D. Y. PATIL COLLEGE OF ENGINEERING AND TECHNOLOGY

KASABA BAWADA, KOLHAPUR

A

PROJECT-II REPORT ON

"Optimization of Electricity Consumption using Machine Learning"

SUBMITTED BY

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UNDER THE GUIDANCE OF

Prof. A. J. Jadhav

D. Y. PATIL COLLEGE OF ENGINEERING AND TECHNOLOGY
KASABA BAWADA, KOLHAPUR

CERTIFICATE

This is to certify that the project group consisting of following members has satisfactorily completed the project-II work entitled "Optimization of Electricity Consumption using Machine Learning" at B.E (CSE) semester – VIII as prescribed in the syllabus of Shivaji University for the academic year 2019-2020

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D. Y. PATIL COLLEGE OF ENGINEERING AND TECHNOLOGY

KASABA BAWADA, KOLHAPUR Year 2019-20

Project Title: "**Optimization of Electricity Consumption using Machine Learning**"

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KASABA BAWADA, KOLHAPUR

DEPARETMENT OF COMPUTER SCIENCE AND ENGINEERING

ACKNOWLEDGEMENT

It is the matter of great satisfaction & pleasure to present the project report on

"**Optimization of Electricity Consumption using Machine Learning**"

We also express our profound gratitude to our project guide Prof. A. J. Jadhav for his valuable guidance, discussion & constant encouragement for the partial completion of this project work. He gave us suggestions and constructive criticisms from time to time in friendly manner which is perhaps an unique and characteristic of his mind.

We wish to extend our thanks to the honorable principal Prof. Dr. K.V. Kulhalli and H.O.D. Prof. B. D. Jitkar and all the staff members who directly or indirectly helped us for our project.

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1 Present Scenario

A power grid is an interconnected network for delivering electricity from producers to consumers. It consists of generating stations that produce electrical power, electrical substations for stepping electrical voltage up for transmission, or down for distribution, high voltage transmission line that carry power from distant sources to demand centres and distribution lines that connect individual customers. Power stations may be located near a fuel source, at a dam site, and are often located away from heavily populated areas. The electric power which is generated, is stepped up to higher voltage at which it connects to the electric power transmission net. This power grid is distributing a power in given area at specified rate. This project minimizes this wastage by predicting amount of energy required in a given area by analysing previous consumption of the consumer.

1.2 Need of work:

In India, the electricity is supplied in a fixed amount in the particular area without taking different parameters in consideration. These parameters include actual utilization of electricity, electricity wastage, seasons and festivals.

As India is becoming a developed country, the need for proper supply of electricity is essential. Due to no proper reports of electricity consumption, most of electricity is wasted, which could have been supplied to areas where there is a shortage of electricity.

Therefore, we are providing a software that will efficiently predict the amount of electricity that will be required in a particular area.

1.3 Problem Statement

To design and develop the system to conserve electricity using machine learning. This project analyzes previous data of electricity consumption in a given zone and predict timely consumption accordingly the amount of electricity required in that zone saving electricity wastage.

1.4 Objectives

1. To provide two-way communication flow between consumers and distributers and to ensure electricity is distributed in the most efficient way.
2. To find daily consumption based on meter readings.
3. To predict the amount of electricity required in a particular zone.

CHAPTER 2

REQUIREMENT SPECIFICATION

2. REQUIREMENT SPECIFICATION

2.1 Information Survey

In order to conserve electricity in the home, and work places, there is the growing need for us to use electricity more efficiently. Indeed, this is a corporate as well as an individual responsibility and there is always the need for energy management in the homes and work places to ensure maximum benefit at a minimum cost to customers. There is the need for consumers to use electricity efficiently and avoid waste.

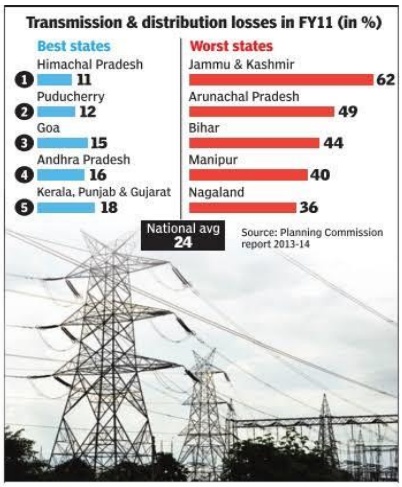

Fig. Transmission and distribution loss.

To help reduce their peak power demands and save money, many utilities are introducing programs that encourage their customers to use electricity during off-peak hours. The programs pass on the savings to the customer, through rebates or reduced electricity rates. However, these are from the consumer or producer side. Many efforts have been carried out in order to save electricity but right now, there are no efficient projects to conserve and supply electricity efficiently.

As per sources, the peak hours of electricity consumption are Morning 6:00 a.m. to 10:00 am and Evening 6:00 p.m. to 10:00 p.m. So during the non-peak hours, the electricity is being supplied but some part may be used or not at all used with respect to residential buildings. Hence, there is wastage of electricity. The transmission and distribution loss is identified by finding percentage of (energy input – energy billed) divide by the energy input. In order to overcome this, we are implementing a project-using machine learning that will smartly predict the correct amount of electricity needed for a particular area.

Hence, there is wastage of electricity. The transmission and distribution loss are identified by finding percentage of (energy input – energy billed) divide by the energy input. In order to overcome

this, we are implementing a project-using machine learning that will smartly predict the correct amount of electricity needed for a particular area.

