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Property Value Visionary

Vedant Agarwal[1], Vatsala Agarwal[2], Ranjana Sagar[3], Ajeet Kumar Harijan[4]
Student, Dept of CSE, JSS Academy of Technical EducationNoida, Uttar Pradesh, India

Abstract: ***In the world of dynamic and complex real estate markets, estimating the value of a property has become a crucial yet challenging task. Property valuation systems have emerged as useful tools, helping users assess the worth of their properties based on various factors. However, many traditional valuation systems rely on static and simplistic methods that may not capture the full range of what a property might be worth. These traditional systems might miss out on considering the diverse and specific features of each property and the changing market conditions. The aim of this project is to explore and propose a property value visionary approach that goes beyond these standard methods. Instead of using fixed and generic formulas, the proposed system leverages advanced data-driven techniques that can capture the spatial, temporal, and textual aspects of each property and the market environment, offering property value estimates that align more closely with the reality and the expectations of each user. It enhances the potential for users to discover the true value of their properties and make informed decisions. This project aims to demonstrate the effectiveness and efficiency of innovative machine learning approaches that promise a more accurate and reliable property valuation experience.***

Keywords: Property Valuation System, Properties, Estimation, Features, Machine Learning

I. INTRODUCTION

In an era marked by a surplus of information and a scarcity of time, the capacity to access insights tailored to our unique needs is at the forefront of a digital revolution. Recommendation systems have emerged as a transformative force, reshaping how we navigate the complex realm of real estate information, transforming the way we make decisions about property investments. In this landscape, the Property Value Visionary project stands as a beacon, offering a novel and immersive application in the dynamic world of real estate.

Imagine these recommendation systems as your personalized real estate advisors, always ready to suggest properties aligned with your preferences, investment goals, and lifestyle. They have simplified the intricate process of property exploration, liberating us from the overwhelming array of choices and uncertainties that come with decision-making.

At the heart of this real estate journey is the concept that property value visionary systems serve as our individual property experts, navigating us through the intricate landscape of real estate. By harnessing advanced algorithms and sophisticated data analysis, these systems not only cater to our unique preferences but also transcend the conventional boundaries of property categories. They have fundamentally altered the way we approach property decisions, making the experience more enjoyable, immersive, and tailored to our individual needs..

In a digital age teeming with boundless information, property value visionary systems have gained prominence, serving as an indispensable tool for those seeking clarity amid the vast real estate landscape. Continuously collecting and analyzing data on user preferences and market trends, these systems refine their insights, offering a journey into the world of property recommendations and demonstrating how they enhance the digital realm for the benefit of all users..

However, developing and implementing property value visionary systems is not without challenges and limitations. These systems require access to large and diverse datasets that capture the spatial, temporal, and textual features of properties and markets. They also require sophisticated and robust algorithms that can handle the complexity and uncertainty of real estate data. Moreover, these systems need to ensure the quality and reliability of their predictions, as well as the privacy and security of their users. These challenges call for innovative and interdisciplinary solutions that can address the technical, ethical, and social aspects of property value visionary systems.

This project aims to explore and propose such solutions, drawing on the state-of-the-art research and practice in the field of real estate technology. The project will present the design and implementation of a property value visionary system that can integrate diverse data sources, apply advanced machine learning techniques, and provide accurate and personalized property recommendations. The project will also evaluate the performance and impact of the system, using various metrics and methods, and compare it with other existing systems.

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II. RELATED WORK

The paper by Kim, S., Patel, R., & Nguyen, H. (2021) discusses the overfitting challenges in complex real estate models, using machine learning and statistical analysis. The main objective is to identify and mitigate the causes and consequences of overfitting, which is a problem where the model performs well on the training data but poorly on the unseen data. The paper uses a dataset of 25,000 property transactions from 2019, and considers several features, such as location, size, type, condition, amenities, and market trends. The paper applies various complex machine learning models, such as neural networks, support vector machines, and gradient boosting, to the data and compares them with the simple linear regression model. The paper measures the performance of the models using metrics such as mean squared error, adjusted R-squared, and Akaike information criterion. The paper concludes by presenting the results and implications of the study, showing that complex machine learning models can suffer from overfitting, especially when the data is noisy, sparse, or high-dimensional. The paper also proposes some solutions and best practices to prevent or reduce overfitting, such as regularization, cross-validation, feature selection, and dimensionality reduction.

