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# **Predictive Modeling and Visualization of U.S. Rental Trends Using Zillow Rent Index**

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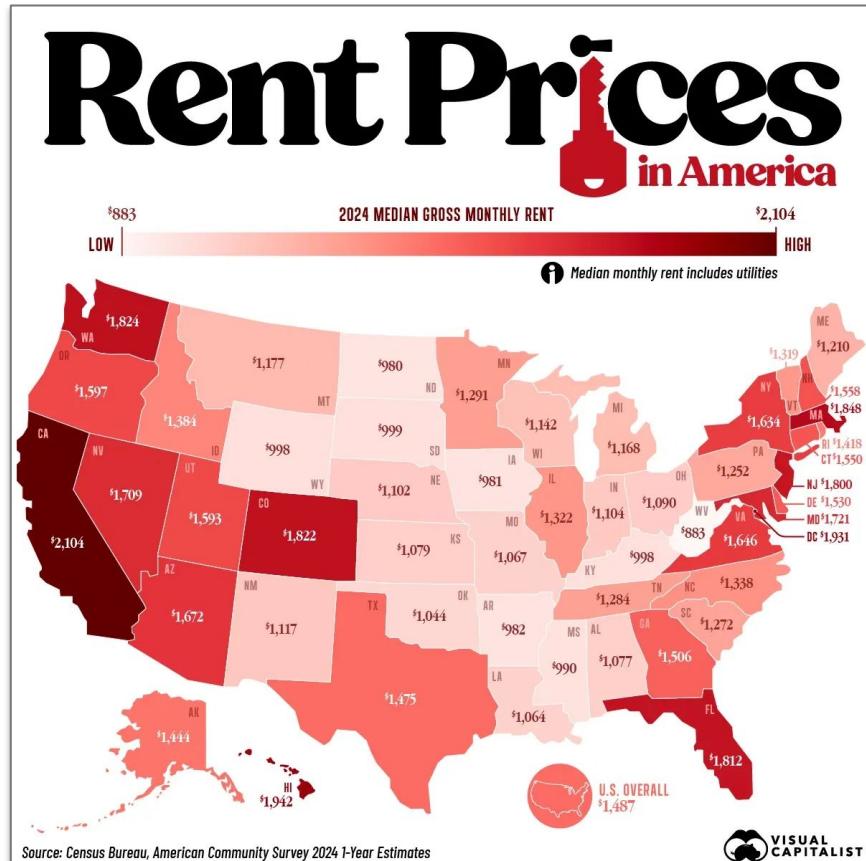
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# The Problem

- The U.S. rental market has experienced significant volatility over the past decade.
- Zillow's ZORI dataset offers rich historical rental data, but it does not provide forward-looking insights.
- Stakeholders such as renters, policymakers, and investors need reliable forecasts to support decision-making.



# Dataset Overview

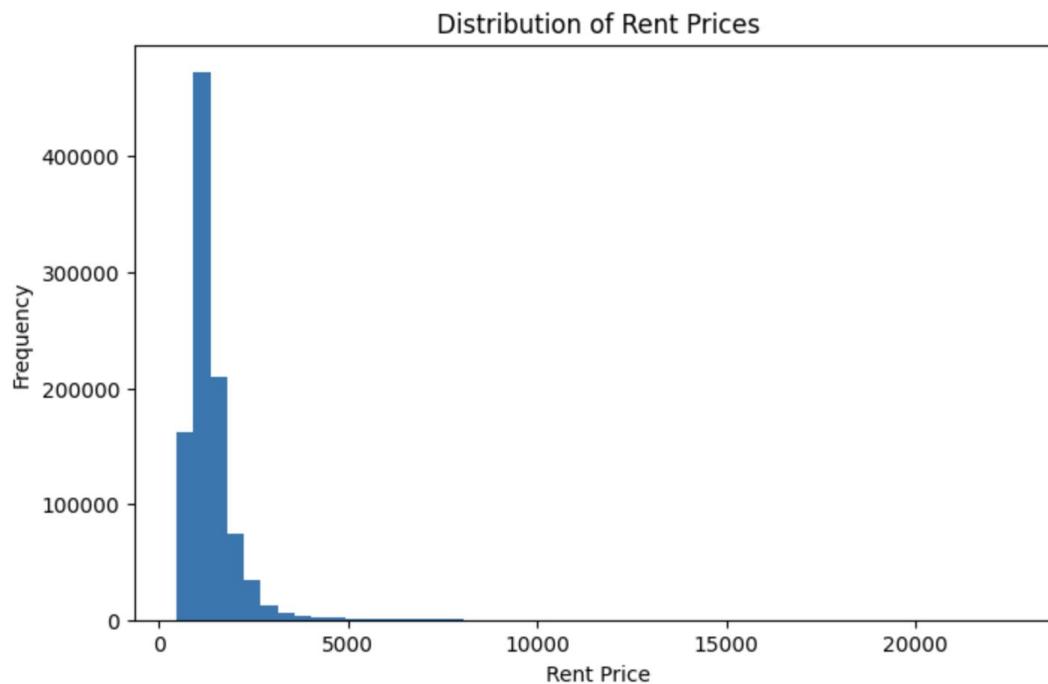
- The project uses Zillow's ZORI dataset, which captures monthly median rents at the city level.
- The raw data is provided in a wide format, with each month represented as a separate column.
- Additional geographic features — including city, state, metro area, and population rank — enable more contextual modeling.