2.2 Functional requirement

The memory requirement is:

- Minimum 4 GB

The processor requirement is:

- Intel(R) Core(TM) i3

The hardware requirements are:

- Endoscope camera: Used to collect reading from electric meter display.
- Electric meter: Used for electricity consumption tracking.

The software requirements are:

- Platform: Windows and Ubuntu
- Tools: Anaconda navigator, Sypder IDE
- Language: Python

2.3 Software Development Model

In the Iterative model, iterative process starts with a simple implementation of a small set of the requirements and iteratively enhances the evolving versions until the complete system is implemented. In this model, there is no need that each phase must be completed before the next phase can begin. In our project, we are using Iterative model. After gathering all requirements, we analyze and build the code, which will be tested.

Requirements:

This phase starts with gathering the requirements. In the subsequent as the product natures, identification of system requirements, subsystem requirements and unit requirements are done in this phase. For gathering requirements, survey and Stanford University papers were referred.

Analysis:

This phase includes understanding the system requirements. In the early system, we had various modules working individually. After the analysis, we have designed a system, which will combine all the modules into one software.

Design:

The design phase starts with the conceptual design and involves system architectural design, logical design of modules, final design. The data flow diagrams are designed for all the modules.

Construct or Build (coding):

The Construct phase refers to coding of the modules. With the help of Data Flow Diagram, modules have been developed. Then with clarity on requirements and design details, the final system is build.

Evaluation and Risk (testing):

Risk Analysis includes identifying, estimating and monitoring the technical feasibility and management risks.

