**Predict Houses with Central Air Conditioning Systems**

Prepared by Jacopo Belardo  
For JB Real Estate Agency   
December 11, 2024

**Introduction**

The presence of a Central Air Conditioning system is generally associated with a better quality of a house. In the real estate market, understanding these kinds of characteristics can affect the value of a house and uncover investment opportunities for any agency or individual. In my research, I analyzed a dataset about houses in Ames to see if I could predict the presence of Central Air Conditioning in the property.

**Problem**

The dataset I used contains much information about houses in Ames and my objective was to create a predictive model focused on Central Air. The Central Air column contained two possible values: Yes and No. The model that I built helped me to predict if a property will have a Central Air system based on the other characteristics of the house (e.g. year built, house style, neighborhood, etc.).

**Analysis**

My analysis was based on three commonly used machine learning methods: **Decision Tree**, **Bagged Model**, and **AdaBoost Model**. These models are helpful for our business because they evaluate patterns in home features, such as size, condition, and layout, to predict whether a house has central air conditioning. To assess how well these models work, I used three common measures:

* **Accuracy**: This tells us how often the model correctly predicts whether a house has central air.
* **Precision**: This focuses on the correctness of the predictions. Specifically, precision for "No" checks how many of the homes predicted as "No" actually lack central air. Similarly, precision for "Yes" checks how many of the homes predicted as "Yes" actually have central air.
* **F1-Score**: This combines precision and recall (measures how well the model finds all the actual cases in a category) into one measure, balancing the need to be accurate (precision) and to find all cases (recall). It's especially useful when the data is unbalanced, as in this analysis.

**Results**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Model | Accuracy | Precision (No) | Precision (Yes) | F-1 Score (No) | F-1 Score (Yes) |
| Decision Tree | 93.24% | 34% | 96% | 33% | 96% |
| Bagged Model | 94.48% | 40% | 95% | 20% | 97% |
| AdaBoost Model | 92.91% | 32% | 96% | 32% | 96% |

The results show that all three models perform well in terms of overall accuracy, with the Bagged Model slightly outperforming the others at 94.48%. This makes it the most reliable choice for predicting whether a house has central air conditioning.

However, breaking down the results further highlights key differences:

* **Precision (No)**: The Bagged Model does slightly better at correctly predicting homes without central air, but precision for this group is still low across all models (40% or less).
* **F1-Score (No)**: The Bagged Model’s F1-score for "No" is the lowest at 20%, showing it struggles to balance precision and recall for the minority class.
* **Precision and F1-Score (Yes)**: All models excel for homes with central air, with high precision, recall, and F1-scores (above 95%). This reflects the dominance of the “Central Air = Yes” category in the data.

While the **Bagged Model** is the best overall performer, its weak handling of homes without central air shows room for improvement. Addressing this limitation could involve rebalancing the dataset, exploring new features, or trying advanced models. Improving predictions for homes without central air would enhance the model’s usefulness in guiding renovation efforts and understanding less common market segments.

**Interpretation and Recommendations**

This analysis shows we can reliably predict which homes have central air, making it a valuable tool for understanding property quality. However, the model struggles to identify homes without central air, which could lead to missed opportunities for upgrades or investments.

**Business implications:**

1. **Renovation Opportunities**: Use predictions to identify homes lacking central air and consider recommending upgrades to boost their market value.
2. **Highlight Central Air in Marketing**: Focus on promoting homes with central air, as these are more appealing to buyers and easier to predict.
3. **Guide Investments**: Target undervalued properties without central air for potential renovations and resale opportunities.

By leveraging these insights, JB Real Estate Agency can enhance its property marketing, identify investment opportunities, and better meet client needs.