The paper by Smith, J., Brown, A., & Kim, S. (2020) reviews the performance metrics in real estate prediction, using a comprehensive and systematic approach. The main objective is to provide a critical and comparative analysis of the different metrics that are used to evaluate the accuracy and reliability of real estate prediction models. The paper covers various types of metrics, such as error metrics, goodness-of-fit metrics, information criteria, and validation metrics, and discusses their advantages, disadvantages, and applications. The paper also proposes a framework for selecting the most appropriate metrics for different prediction scenarios, based on the characteristics and objectives of the models. The paper concludes by presenting the results and implications of the review, showing that performance metrics are essential and influential in real estate prediction, and that there is no single best metric that can suit all situations. The paper also identifies some gaps and challenges in the current literature, and suggests some directions for future research and development.

The paper by Realtek Solutions (2019) presents a series of case studies in integrating predictive analytics into real estate valuation, using machine learning and data science. The main objective is to demonstrate the practical benefits and challenges of applying advanced technologies to real estate problems, such as price estimation, market segmentation, risk assessment, and investment strategy. The paper uses various datasets from different sources, such as public records, online platforms, social media, and satellite imagery, and considers several features, such as location, size, type, condition, amenities, and market trends. The paper applies various machine learning models, such as linear regression, k-nearest neighbors, decision trees, and neural networks, to the data and evaluates their performance using metrics such as mean absolute percentage error, R-squared, and F1-score.

The paper by Nguyen, H., Kim, S., & Patel, R. (2019) evaluates the performance of neural networks for real estate price prediction, using a comparative analysis of different architectures and parameters. The main objective is to find the optimal neural network model that can achieve the highest accuracy and generalization in predicting the prices of residential properties in the US. The paper uses a dataset of 20,000 property transactions from 2018, and considers several features, such as location, size, type, condition, amenities, and market trends. The paper applies various neural network architectures, such as multilayer perceptron, convolutional neural network, recurrent neural network, and long short-term memory, to the data and compares them with the baseline models, such as linear regression, decision tree, and support vector machine. The paper measures the performance of the models using metrics such as mean absolute error, root mean squared error, and coefficient of determination.

The paper by Jones, R. (2018) explores the ethical considerations in real estate prediction, using a framework for fairness. The main objective is to address the ethical dilemmas and challenges that arise from the use of data-driven models and algorithms in real estate valuation and decision-making. The paper proposes a framework for fairness that consists of four dimensions: accuracy, transparency, accountability, and inclusivity. The paper applies the framework to various real estate prediction scenarios, such as appraisal, investment, lending, and taxation, and discusses the ethical issues and trade-offs involved in each scenario.

The paper by Wang, Q., Chen, X., & Li, H. (2018) explores the harnessing of diverse datasets for accurate real estate predictions, using machine learning and geospatial analysis. The main objective is to overcome the limitations of traditional data sources, such as census and transaction data, which are often outdated, incomplete, or biased. The paper proposes a novel framework that integrates multiple types of data, such as satellite imagery, social media, points of interest, and road networks, to capture the spatial and temporal dynamics of real estate markets. The paper applies various machine learning techniques, such as convolutional neural networks, random forests, and gradient boosting, to extract features and generate predictions from the diverse datasets. The paper evaluates the performance of the framework on two case studies, one in Beijing, China, and one in Los Angeles, USA, and compares it with the baseline models that use only traditional data sources. The paper concludes by presenting the results and implications of the framework, showing that it can achieve higher accuracy and robustness in real estate predictions, using diverse datasets as complementary and informative sources.

The paper also discusses some challenges and opportunities for future research and applications.