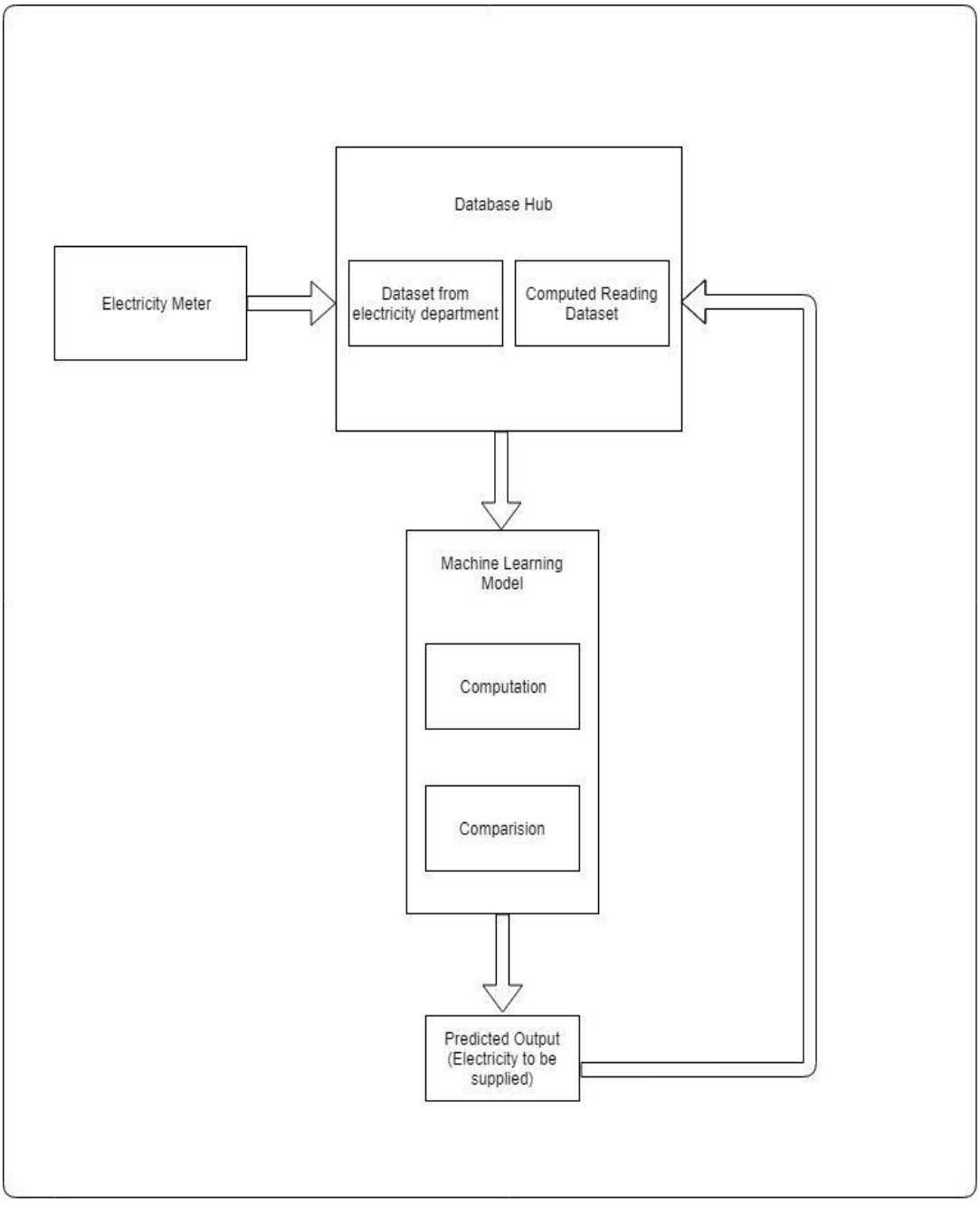

Fig 2.3 Software Development Model

CHAPTER 3

DESIGN

3. DESIGN

3.1 System Architecture

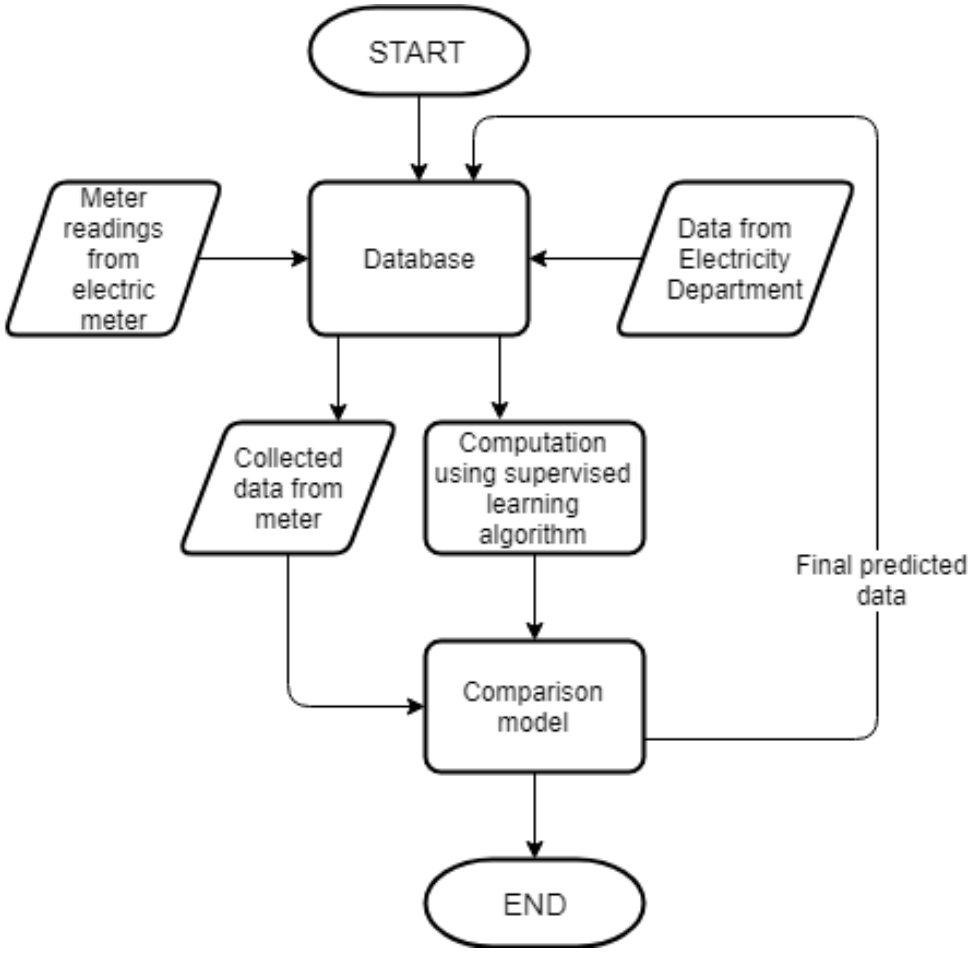

Fig. 3.1 System Architecture

3.2 Modules

3.2.1 Machine Learning Model:

This model consists of two distinct operations.

a) Computation model
b) Comparison model

The computation model will majorly work on taking the input of the previously stored datasets and compute them to predict the most efficient output. The algorithm used in this computation model is supervised learning algorithm. The project uses supervised learning algorithm as there are labelled datasets and there is no need of patterns (Only optimal solution). The comparison model compares the data given by the electricity department and the data computed by the computation model.

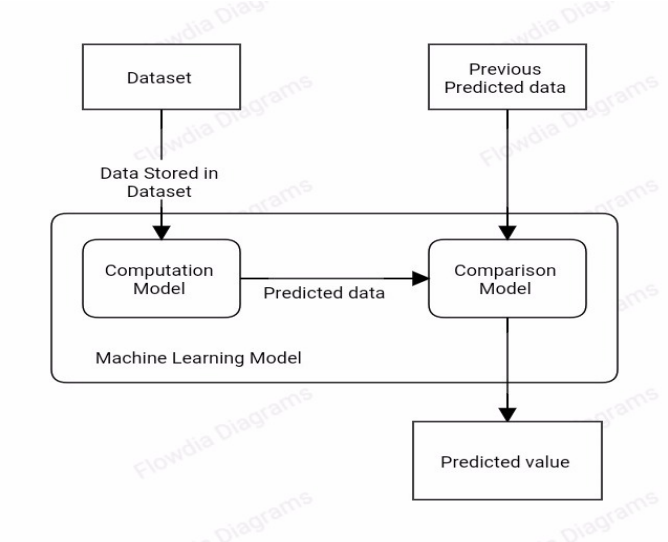

Fig. 3.2.1 Machine Learning Model

3.2.2 Database Hub:

The database hub consists of the two subparts. These are the actual data (Data read from meter) and the data provided by the electricity department. This will also consist the predicted data that was computed from computation model.

