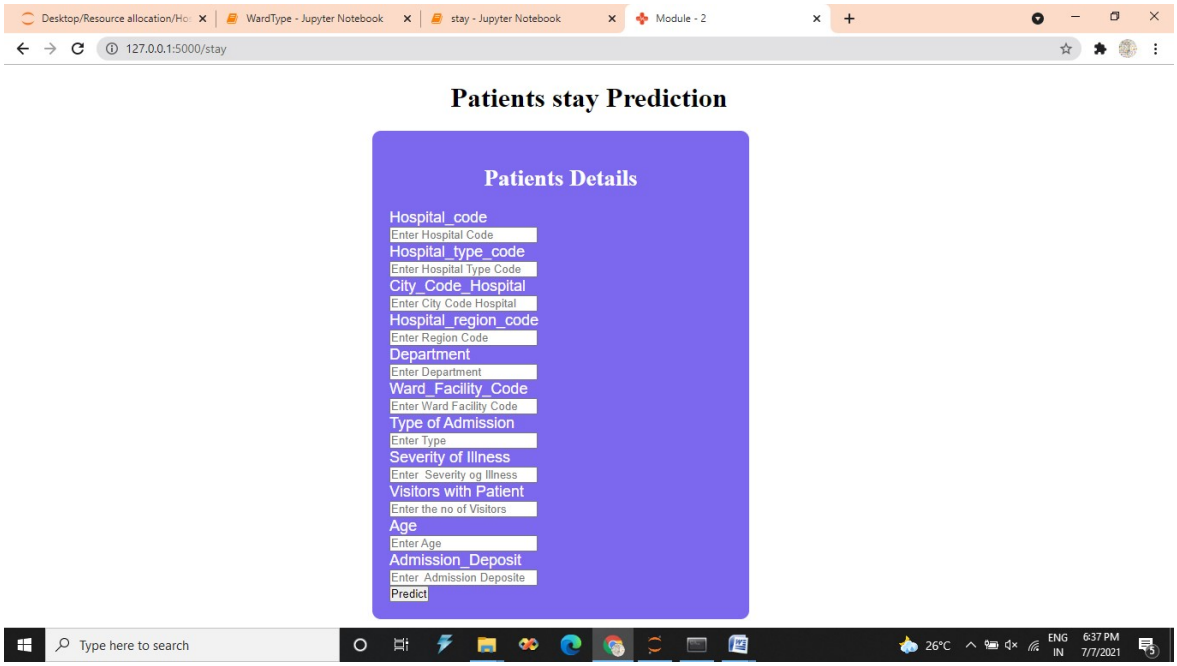

Fig 6.2.4 Patient Details

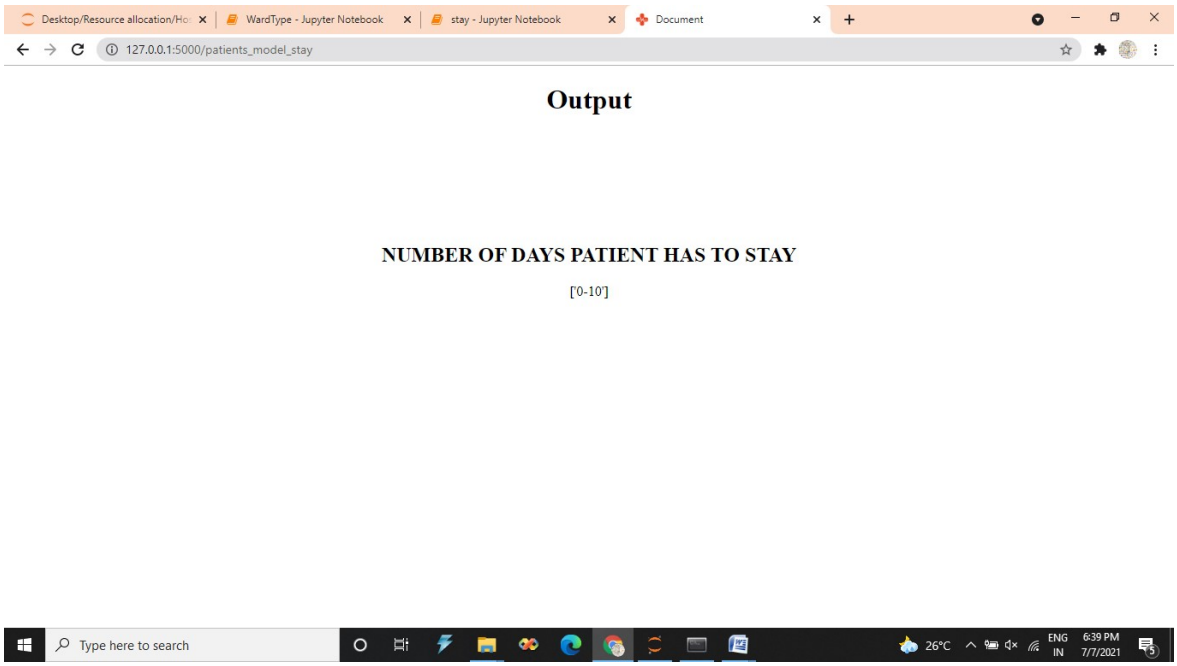

Fig 6.2.5 Stay output

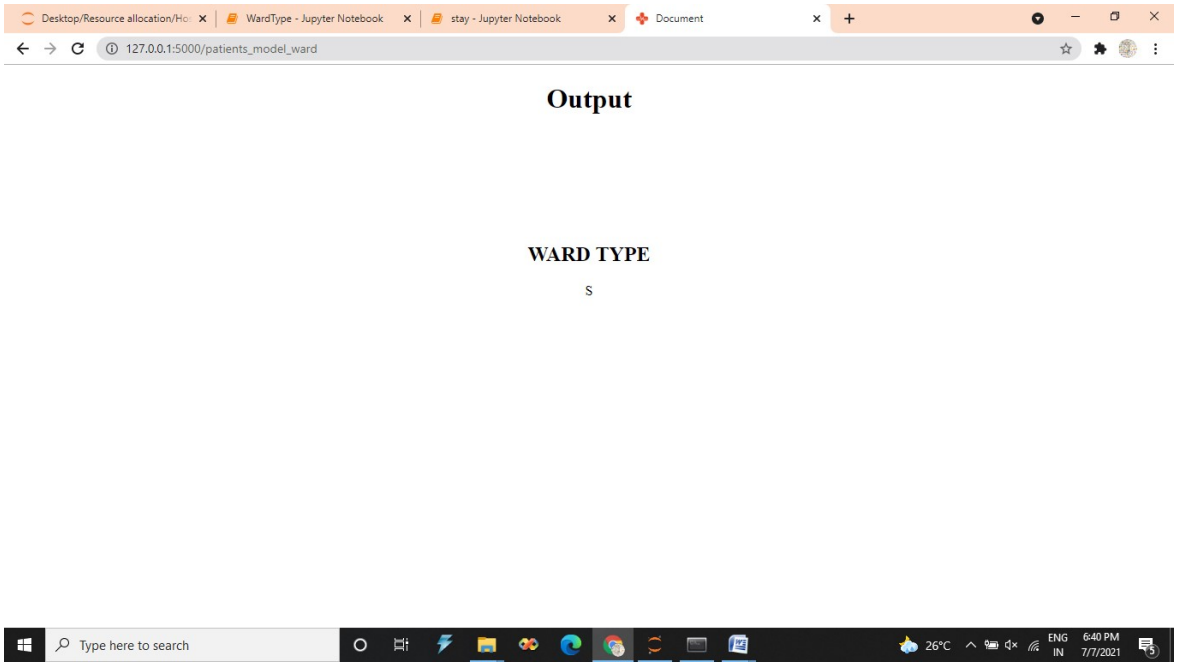

Fig 6.2.6 Ward Type output

Chapter 7: Software Testing

Software testing isn't really a method for creating reliable systems, though it is a methodology that has been used since we know that we've not been able to create a flawed free program or device. Software Testing is a testing process that refers to a predetermined series of criteria and for task of preventing faults.

7.1 Test cases

- Unit Testing

Unit testing is evaluated all the specified modules as units, which is a part of performance metric system. All the modules are tested with both pass and fail cases

Test case Id	Test case Description	Input	Expected Output	Actual Output	Remark
UT-1	Valid Username and Password	Username= admin Password= admin	Valid	Valid	Pass
UT-2	Invalid Username and Password	Username= root Password= root	Invalid	Invalid	Pass
UT-3	Invalid Username and Valid Password	Username= root Password= admin	Invalid	Invalid	Pass
UT-4	Valid Username and Invalid Password	Username= admin Password= root	Invalid	Invalid	Pass
UT-5	Empty Username and Password	Username= Null Password= Null	Invalid	Invalid	Pass
UT-6	mail, address, phone number, department, designation	mail, address, phone number, department, designation	Registration Successful	Registration Successful	Pass
UT-7	Enter Phone number other than Integer	Entering number in string	Registration Unsuccessful	Registration Unsuccessful	Pass