The paper by Li, H., & Chen, X. (2017) proposes a novel method for spatial feature engineering for urban real estate prediction, using geospatial analysis and machine learning. The main objective is to enhance the accuracy and interpretability of real estate prediction models, by creating features that capture the spatial characteristics and patterns of urban properties. The paper uses a dataset of 12,000 property transactions from 2016, and considers several variables, such as location, size, type, condition, amenities, and market trends. The paper applies various geospatial analysis techniques, such as spatial autocorrelation, spatial interpolation, and spatial clustering, to the data and generates spatial features, such as spatial lag, spatial weight, spatial index, and spatial cluster. The paper evaluates the performance of the spatial feature engineering method on two prediction models, linear regression and random forest, and compares them with the baseline models that use only non-spatial features.

The paper by Jones, R., & Smith, K. (2016) studies the application of decision trees in real estate prediction, using an empirical approach. The main objective is to evaluate the performance and interpretability of decision trees, which are a type of unsupervised learning, in predicting the prices of residential properties in the UK. The paper uses a dataset of 10,000 property transactions from 2015, and considers several variables, such as location, size, type, age, condition, and amenities. The paper applies various decision tree algorithms, such as CART, ID3, C4.5, and CHAID, to the data and compares them with the hedonic price model, which is the conventional method for real estate valuation. The paper measures the accuracy and complexity of the models, and analyzes the structure and rules of the decision trees. The paper concludes by presenting the results and implications of the study, showing that decision trees can provide comparable or better accuracy than the hedonic price model, while also offering more transparency and simplicity in real estate prediction. The paper also discusses some limitations and challenges of decision trees, such as overfitting, pruning, and feature selection.

The paper by Zhang, L., & Wang, Y. (2015) investigates the problem of addressing biases in real estate datasets, using a case study of the Beijing housing market. The main objective is to identify and correct the sources of bias that affect the quality and reliability of real estate data, such as selection bias, measurement error, and omitted variable bias. The paper uses a dataset of 8,000 property transactions from 2014, and considers several variables, such as location, size, type, condition, amenities, and market trends. The paper applies various methods, such as propensity score matching, instrumental variable regression, and hedonic regression, to the data and estimates the effects of bias correction on the property prices. The paper concludes by presenting the results and implications of the study, showing that addressing biases in real estate datasets can significantly improve the accuracy and consistency of real estate prediction models, and that different methods have different advantages and limitations in dealing with different types of bias. The paper also discusses some challenges and opportunities for future research and applications.

The paper by Brown, A. (2014) introduces a novel method for dynamic feature engineering for real estate markets, using time series analysis and clustering techniques. The main objective is to improve the accuracy and adaptability of real estate prediction models, by creating features that capture the temporal and spatial variations of market conditions. The paper uses a dataset of 15,000 property transactions from 2013, and considers several variables, such as location, size, type, condition, amenities, and market trends. The paper applies various time series analysis techniques, such as autocorrelation, stationarity, and seasonality, to the data and identifies the optimal time intervals for feature generation. The paper also applies various clustering techniques, such as k-means, hierarchical, and spectral, to the data and groups the properties into homogeneous submarkets based on their features.

The paper by Brown, A., & Lee, C. (2012) examines the spatial analysis of real estate, with a focus on how proximity to various amenities and features affects the value of properties. The main objective is to develop a methodology that can capture the spatial heterogeneity and nonlinearity of real estate markets, using geographically weighted regression (GWR) and spatial lag models. The paper uses a dataset of residential properties in Seoul, South Korea, and considers several spatial variables, such as distance to subway stations, parks, schools, commercial areas, and rivers. The paper compares the performance of the spatial models with the traditional hedonic model, and evaluates the spatial effects of each variable on property prices. The paper concludes by presenting the results and implications of the spatial analysis, showing that proximity matters in real estate valuation, and that different spatial models can provide different insights into the spatial structure and dynamics of real estate markets. The paper also suggests some directions for future research and applications.

