Houses' Energy Efficiency Prediction

Waad Aljehani, Amal Alharthie, Bedar Bahassan, Ghaidaa Allukmani, Dr Ines Boufateh
Department of Information Systems & Technology

كلية علوم وهندسة الحاسب
College of Computer Science & Engineering
جامعة جدة
University of Jeddah

Introduction

According to The Energy Statistics Department in the Kingdom of Saudi Arabia, the residential sector has consumed **47.58%** of the total electrical energy in **2020** [1].

the kingdom of Saudi Arabia has developed programs as a part of **Vision 2030** that concentrates on sustainability such as "**Saudi Energy Efficiency Program**". In this framework, the Saudi Energy Efficiency Center focuses on increasing the energy efficiency in production and consumption to preserve KSA natural resources and enhancing the economic and social welfare of KSA population [2].

In this study, we target the residential sector and aim to build a chatbot that will help consumers estimate houses' energy efficiency.

Suppliers now offer different solutions to save energy, such as choosing LED lights instead of halogen. In addition, consumers are interested in reading the energy label on electrical appliances. All These factors have made it important for customers to consider the energy efficiency aspect when buying or renting a house to save the environment. However, estimating the energy profile is not an easy task for consumers.

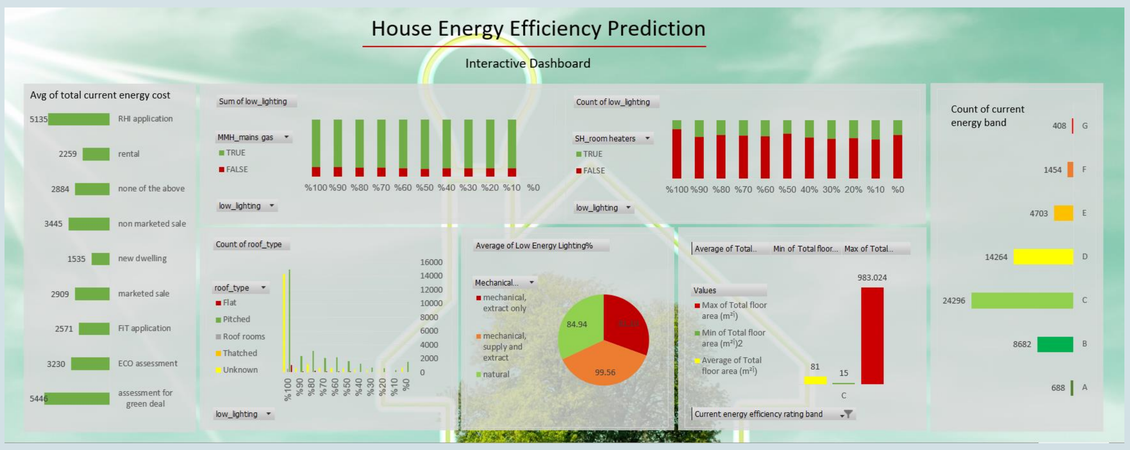
To solve this problem, we will apply energy efficiency estimation in houses by using **machine learning models** and implement it through a **chatbot** to make the tool user friendly.

Objectives

1. Literature review of Energy Efficiency in Housing domain to distinguish our work by developing new ideas based on Machine Learning to help the consumers in evaluating their houses' energy efficiency profile.
2. Data collection, exploration, preparation and pre-processing to ensure a good quality input for our Machine Learning Models.
3. Model building and validation of the optimal result.
4. Chatbot development and implementation of machine learning model.
5. Results communication and recommendations for future work.