# Data Wrangling

- Transformed the dataset from wide to long format to create a usable time-series structure.
- Generated a unified date index to ensure chronological consistency.
- Addressed missing data through a combination of filtering and forward-filling.
- Capped extreme outliers to stabilize model training and reduce distortion.

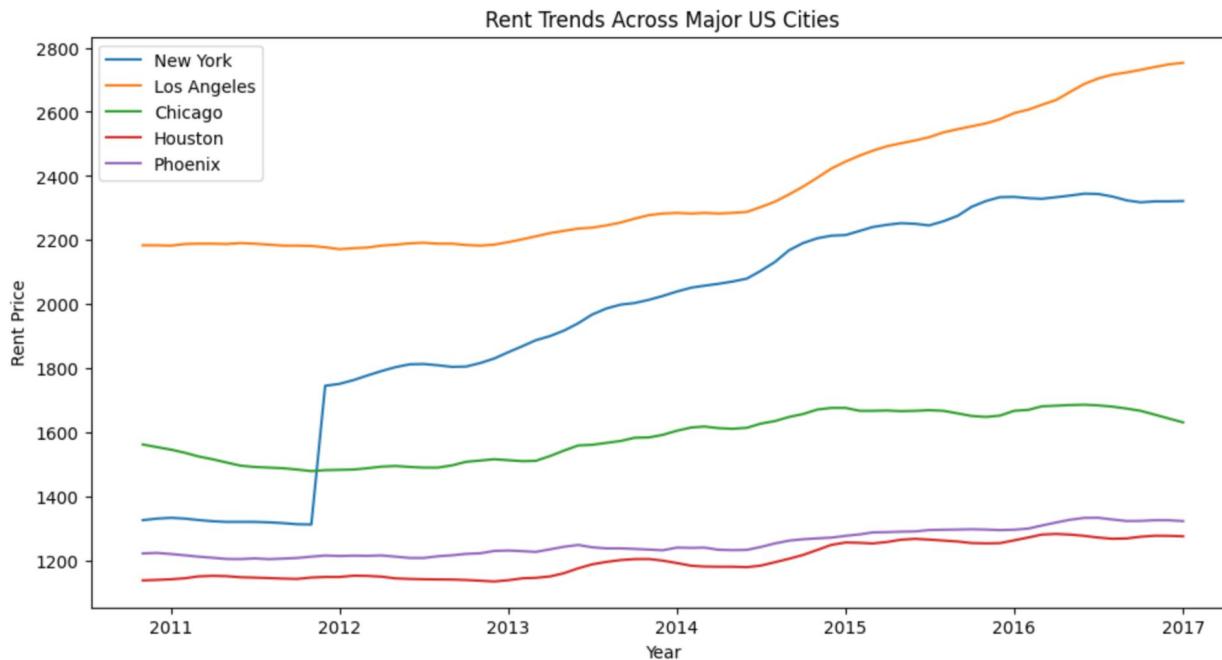
# EDA: Distribution Analysis

- Rental prices show a right-skewed distribution, driven by a small number of high-cost cities.
- This pattern highlights the importance of outlier treatment prior to modeling.