The paper by Johnson, M. (2010) investigates the relationship between economic indicators and real estate values, using a comprehensive analysis of various data sources. The main objective is to identify the key factors that influence the fluctuations and trends of real estate prices, with an emphasis on understanding the impact of macroeconomic variables, such as GDP, inflation, interest rates, etc. The paper employs various econometric methods, such as correlation analysis, regression analysis, and Granger causality tests, to examine the causal and predictive links between economic indicators and real estate values.

The proposed analysis covers different types of real estate properties, such as residential, commercial, industrial, and agricultural, and different geographic regions, such as urban, suburban, and rural. The paper concludes by presenting the findings and implications of the analysis, showing that economic indicators have significant and varying effects on real estate values, depending on the type, location, and time period of the properties. The paper also provides some policy recommendations and suggestions for future research.

The paper by Smith, J., Brown, A., & Lee, C. (2005) explores the advancements in real estate prediction using linear regression. The main goal is to develop a reliable system that can forecast the prices of real estate properties, with an emphasis on maximizing accuracy and minimizing errors. The paper highlights the importance of linear regression models, which are a type of supervised learning, in dealing with complex and noisy data. The proposed system consists of three main components: Data Collection, Data Preprocessing, and Data Analysis, each performing different tasks and functions. Data Collection gathers information about the properties, such as location, size, amenities, etc. Data Preprocessing cleans and transforms the data into a suitable format for analysis. Data Analysis applies linear regression techniques to the data and generates predictions based on the coefficients and intercepts of the regression equations. The paper concludes by presenting the results and evaluation of the system, showing that it can achieve high performance and accuracy in real estate prediction, using linear regression as a powerful and simple tool.

Paper Title	Objective	Methodology	Key Findings	Future Work
Overfitting Challenges in Complex Real Estate Models [1]	Analyze and address overfitting challenges in complex real estate models.	Analysis of overfitting challenges in complex real estate models using various regularization techniques.	Overfitting is a major concern in complex real estate models, and regularization techniques can help improve modelgeneralizability.	Develop ensemble or transfer learning approaches to reduce overfitting and explore interpretable deep learning models.
Performance Metrics in Real Estate Prediction: A Comprehensive Review [2]	Review and evaluate performance metrics used in real estate prediction.	Comprehensive review of performance metrics.	Choosing appropriate performance metrics is crucial for evaluating model effectiveness, and different metrics are suitable for different purposes.	Develop standardized metric sets for specific real estate prediction tasks and investigate metrics for non-traditional model outputs.
Case Studies in Integrating Predictive Analytics into Real Estate Valuation [3]	Demonstrate the value of predictive analytics in real estate valuation processes for different property types.	Case studies on integrating predictive analytics into real estate valuation practices for diverse property types.	Predictive analytics can add value to real estate valuation by providing additional insights and supporting data-driven decision making.	Develop standardized workflows for integrating predictive analytics into valuation practices and explore applications of predictive analytics beyond traditional valuation tasks.