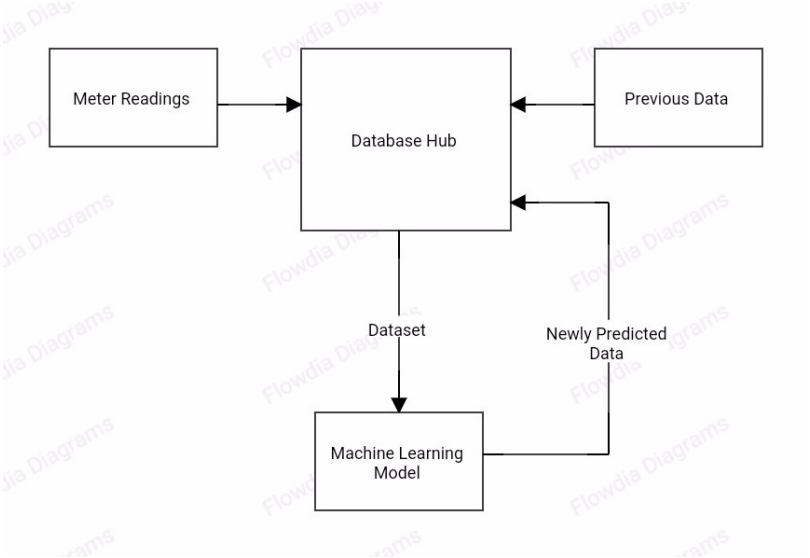

Fig. 3.2.2 Database Hub

3.2.3 Live Data Counter:

This module gathers data from the electric meters and stores this data directly into the database. The data sent to the database will be sorted according to months. This module will consist of an endoscope camera, which will be implanted inside the box where the meter is housed.

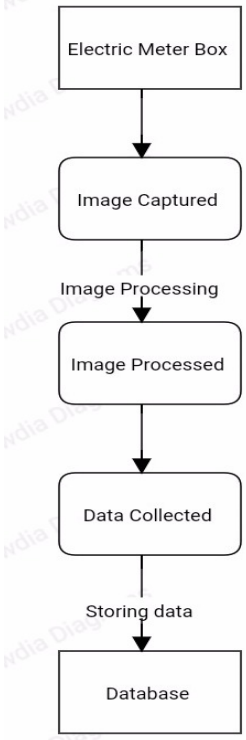

Fig. 3.2.3 Live Data Counter

3.2.4 Designing Distributed System:

This will enable the machine-learning module to compute the results faster using multiple nodes. We are creating a distributed system that will take the dataset and use the parallel processing concept for computation. The parallel processing concept will help in reducing time for computations.

CHAPTER 4

IMPLEMENTATION

4. Implementation

4.1. Technology Used

Machine learning (ML) is the study of computer algorithms that improve automatically through experience. It is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as email filtering and computer vision, where it is difficult or infeasible to develop conventional algorithms to perform the needed tasks.

Machine learning is closely related to computational statistics, which focuses on making predictions using computers. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Data mining is a related field of study, focusing on exploratory data analysis through unsupervised learning.

We choose machine-learning technology for this project because the system involves prediction task. Hence, machine learning is the best suitable technology.

4.2 Language Used:

4.2.1 Python

Python is a widely used general-purpose, high level programming language. Python was initially designed by Guido van Rossum in 1991 and developed by Python Software Foundation. It was mainly developed for emphasis on code readability, and its syntax allows programmers to express concepts in fewer lines of code. Python is a programming language that lets you work quickly and integrate systems more efficiently. Python consists suitable libraries required for our project such as, “numpy” for machine learning, “pandas” for accessing datasets and “matplotlib” for plotting the regression line.

4.3 Description of tools used:

4.3.1 Anaconda:

Envision a world where data scientists can regularly deploy AI and machine learning projects into production at scale, quickly delivering insights into the hands of decision-makers. How would that impact your business? Anaconda Enterprise supports your organization no matter the size, easily scaling from a single user on one laptop to thousands of machines. No headaches, no IT nightmares.

Anaconda is a free and open-source distribution of the Python and R programming languages for scientific computing (data science, machine learning applications, large-scale data processing, predictive analytics, etc.), that aims to simplify package management and deployment. Package versions are managed by the package management system conda. The Anaconda distribution is used by over 15 million users and includes more than 1500 popular data-science packages suitable for Windows, Linux, and MacOS.

4.3.2 Spyder IDE:

Spyder, the Scientific Python Development Environment, is a free integrated development environment (IDE) that is included with Anaconda. It includes editing, interactive testing, debugging and introspection features. Spyder is an open source cross-platform integrated development environment (IDE) for scientific programming in the Python language. Spyder integrates with a number of prominent packages in the scientific Python stack, including NumPy, SciPy, Matplotlib, pandas, IPython, SymPy and Cython, as well as other open source software.

4.4 Algorithm:

The algorithm used in this project is linear regression model. Linear Regression is perhaps one of the most well known and well understood algorithms in statistics and machine learning. Regression models a target prediction value based on independent variables. It is mostly used for finding out the relationship between variables and forecasting. Different regression models differ based on – the kind of relationship between dependent and independent variables, they are considering and the number of independent variables being used.

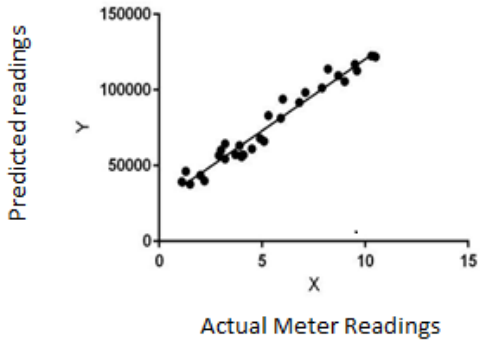

Fig.5.3.1. Linear Regression Graph

Linear regression performs the task to predict a dependent variable value (y) based on a given independent variable (x). So, this regression technique finds out a linear relationship between x (input) and y(output). Hence, the name is Linear Regression.

CHAPTER 5

TESTING AND RESULT

5.1 Testing Method

5.1.1 Unit Testing

Unit testing is a level of software testing where individual units/components of a software are tested. In this system, individual modules are tested under separate environments to check whether they operate according to project needs. Unit testing is essential for verification of the code produced during the coding phase, and hence the goal is to test the internal logic of the modules.

5.1.2 Integration Testing

Integration testing is the phase in which individual software modules are combined and tested as a group. In this system, all the modules are combined and tested under the same environment, to check the integrity as a whole.