UT-8	Registration with same username who have already register	Entering same username	Username already exists	Username already exists	Pass

Table 1.1

- Integration Testing

Integration Testing (IT) is directed to validate the relationship seen between modules i.e. Table Integration with Publish Reports and Task Scheduler with Data Cleansing.

Test case Id	Test case Description	Input	Expected Output	Actual Output	Remark
IT-1	Check all the fields match the columns of dataset	Web page	Fields match	Fields match	Pass
IT-2	Check for valid inputs	Values of fields	Valid inputs	Valid inputs	Pass
IT-3	Check for valid inputs	Values of fields	Invalid inputs	Invalid inputs	Pass
IT-4	Check values are passing successfully	Values	Successfully passing data	Successfully passing data	Pass
IT-5	Check if proper results is retuned	Values	Proper result	Proper result	Pass

Table 1.2

Chapter 8: Conclusion

As the main purpose of the project is to apply machine learning algorithms to allocate the resources effectively such that it helps patients during emergencies. The system will apply machine learning algorithms to allocate the resources properly such that it helps patients in emergency condition. And it will also help hospitals to allocate beds for patients efficiently at emergencies and helps in connecting patient demand prediction to hospital staffing optimization. Hospital can also allocate their staff effectively to particular wards and proper shifts based on rotation and rescheduling during emergency.

