HIGH LEVEL DESIGN (HLD)

ENERGY EFFICIENCY

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Document Version Control

Date Issued	Version	Description	Author
21/08/2021	1.0	1. There are many blank pages 2. Explanation for Design Details in required 3. HLD Content- Add more information about its uses and application. 4. Naming for Images is required	Mayur Borkar
27/08/2021	2.0		

Content

Abstract

This study looked into assessing the heating load and cooling load requirements of buildings (that is, energy efficiency) as a function of building parameters. We perform energy analysis using 12 different building shapes simulated in Ecotect. The buildings differ with respect to the glazing area, the glazing area distribution, and the orientation, amongst other parameters. We simulate various settings as functions of the afore-mentioned characteristics to obtain 768 building shapes. The dataset comprises 768 samples and 8 features, aiming to predict two real valued responses. It can also be used as a multi-class classification problem if the response is rounded to the nearest integer.

1. INTRODUCTION

1.1 Why This High-Level Design Document

The purpose of this High Level Design (HLD) Document is to add the necessary detail to the current project description to represent a suitable model for coding. This document is also intended to help detect contradictions prior to coding, and can be used as a reference manual for how the modules interact at a high level.

1.2 Scope

The HLD documentation presents the structure of the system, such as the database architecture, application architecture (layers), application flow (Navigation), and technology architecture. The HLD uses non-technical to mildly-technical terms which should be understandable to the administrators of the system.

1.3 Definitions

Term	Definitions
EE	Energy Efficiency
Database	Collection of all the information monitored by this system
IDE	Integrated Development Environment
AWS	Amazon Web Service

1.4. Overview

The HLD will:

• present all of the design aspects and define them in detail

• describe the user interface being implemented

• describe the hardware and software interfaces

• describe the performance requirements

• include design features and the architecture of the project

1.5 Uses

- This document is designed to help in operational requirement and can be used as a reference manual for how the modules interact.

- HLD briefly describes about the platforms/products/services/processes, flow of traffic that it depends on and includes any important changes that need to be made to them.

- HLD is the input for creating the LLD (Low Level Design) since the key communication items are displayed in HLD which are then converted to detailed communication in LLD, showing connectivity and physical level

1.6 Application

1] Website Development

2] Application Development

3] Data Science Project

2. GENERAL DESCRIPTION

2.1 Product Perspective

The EE (Energy Efficiency) solution system is machine learning model which helps to find out the co-relation between the input variable and output variable of residential building. Each row of dataset represents the one residential building parameter. So our task is to predict the output on the basis of given input variable.

2.2 Problem Statement

The effect of eight input variables (relative compactness, surface area, wall area, roof area, overall height, orientation, glazing area, glazing area distribution) on two output variables, namely heating load (HL) and cooling load (CL), of residential buildings is investigated using a statistical machine learning framework. We have to use a number of classical and non-parametric statistical analytic tools to carefully analyze the strength of each input variable's correlation with each of the output variables in order to discover the most strongly associated input variables. We need to estimate HL and CL; we can compare a traditional linear regression approach to a sophisticated state-of-the-art nonlinear non-parametric method, random forests.

2.3 Proposed Solution

The heating load is the amount of heat energy that would need to be added to a space to maintain the temperature in an acceptable range. The cooling load is the amount of heat energy that would need to be removed from a space (cooling) to maintain the temperature in an acceptable range. So from the above problem statement we can find out that HL & CL from the given input attribute. The HL & CL will help you to find out the different parameter that is required for the building estimation in terms of the electricity. In the given model we take data from the client whatever we required for the predicting the HL & CL.

2.4 Technical Requirement

In this Project the requirements to get energy efficiency through various platform. For that, in this project we are going to use different technologies. Here is some requirements for this project.

- Model should be exposed through API or User Interface, so that anyone can test model.
- Model should be deployed on cloud (Azure, AWS, and GCP) for the public used.
- Cassandra database should be integrated in this project for any kind of user input.

2.5 Data Requirements

Data Requirement completely depends on our problem.

- For training and testing the model, we are using flight fare prediction dataset from kaggle.
- From user we are taking following input :
  - Relative Compactness
  - Surface Area
  - Wall Area
  - Roof Area
  - Overall Height
  - Orientation
  - Glazing Area
  - Glazing Area Distribution

2.6 Tools Used

Python programming language and frameworks such as NumPy, Pandas and Scikit-learn are used to build the whole model.