5.1.3 System Testing

System testing is a level of testing that validates the complete and fully integrated software product. After integration of all modules, this testing is performed on whole system to check the reliability.

5.1.4 Regression Testing

Regression testing is defined as a type of software testing to confirm that a recent program or code change has not adversely affected existing features. The purpose of regression testing is to ensure that changes such as those mentioned above have not introduced new faults.

5.2 Result

5.2.1. Live Data Counter:

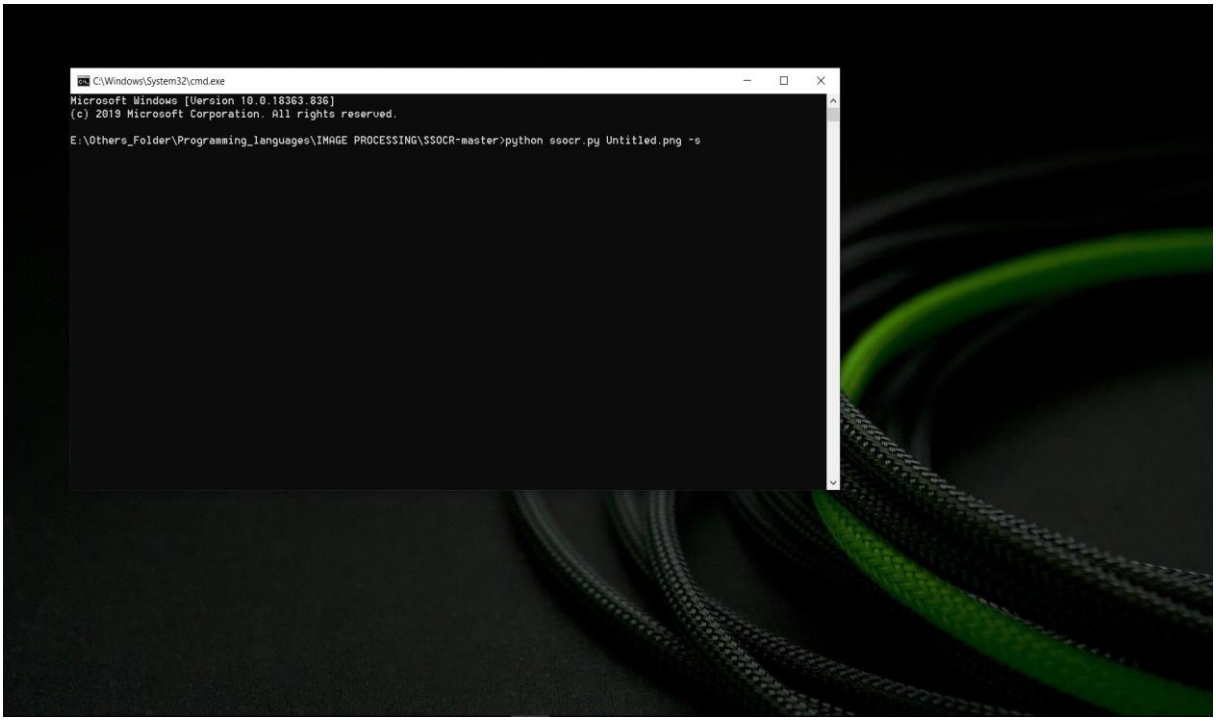

Fig 5.2.1.1 Execution of module

This command runs the program for capturing the meter readings from electric meter.

After running, this module detects numbers from electric meter and stores it in a database.

