Satellite Imagery–Based Property Valuation

This report presents a multimodal property valuation framework that integrates satellite imagery with traditional tabular real estate data. The objective is to capture environmental and neighborhood context that significantly influences property prices but is not represented in structured datasets. Empirical results show that incorporating satellite imagery leads to a substantial improvement in prediction accuracy over tabular-only models.

Introduction

Property valuation models commonly rely on structured attributes such as area, number of rooms, and geographic coordinates. While effective, these models ignore visual and spatial cues such as green cover, road connectivity, and neighborhood layout. Satellite imagery provides a scalable means of capturing such contextual information. This project investigates how satellite imagery can enhance traditional valuation models when used in a multimodal learning framework.

Data Description

The dataset consists of structured tabular data containing property-level features and corresponding transaction prices, along with satellite images obtained using latitude and longitude coordinates. Each satellite image represents the surrounding environment of a property at a fixed spatial scale.

Methodology

Satellite images are downloaded using a static mapping service at a fixed zoom level to ensure consistent spatial coverage. A pretrained ResNet50 convolutional neural network is used as a feature extractor to generate high-level visual embeddings. These image-derived features are concatenated with normalized tabular features to form a multimodal feature vector used for regression.

Model Architecture

Baseline models are trained using only tabular features to establish a performance reference.
Subsequently, multimodal models incorporating both tabular and satellite image features are trained. Tree-based ensemble models such as Random Forest Regressors are employed due to their robustness to high-dimensional feature spaces.

Evaluation Metrics

Model performance is evaluated using Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and the coefficient of determination (R^2). These metrics allow direct comparison between tabular-only and multimodal models.

Results and Discussion

The tabular-only regression model achieves an R^2 score of approximately **0.85**, indicating strong baseline predictive performance. When satellite image features are incorporated, the multimodal model achieves an R^2 score of approximately **0.90.** This improvement of nearly five percentage points demonstrates that satellite imagery provides complementary spatial information that is not captured by structured attributes alone.

Table 1

With Tabular Data only	With Satellite based Imaginary data
RMSE: 137183.53 **MAE: 72583.64** **R2: 0.85**	**RMSE: 0.1647** **MAE : 0.1162** **R2 : 0.9014**

Conclusion

This study demonstrates that integrating satellite imagery with tabular data significantly enhances property valuation performance. The observed improvement in R^2 confirms the importance of visual and spatial context in real estate analytics and motivates further research into advanced multimodal larning architectures.

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