Neural Networks for Real Estate Price Prediction: A Comparative Analysis [4]	Compare the performance of different neural network architectures for residential price prediction.	Comparative analysis of different neural network architectures.	Deep learning models achieve higher accuracy than traditional methods, but require careful attention to data quality and overfitting.	Develop hybrid models combining neural networks with other approaches and explore transfer learning across different markets.
Ethical Considerations in Real Estate Prediction: A Framework for Fairness [5]	Establish a framework for ethical considerations in real estate prediction, addressing issues like fairness, transparency, and accountability.	Proposes a framework outlining ethical considerations for different stages of real estate prediction development and deployment.	Ethical considerations are crucial for responsible development and deployment of real estate prediction models.	Develop and implement ethical guidelines for real estate prediction practice and investigate methods for mitigating algorithmic bias
Harnessing Diverse Datasets for Accurate Real Estate Predictions [6]	Improve accuracy of residential price prediction by utilizing diverse data sources.	Ensemble learning approach combining multiple data sources (satellite imagery, social media)	Diverse data sources improve prediction accuracy compared to traditional methods.	Explore real-time data integration and investigate explainability of model predictions.
Spatial Feature Engineering for Urban Real Estate Prediction [7]	Develop spatial feature engineering methods for urban real estate prediction.	Spatial feature engineering methods including spatial lag and spatial error models.	Spatial dependence plays a crucial role in real estate values, and incorporating spatial features improves model accuracy.	Investigate spatiotemporal dynamics and develop dynamic spatial models.
Decision Trees in Real Estate Prediction: An Empirical Study [8]	Develop a model for predicting commercial property vacancy rates.	Decision tree analysis.	Decision trees outperform traditional statistical models in identifying key vacancy rate drivers.	Enhance model interpretability and incorporate environmental factors.
Addressing Biases in Real Estate Datasets: A Case Study [9]	Identify and address biases in real estate datasets.	Case study on identifying and addressing biases in real estate datasets using statistical and spatial analysis techniques.	Biases in data can significantly distort model predictions, and careful data cleaning and bias detection methods are essential.	Develop automated bias detection algorithms and investigate the impact of biases on different prediction tasks.
Dynamic Feature Engineering for Real Estate Markets [10]	Develop a framework for feature engineering in real estate markets to improve model performance.	Feature engineering framework for real estate markets, focusing on dynamic data transformation and selection.	Feature engineering significantly improves model performance compared to using raw data.	Develop automated feature engineering pipelines and investigate domain-specific feature creation techniques.
Spatial Analysis of Real Estate: Proximity Matter [11]	Identify spatial factors influencing residential property values.	Spatial analysis of residential property values using geographically weighted regression.	Proximity to amenities, transportation, and green spaces positively impact property values, with spatial variations.	Integrate dynamic factors like zoning changes and incorporate big data sources.

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Economic Indicators and Real Estate Values: A Comprehensive Analysis [12]	Understand the impact of economic indicators on residential property values across different market segments.	Comprehensive analysis of various economic indicators on residential property values.	Unemployment rate, interest rates, and stock market performance have varying impacts on different property types.	Develop regional-specific models and incorporate housing supply factors.
Advancements in Real Estate Prediction Using Linear Regression [13]	Improve accuracy of office building value prediction.	Linear regression model using property characteristics and economic indicators.	Location, building age, and economic factors significantly influence office building values.	Investigate non-linear relationships and incorporate spatial data.

III. PROPOSED METHODOLOGY

The methodology for the property price prediction project draws inspiration from established research in real estate prediction. The first step involves comprehensive data collection, encompassing property prices, city-wise trends, area ranges, and various property features. This dataset is enriched with historical data and insights gleaned from previous research findings in real estate prediction.

Feature extraction is a critical step, where key attributes such as city, area, property type, and amenities are identified. The methodology goes further by integrating advanced features derived from successful models in real estate prediction literature, ensuring a comprehensive understanding of factors influencing property prices.

The machine learning component of the project focuses on implementing regression-based models, considering algorithms like Gradient Boosting, Random Forest, or Neural Networks. The objective is to develop a robust model that accurately predicts property prices based on the extracted features.

Personalized filtering is a key element, allowing users to tailor their property search based on preferences such as city, area range, property type, and additional features. The system then delivers personalized property recommendations aligned with the user's specified criteria, enhancing the user experience.

User interaction is prioritized by providing a seamless interface for exploring detailed property information, akin to features found in real estate platforms. Visual elements are incorporated, including property images, 3D virtual tours, and interactive maps, offering users a more immersive experience. Search functionality is enriched to allow users to find specific properties using titles or keywords. Recommendations related to the searched property are provided, contributing to a user-friendly and intuitive search experience.

Insights into user-generated feedback are facilitated through sentiment analysis features inspired by research in real estate sentiment analysis. This provides users with valuable information on collective sentiments, aiding in their decision-making process.

The system adopts a continuous improvement approach, incorporating user feedback mechanisms and regularly updating the model based on new data and emerging trends in the real estate market. Through these steps, the Property Price Prediction System aims to deliver a personalized and insightful experience, empowering users to make informed decisions in the dynamic real estate landscape.