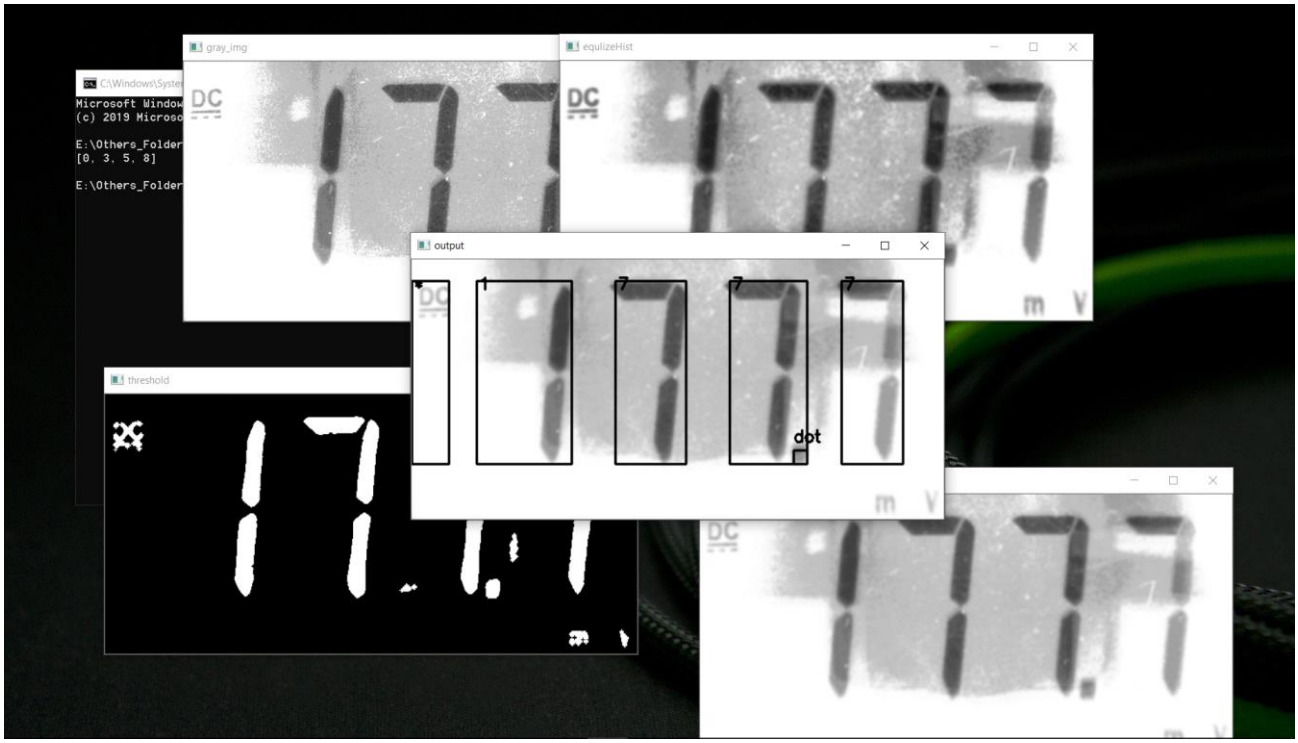

Fig 5.2.1.2 Detection of numbers from meter display

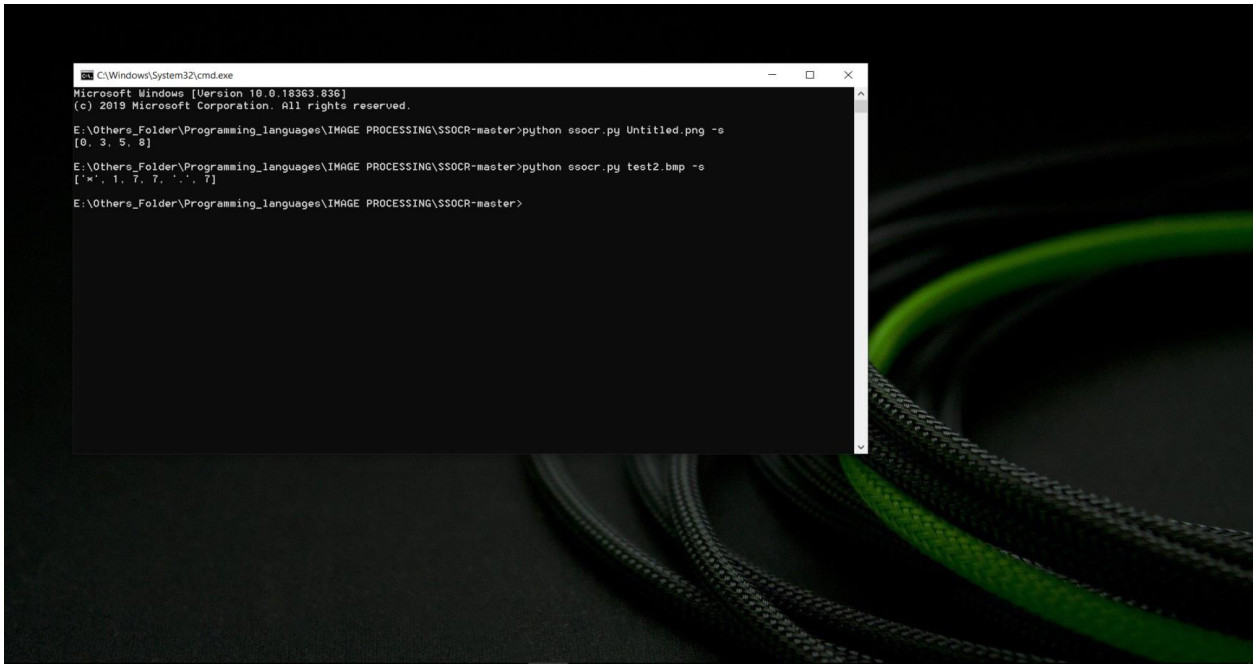

Fig 5.2.1.3 Displays and stores the meter reading in the database

As shown in the fig 5.2.1.3 below, this module captures the meter reading and displays as well as stores it in a database.

5.2.2. Machine Learning Model:

This module takes the input in the form of dataset, learns according to the patterns in the dataset and predict the required electricity value.

Using the python library pandas, the dataset of electric meter readings has been imported. To import the dataset into our program, read_csv() method is used.