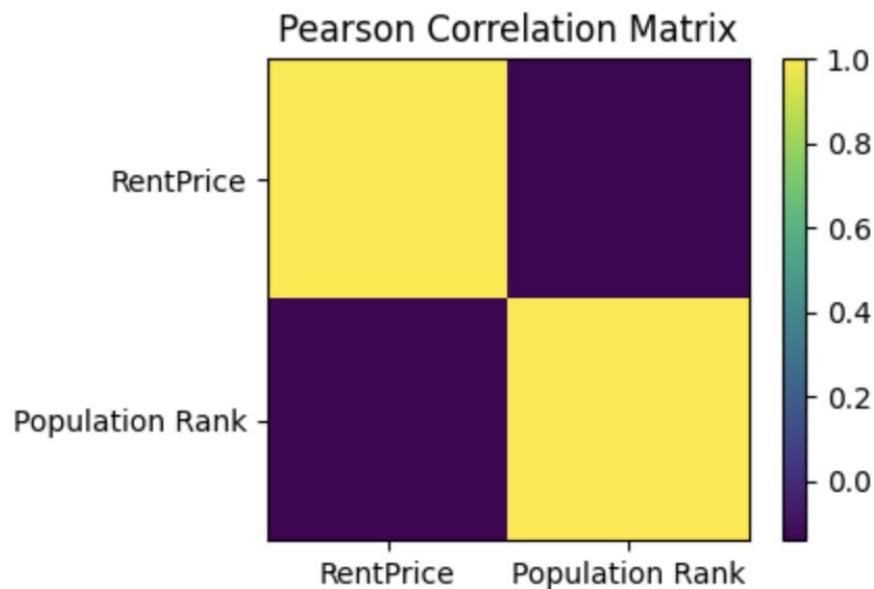
# EDA: Temporal Trends

- Rent values across major U.S. cities exhibit persistent upward trends.
- The rate and magnitude of growth vary by city, reinforcing the need for localized forecasting.



# EDA: Geographic Relationships

- Population rank has a moderate positive correlation with rent levels.
- However, the relationship alone is insufficient for predictive accuracy, supporting a multivariate modeling approach.



# Preprocessing Approach

- Engineered temporal features such as year, month, and ordinal indices to capture seasonality and long-term trends.
- Encoded geographic attributes to support model generalization.
- Applied a chronological train–test split to prevent data leakage and ensure forecasting validity.

# Modeling Strategy

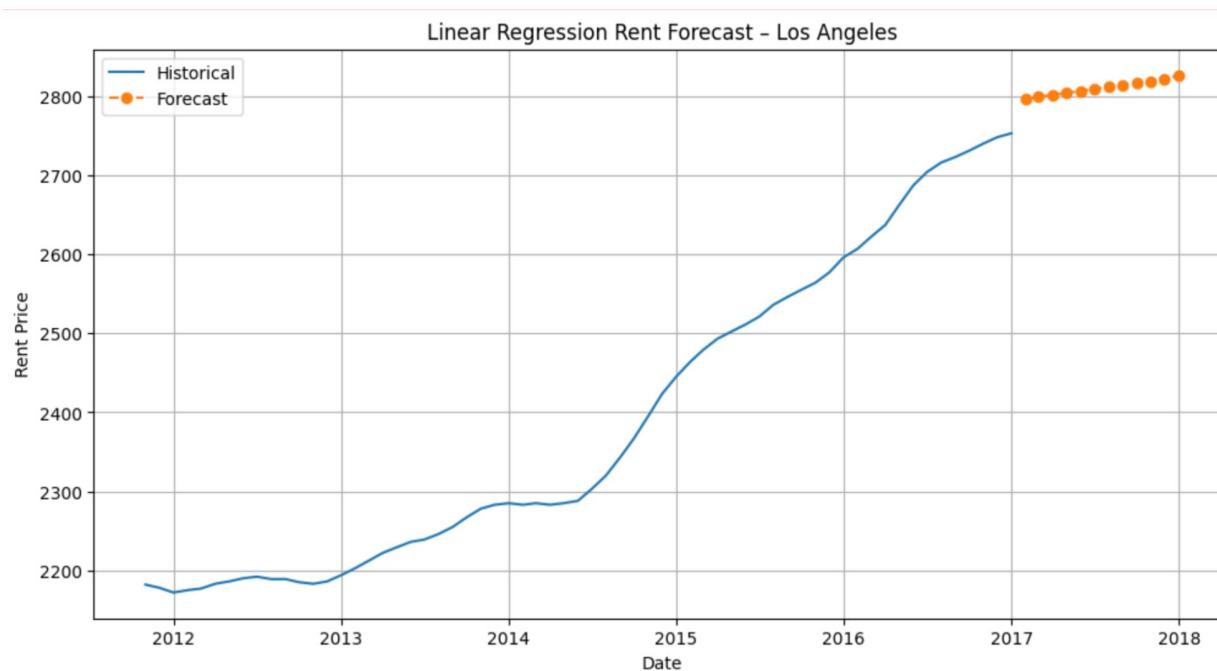
- Evaluated Linear Regression, Random Forest, and Gradient Boosting models.
- Prioritized interpretability, stability, and computational efficiency.
- Linear Regression emerged as the strongest model given the engineered, largely linear feature structure.