Methodology

1. **Business Understanding: i**dentify data's power and how to use it to accomplish the project objectives. Furthermore, the primary goal is to estimate building energy efficiency ratings by using machine learning techniques.
2. **Data collection**: the project's initial stage is to collect data from data published Zendo repository which combines research articles, data sets, research, and reports. The data was gathered between 2012 and 2022 in the United Kingdom [3].
3. **Exploratory data analysis:** the exploratory analysis represents statistical inference and visualization for data and the relation between features. First, libraries are imported and data is explored using Pandas. Graphs are plotted using matplotlib. Moreover, we start to make assumptions about our data and the problem we are attempting to solve.
4. **Data preparation and preprocessing:** the most time-consuming stage of all data cleaning and processing involves resolving inconsistencies, handling incorrect and missing values, dropping outliers and redundant features, textual data preparation, and features are selected using the mutual information method.
5. **Machine Learning model building:** various machine learning models such as XGBoost, Random Forest, KNN, SVM as well as deep learning models, are tested to see the accuracy of each one and select the top 3 based on the highest accuracy rate, then model optimization using RandomizedSearch() is performed on the selected models.
6. **Performance evaluation and model validation:** the effectiveness of the models is assessed using a variety of performance metrics such as accuracy, F1-score and confusion matrix.
7. **Chatbot development and implementation:** the selected model (XGBoost) is implemented as the core of the chatbot, to be used to predict the energy efficiency to make the tool user-friendly.

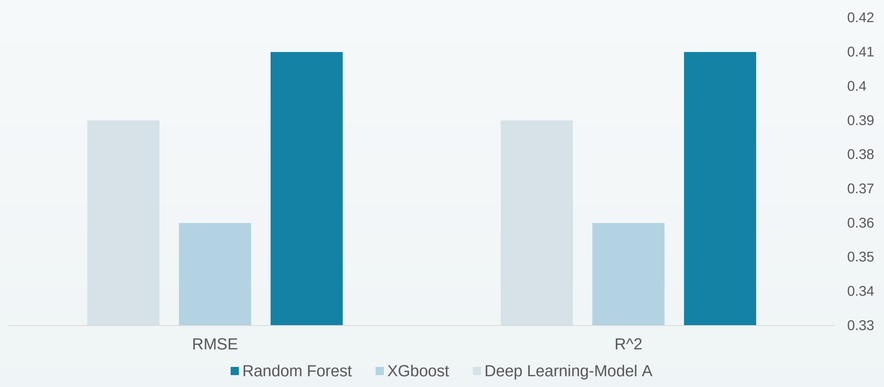


Results

- SVM had the lowest prediction accuracy (72%) but was the fastest in calculations.
- RF contributed to raising the accuracy rate, which was 86%.
- Deep ANN after improvement performs excellently at 87%.
- XGBoost predicts the energy efficiency rating band and achieves 89% ➔ Validated to be used in the Chatbot.

```
Welcome to our Energy Efficiency Prediction chatbot
==================================================
Please choose one of the choices:
1- Calculate energy efficiency rating band
2- exit from chat
```

```
The prediction of Energy Efficiency Rating Band is:  D
```



Conclusion

We created a prototype of a chatbot that helps predict the energy efficiency rating band for the home after training the models to select the best model with high accuracy which is the XGBoost.

	Accuracy	Precision	Recall	F1-score	R^2	RMSE
Support Vector Machine	72%	0.45	0.55	0.48	0.58	0.58
Random Forest	86%	0.69	0.79	0.73	0.41	0.41
XGboost	89%	0.76	0.83	0.79	0.36	0.36
Deep Learning - Model A	87%	0.87	0.87	0.87	0.39	0.39

References

[1] "Saudi Arabia Energy . "،Available in: https://www.worldometers.info/energy/saudi-arabiaenergy
[2] "Energy & Sustainability " Available in: https://www.vision2030.gov.sa/thekingdom/explore/energy./
[3] Maoran Sun: "Building Energy Efficiency" Glasgow 27 July.2022 .Available in: https://zenodo.org/record/6913572#.YyxtsKRBy3A.

Acknowledgements

All praise is to Allah, praise in abundance, good and blessed. Our completion of this project could not have been accomplished without the support of Allah. Thanks to Allah for giving us knowledge, guidance, and the opportunity to complete this project and reach our objectives. with full gratitude to everyone who supported us, starting with our parents, and friends who believed in our capabilities to finish this semester. We also address a special thanks to Dr. Ines Boufateh for standing with us step by step and finally, we would like to thank ourselves for completing this project.

Contact Details