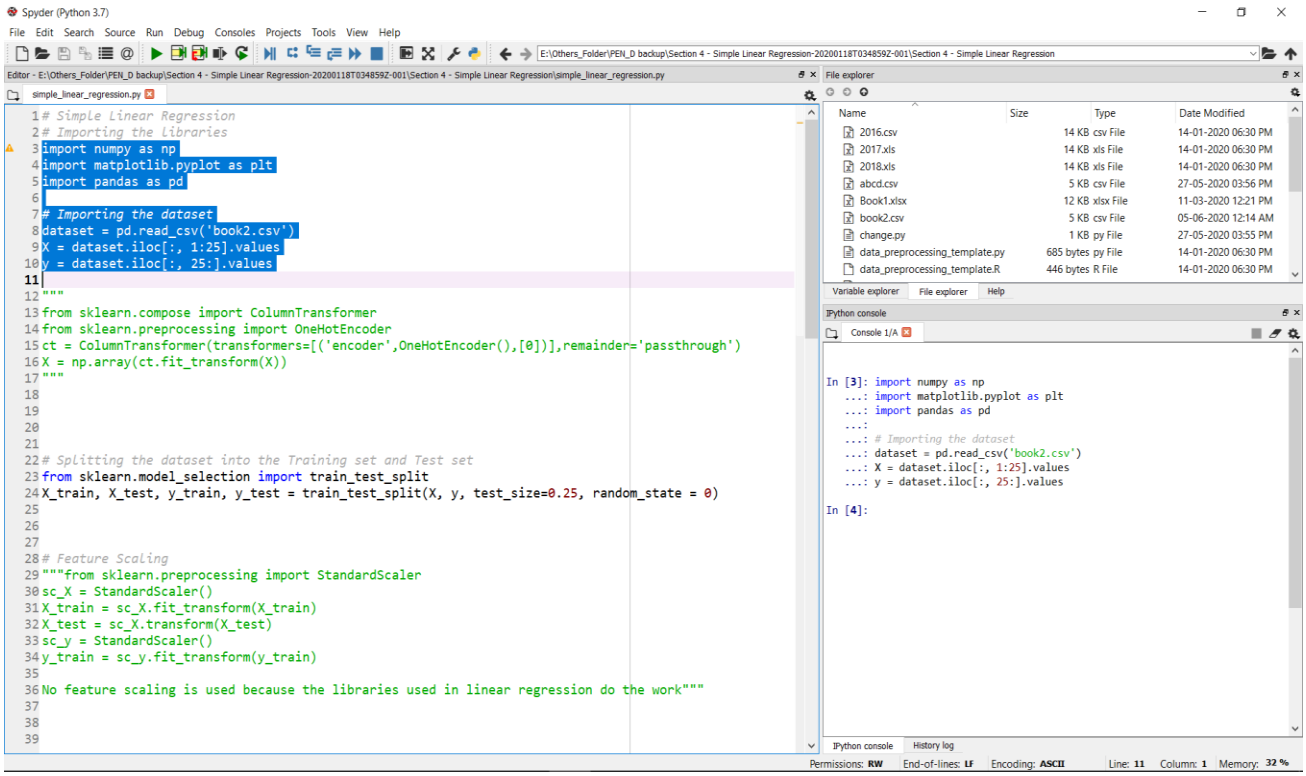

Fig 5.2.2.1 Importing the dataset into the program

Before predicting anything, a machine has to learn different patterns on which it predict, based on gathered data.

Therefore, to learn the machine, we have divided our dataset into two parts:

- Training set
- Test set

Training set to train the machine and learn the patterns using linear regression algorithm.

Test set for applying the knowledge it has learnt.

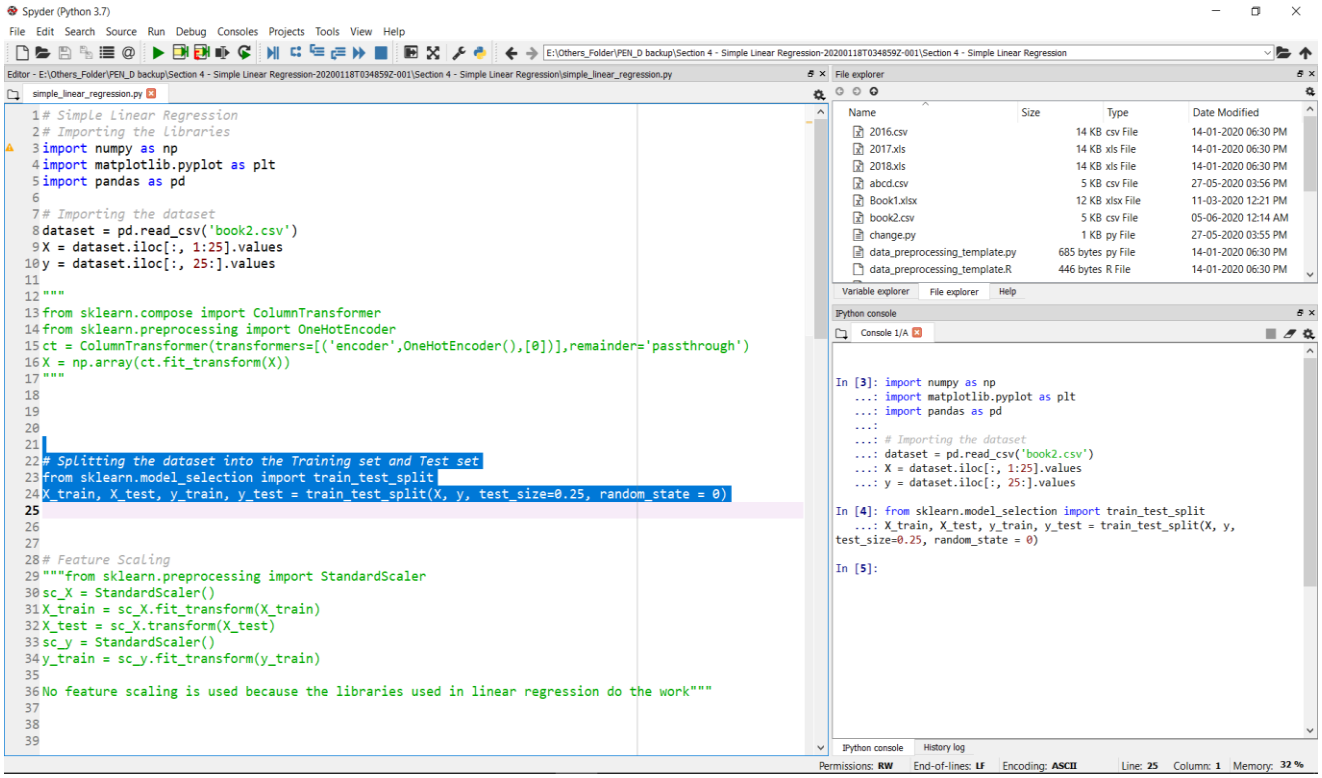

Fig 5.3.2.2 Dividing set into training and test set

After dividing the set into training and test set, machine has to learn according to the training set.