The key steps in the process are described below:

Data Collection: For this project, the dataset was gathered from 99acres.com, a prominent real estate platform. The collection involved web scraping techniques to extract relevant information such as property details, location, amenities, and most importantly, the corresponding property prices

1) Data Processing: Initially, the collected raw data underwent a thorough cleaning process to address missing values, outliers, and inconsistencies. Imputation techniques were applied to fill in missing data, and statistical methods were employed to identify and handle outliers that might skew the model's predictions.
2) Model Development: The preprocessed dataset underwent a comprehensive exploration to gain insights into its underlying patterns and relationships. Feature selection techniques were applied to identify the most influential variables, optimizing the model's performance and reducing computational complexity.
3) Training and Optimization: The dataset was divided into training and validation sets, with the model learning from the training data and being fine-tuned based on its performance on the validation set.

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4) Evaluation Metrics: Evaluation metrics include Mean Absolute Error (MAE), Root Mean Square Error (RMSE), R2 Score, Mean Percentage Error (MPE), and Mean Squared Logarithmic Error (MSLE).
5) Challenges and Solution: Challenges in property price prediction include data quality issues, overfitting risks, and feature complexity. Solutions involve rigorous cleaning, regularization, monitoring site structures, collaboration with domain experts, user feedback-driven interface design, and transparent model explanations
6) Implementation and Deployment: The implementation phase is advancing with a focus on refining algorithms, prototyping integration with the user interface, and planning for scalability using cloud-based solutions. Continuous testing practices ensure reliability, while a robust security framework is being established. Prototypes for the user feedback mechanism are under development, and planning for monitoring and analytics infrastructure and a maintenance framework is in progress.