- PyCharm is used as IDE
- For visualization of the plots, Matplotlib, Seaborn and Plotly are used.
- AWS used for deployment of the model
- Tableau/Power BI is used for dashboard creation
- Cassandra is used to insert, delete, retrieve and update the database.

- Front end development is done using HTML/CSS
- Python flask is used for backend development
- GitHub is used as version control system.

Figure No. 1 The entire Library That We Used in Project

2.7 Constraints

The energy efficiency prediction system must be user friendly, errors free and users should not be required to know any of the back-end working.

3. DESIGN DETAILS

3.1 Process Flow

For identifying the different type of anomalies, we will use a machine learning base model. Below is the process flow diagram is as shown below.

3.1.1 Proposed Methodology

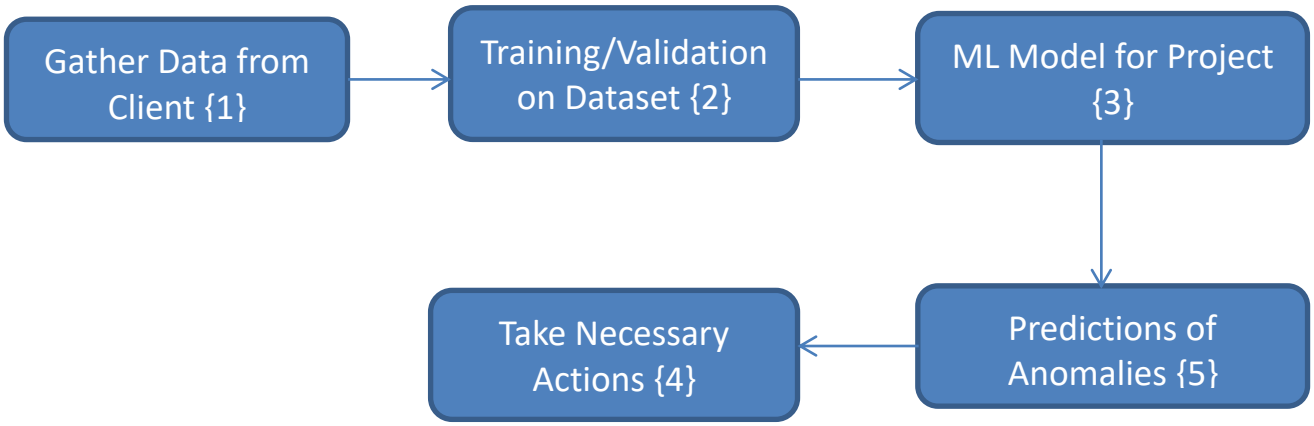


Figure No. 2 Proposed Methodology

1] In which we get the data from client by doing a Data Sharing Agreement.

2] After, that we perform training and testing on the dataset and use validation dataset to testing purpose.

3] After, we can create the model on training dataset by applying the algorithms.

4] Then we predict the target column according to our requirements.

3.1.2 Model Training & Evaluation

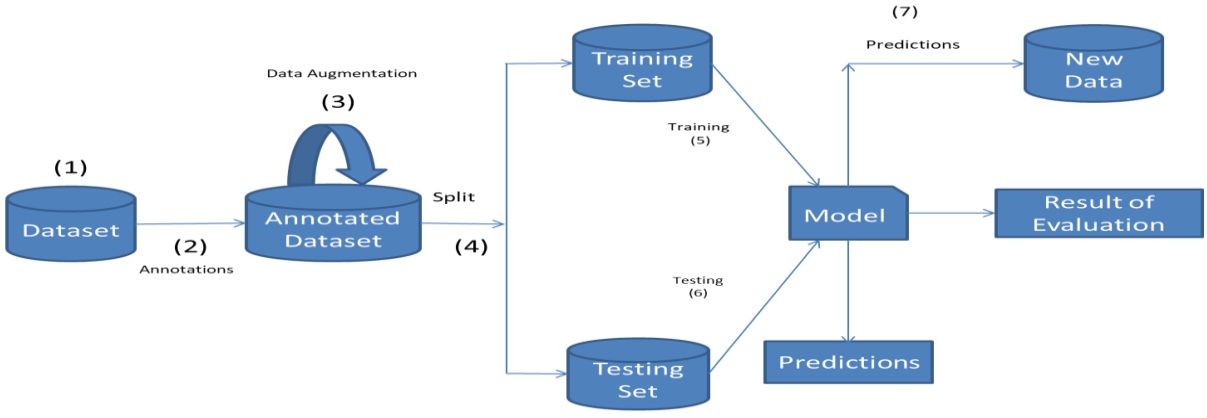


Figure No. 3 The Total Model Process

1] **Dataset:** The given data can be taken from client by doing the Data Sharing Agreement with the client.