# Linear Regression Results

- MAE: 254.7
- RMSE: 495.1
- $R^2$ : 0.43
- Linear Regression outperformed more complex models, delivering consistent and interpretable results.

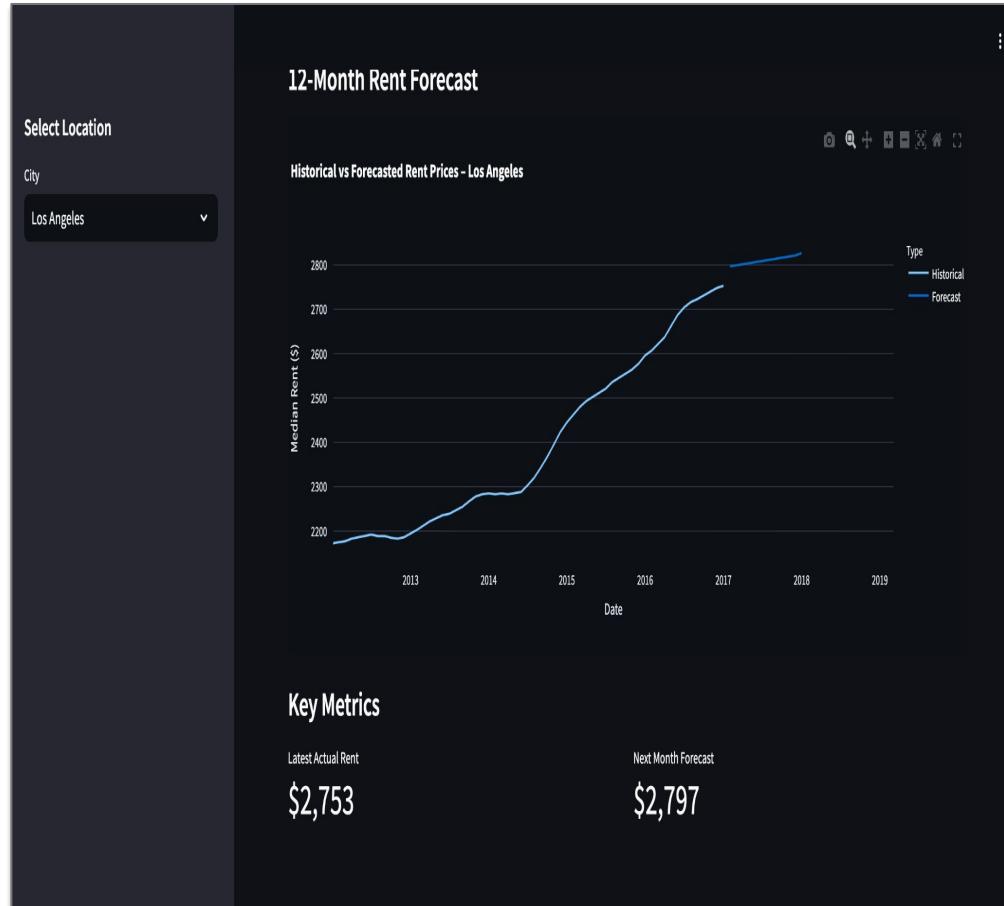
# Forecast Visualization

- Produced 12-month rental forecasts for each city.
- Forecasts demonstrate smooth temporal patterns aligned with historical trends and seasonal variations.



# Interactive Dashboard

- Developed an interactive Streamlit dashboard to make forecasts accessible.
- Users can select cities, view historical rent trends, and generate 12-month predictions.
- Includes key metrics such as the latest rent value and near-term forecast.



# Conclusion

- Successfully developed a forecasting pipeline that transforms historical ZORI data into actionable insights.
- Linear Regression provided the best balance between performance and interpretability.
- The dashboard enhances usability, enabling stakeholders to explore trends with ease.

# Future Work

- Integrate external predictors such as economic indicators or housing supply metrics.
- Experiment with advanced forecasting techniques (e.g., Prophet, XGBoost, LSTMs).
- Expand dashboard functionality and consider deployment for broader public use.