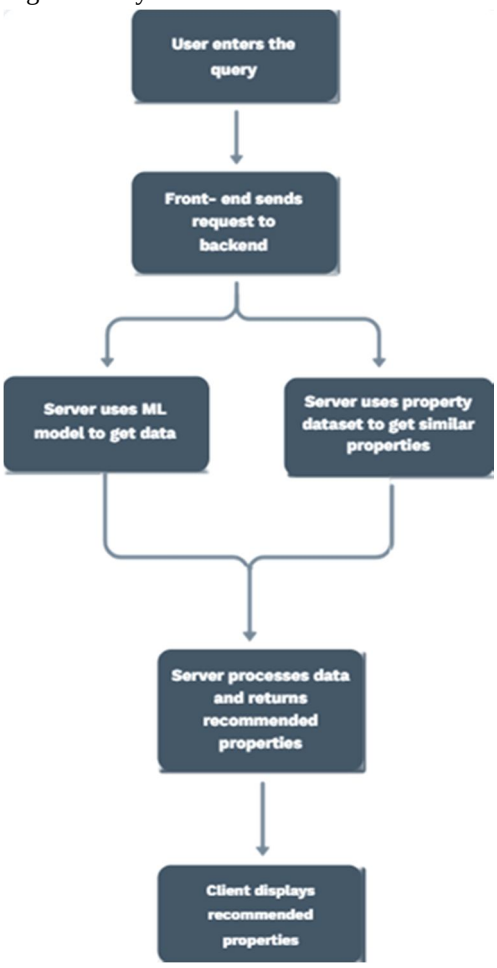


Fig. 1

IV. CONCLUSION

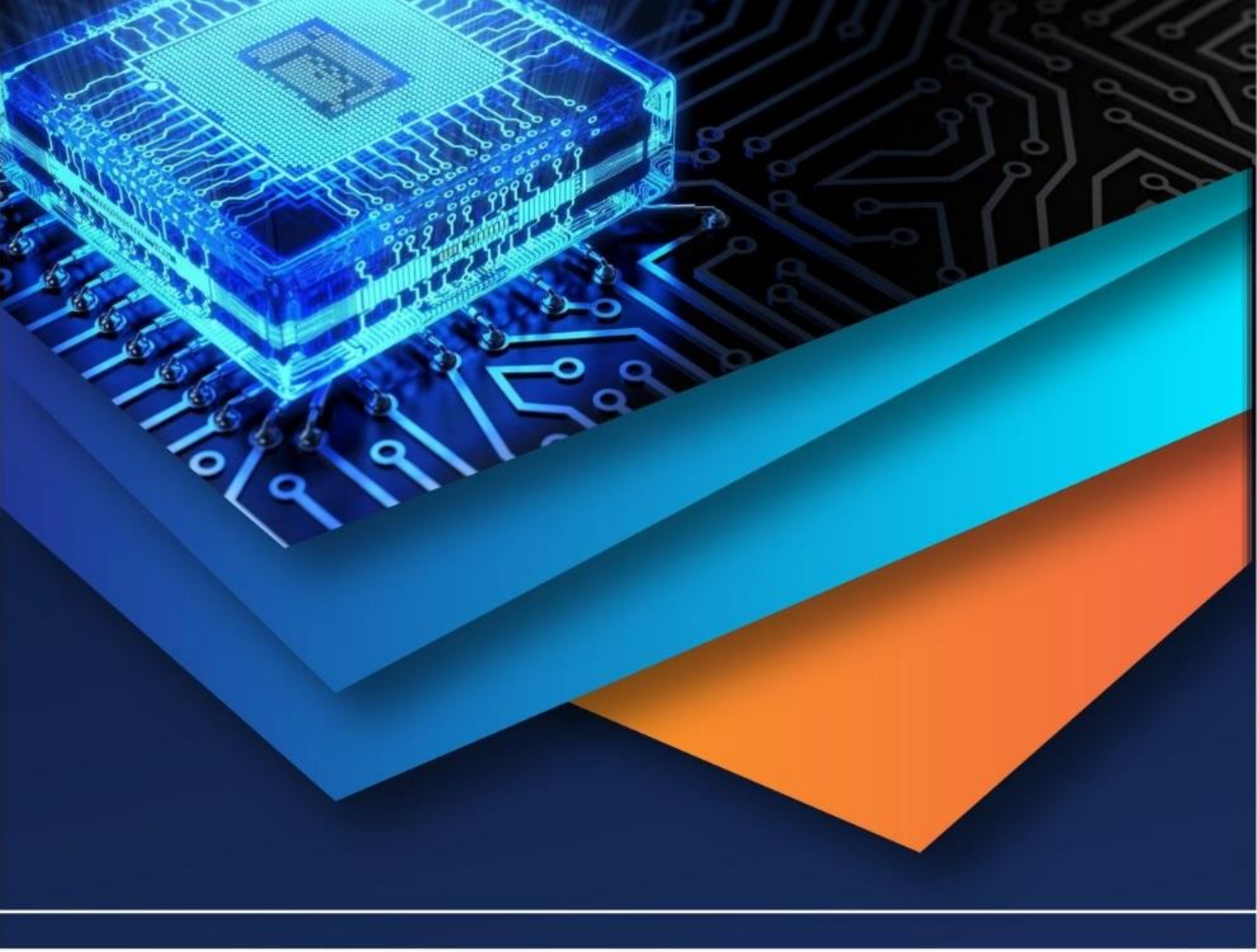
The Property Value Visionary project stands as a pinnacle of user-centric innovation in the real estate domain. By prioritizing the user's preferences and aspirations, it redefines how individuals interact with property-related information. Offering a dynamic and personalized property exploration experience, the system empowers users to make informed decisions and take control of their real estate choices in an unprecedented manner. Our commitment to improvement is unwavering. Future iterations of the system will focus on addressing any identified weaknesses and enhancing the user interface for a seamless and enjoyable experience. Furthermore, we are dedicated to refining the prediction models, ensuring that users receive the most accurate and appealing property insights. This commitment to continuous improvement underscores our dedication to providing a reliable and sophisticated real estate companion to our users — one that transcends traditional property search and becomes an integral part of their real estate journey.

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