2] **Annoted Dataset:** The data which taken from the client we do the annotation do the dataset. In the given dataset we apply multiple methods to fill up the null value.

3] **Split:** The data which we converted into standard format, after that we split the dataset into train & test set

4] **Model:** After splitting the data into train and test we provide the data to the model for predicting the output.

5] **Predictions:** In that process we predict the target columns which are mention in the problem statement.

3.1.2 Deployment Process

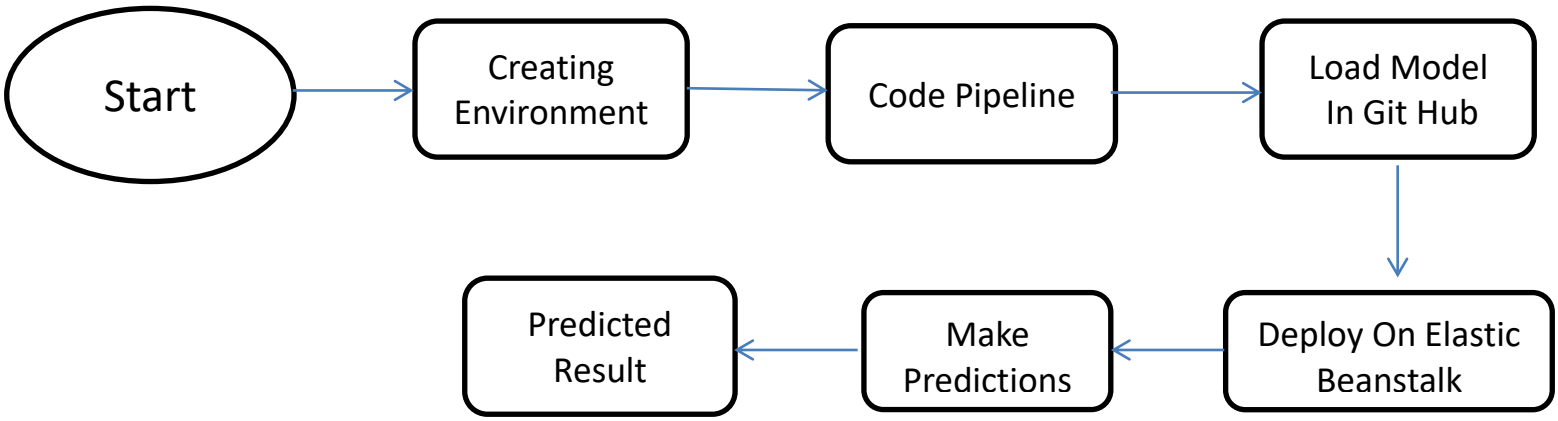


Figure No. 4 The Deployment process

1] For creating the environment we need different file such as

- App.py for interaction purpose
- Templates for the HTML content
- Static for the decorating the HTML page

2] Then we create code pipeline for the continuous process, so that we don't need to create every time.

3] After that we can load our total model on the git hub server, so from that we can upload on the server such as AWS, Azure and Google Cloud Platform

3.2 Event Log

The System should log every event so that the user will know what process is running internally.

Internal Step-By-Step Description

- In this Project we defined logging for every function, class.
- By logging we can monitor every insertion, every flow of data in database.
- By logging we are monitor every step which may create problem or every step which is important in file system.
- We have designed logging in such a way that system should not hang even after so many logging's, so that we can easily debug issues which may arises during process flow.

3.3 Error Handling

Should errors be encountered, an explanation will be displayed as to what went wrong? An error will be defined as anything that falls outside the normal and intended usage.

4 . Performance

Solution of energy efficiency prediction is used to predict the heating & cooling load in advance, so it should be as accurate as possible so that it should give as much as possible accurate prediction. That's why before building this model we followed complete process of Machine Learning. Here are summary of complete process:

1. First we cleaned our dataset properly by removing all null value and duplicate value present in dataset.
2. Second we have to handle the outlier and skewness form the dataset so that it can't effect on the accuracy.
3. Then I split the whole data set train-test split. After that I performed scaling on X_train and X_test.
4. After performing above step I was ready for model training. In this step, I trained my dataset on different Regression Learning algorithm (Linear, Random-Forest).
5. After that I applied hyper-parameter tuning on all models which I have described above.
6. After that I saved my model in pickle file format for model deployment.
7. After that my model was ready to deploy. I deployed this model on various cloud storage (Azure, AWS and Heroku)

4.1 Reusability

The code written and the component used should have the ability to be reused with no problems.