Therefore, to learn the machine we have used the linear regression algorithm to final the best suitable line of predicted outputs.

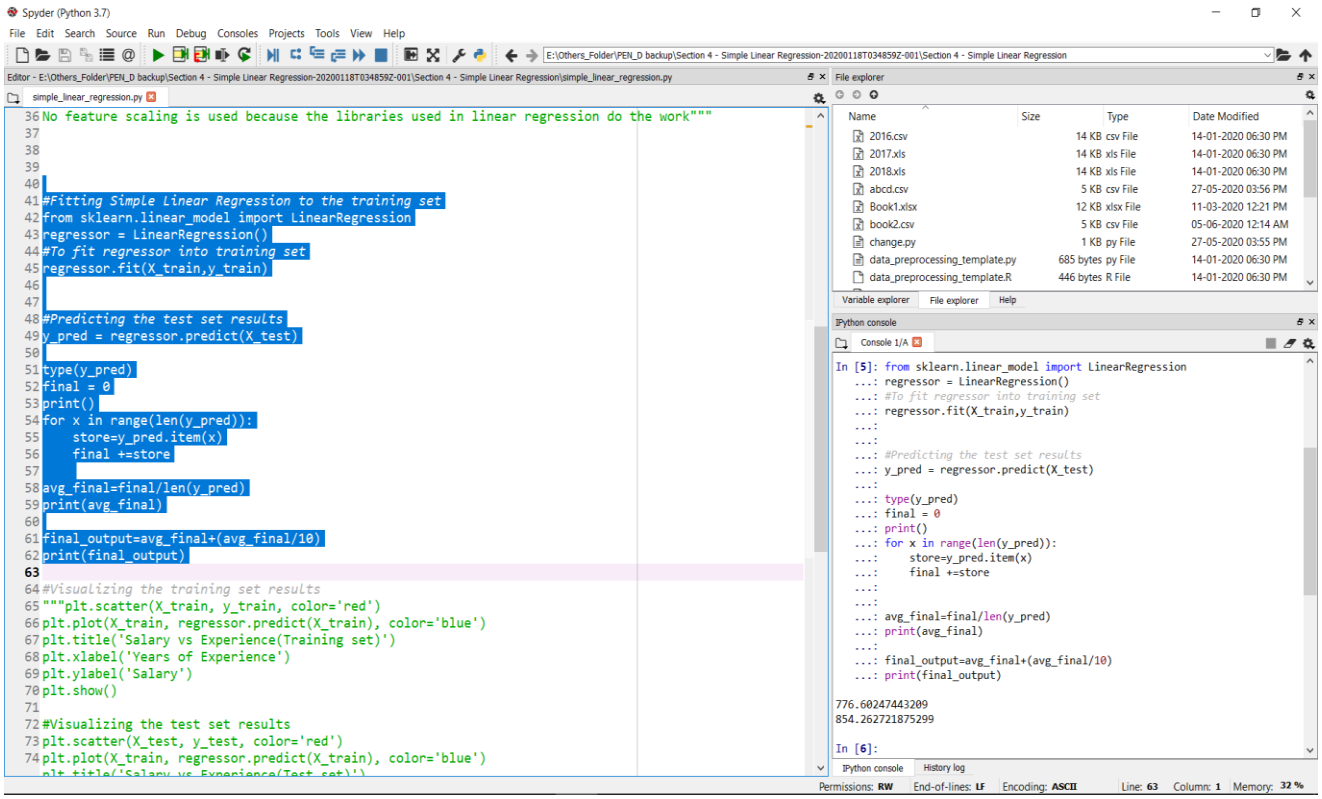

Fig 5.2.2.3 Learn the model

To train the machine, we have first imported the module LinearRegression from the library called scikit learn.

Then using the object of the module we have fit the training set into the linear regression model. At this point, our machine's learning process is finished.

Then predict() method is used to predict the output using test set.

CHAPTER 6

CONCLUSION

6.1 Conclusion

Electricity wastage is a serious issue, which needs to be addressed in the near future. As per the surveys conducted and research papers read, a major loophole was found in distribution of electricity. This was due to static distribution technique. To tackle this situation, the system so created was based on dynamic distribution technique, which took machine learning as the core of proposed system. This system uses multiple modules to deal with the issues caused by static distribution techniques and overcomes these problems efficiently. As can be seen, the system generates optimal set of data, which is generally the amount of electricity needed to be drawn in the feeder accordingly. Lastly, to sum up by using this technology, a huge amount electricity can be saved which was being wasted before during distribution. This will be a great step towards greater India.

CHAPTER 7

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7.2 Links

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CHAPTER 8

PUBLICATION

8.1 Certificate of Paper Publication:


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in recognition of the publication of the paper entitled
Optimization of Electricity Consumption
by using Machine Learning
published in e-journal
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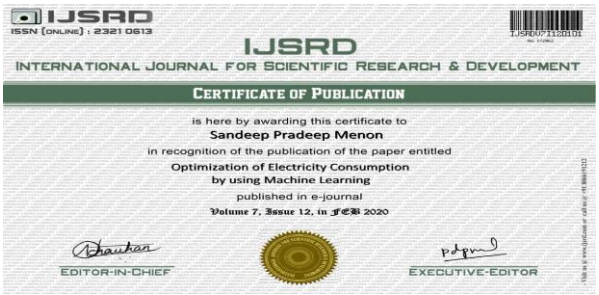
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