Chapter 9: Future Enhancements

- Project can be updated in near future as and when requirement for the same arises, as it is very flexible in terms of expansion
- Equipment allocation will be included in the future
- Staff allocation can be done more efficiently in the future

Bibliography

1. Christian Munthe, Davide Fumagalli, Erik Malmqvist, Sustainability principle for the ethics of healthcare resource allocation, 5 November 2020, J Med Ethics: first published as 10.1136/medethics-2020-106644
2. Sahar Imtiaz, Sebastian Schiessl, Georgios P. Koudouridis and James Gross, Co-ordinates-based Resource Allocation Through Supervised Machine Learning , May 1, 2020, S. Schiessl is with u-blox Athens S.A., 15125 Maroussi, Greece. Manuscript received
3. Mengyuan Lee, Guanding Yu, Learning to Branch: Accelerating Resource Allocation in Wireless Networks , january 2020, IEEE transactions on vehicular technology, Vol. 69, no1.
4. Jan Schoenfelder a,Kurt M. Bretthauer b , P. Daniel Wright c , Edwin Coe d, Nurse scheduling with quick-response methods: Improving hospital performance, nurse workload, and patient experience , 2020, J. Schoenfelder, K.M. Bretthauer and P.D. Wright et al. / European Journal of Operational Research 283 (2020) 390–403
5. A.D. Asante,Factors influencing resource allocation decisions and equity in the health system of Ghana , 29 January 2018, The University of New South Wales, Sydney NSW 2052, Australia. uploaded by Anthony Zwi
6. BYRON GRAHAM, RAYMOND BOND, MICHAEL QUINN AND MAURICE MULVENNA, Using Data Mining to Predict Hospital Admissions From the Emergency Department , March 15, 2018, Received January 5, 2018, accepted February 15, 2018, date of publication February 22, 2018, date of current.
7. Hsiao-Ko Chang Using Machine Learning Algorithms in Medication for Cardiac Arrest Early Warning System Construction and Forecasting , 2018, Conference on Technologies and Applications of Artificial Intelligence (TAAI)
8. Jun-Bo Wang, Junyuan Wang, Yongpeng Wu, Jin-Yuan Wang, Huiling Zhu, Min Lin, Jiangzhou Wang . A Machine Learning Framework for Resource Allocation Assisted by Cloud Computing , 16 Dec 2017, College of Telecommunications and Information Engineering, Nanjing University of Posts and Telecommunications, Nanjing 210003, China
9. Mehdi A. Kamran, Behrooz Karimi, Hamidreza Bakhtiari and Sina Masoumzadeh, A resource allocation model in a healthcare emergency center using goal programming , December 2016, Department of Industrial Engineering, Amirkabir University of Technology, Tehran, Iran
10. Praveen Kumar K M. A Resource Allocation Model for Hospital Administration. 2015, International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Published by, www.ijert.org NCERAME - 2015 Conference Proceedings
11. On the Feasibility of Coordinates-Based Resource Allocation Through Machine Learning Sahar Imtiaz Division of ISE, EECS School KTH Royal Institute of Technology Stockholm, Sweden
12. Crew resource management training in healthcare: a systematic review of intervention design, training conditions and evaluation Benedict Gross,1 Leonie Rusin,1 Jan Kiesewetter,2 Jan M Zottmann,2 Martin R Fischer,2 Stephan Prückner,1 Alexandra Zech
13. Coordinates-based Resource Allocation Through Supervised Machine Learning Sahar Imtiaz, Student Member, IEEE, Sebastian Schiessl, Member, IEEE. Georgios P. Koudouridis, Member, IEEE. and James Gross, Senior Member, IEEE.
14. Emergency medical service resource allocation in a mass casualty incident by integrating patient prioritization and hospital selection problems
15. IT and Multi-layer Online Resource Allocation and Offline Planning in Metropolitan Networks Miquel Garrich , José-Luis Romero-Gázquez .

16. On the Feasibility of Coordinates-Based Resource Allocation Through Machine Learning Sahar Imtiaz Division of ISE, EECS School KTH Royal Institute of Technology Stockholm, Sweden
17. Crew resource management training in healthcare: a systematic review of intervention design, training conditions and evaluation Benedict Gross,1 Leonie Rusin,1 Jan Kiesewetter,2 Jan M Zottmann,2 Martin R Fischer,2 Stephan Prückner,1 Alexandra Zech
18. Coordinates-based Resource Allocation Through Supervised Machine Learning Sahar Imtiaz, Student Member, IEEE, Sebastian Schiessl, Member, IEEE. Georgios P. Koudouridis, Member, IEEE. and James Gross, Senior Member, IEEE.
19. Emergency medical service resource allocation in a mass casualty incident by integrating patient prioritization and hospital selection problems
20. IT and Multi-layer Online Resource Allocation and Offline Planning in Metropolitan Networks Miquel Garrich , José-Luis Romero-Gázquez