4.2 Application Compatibility

The different component for this project will be using Python as an interface between them. Each component will have its own task to perform, and it is job of the Python to ensure proper transfer of information.

4.3 Resource Utilization

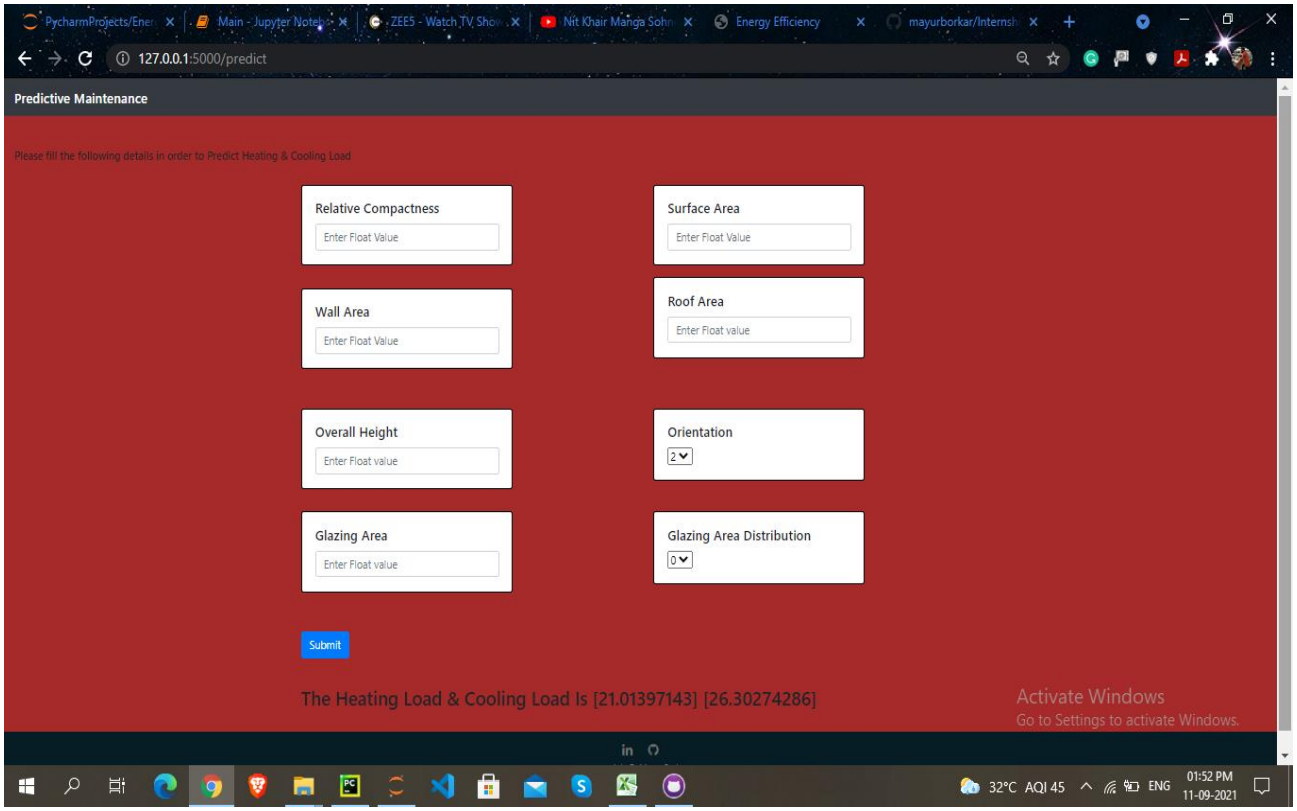
When any task is performed, it will likely use all the processing power available until that function is finished.

4.4 Deployment

Figure No. 5 All Deployment Service

4.5 User Interface

We have created an UI for user by using HTML and CSS.



5. Conclusion

The Energy Efficiency application will find out the Heating Load (HL) and Cooling Load (CL). The effect of eight input variables (relative compactness, surface area, wall area, roof area, overall height, orientation, glazing area, glazing area distribution) on the output variable.