Forecasting Spatiotemporal Dynamics of Suburban Rent Using Machine Learning

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1 Introduction

The rental market exhibits a strong and highly intricate dynamic correlation with economic conditions and societal structures. From a macro perspective, researchers have extended the analysis of rental price determinants to incorporate geospatial dimensions. However, from a micro-level standpoint, the specific mechanisms through which these factors influence rental dynamics in the long term remain a complex and unresolved research challenge[1]. To address this issue, existing works have progressively explored a range of methodologies, from simple linear regression models to deep learning techniques[2].

Nevertheless, critical limitations persist. The precise segmentation of the rental market is difficult to define due to its irregular boundaries. Furthermore, the rental market is inherently dynamic, exhibiting spatiotemporal variability that conventional segmentation approaches often overlook. Within this context, rental price prediction and determination should simultaneously incorporate both temporal and spatial factors to achieve greater accuracy and robustness.

Thus, our primary research objectives highlight the dynamic changes in the rental market, as illustrated in Fig. 1, and resolve around these critical limitations: 1)Developing a novel adaptive market segmentation framework; 2) Enhancing the accuracy of rental price range prediction through the integration of spatiotemporal factors; 3) Gaining an overall insight into the dynamics of the entire rental market.

2 Proposed Research Plan

- **Adaptive Rental Grid Construction.** Census, economic, and property data are matched with census blocks, forming spatial partitions based on feature sensitivity and constructing a bipartite network between census blocks and spatial grids.
- **Rental Price Forecasting.** The graph-based hybrid model represents grids or clusters as nodes and relationships as edges, while the forecasting module predicts rental prices and captures variable dependencies.
- **Dynamic Rental Market Monitor.** Geospatial Visualization: Mapping market structure dynamics and rental price fluctuations.

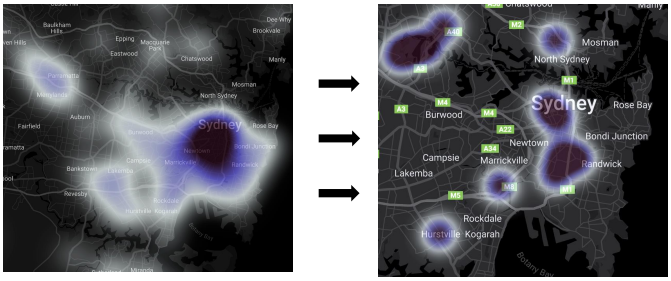

Fig. 1. Conceptual Diagram of the Long-Term Dynamic Evolution of Market Segmentation in the Sydney Rental Market

3 Anticipated Contributions

The key contributions of our work are summarized as follows: 1) **An novel adaptive rental market grid partitioning method.**It breaks away from existing segmentation frameworks, reducing the dominance of administrative boundaries. 2) **A hybrid spatiotemporal model.**Our work employs a hybrid model combining Spectral Graph Neural Networks (Spectral GNNs) and Spatial Graph Neural Networks (Spatial GNNs) to simultaneously capture the dependencies among inter-variable and time points relationships, thereby enhancing the accuracy of rental price prediction. 3) **Rental market monitoring framework.**We implement long-term monitoring of market conditions to continuously track the dynamic evolution of rental market segmentation and rental price fluctuations. This approach enables real-time insights, providing overall data-driven decision-making support for both tenants and property owners.

4 Planned Timeline

- 01/2025-06/2025: Adaptive rental grid construction
- 07/2025-12/2025: Hybrid GNN model and pre-training
- 01/2026-06/2026: Model optimization and experimentation
- 07/2026-12/2026: System deployment and dynamic monitoring
- 01/2027-06/2027: Drafting the initial thesis manuscript

References

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