Spatial - Temporal Graph Attention Networks for Learning Urban Location Quality and Optimal University Dormitory Site Selection

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Abstract:
The appropriate placement of university dormitories is a foundational pillar of sustainable urban development and equitable access to higher education. Conventional site-selection approaches are typically constrained by rule-based criteria or limited spatial indicators that do not adequately capture the interconnected structure of urban environments. We propose a spatial–temporal urban learning framework based on Spatial–Temporal Graph Attention Networks (STGAT) to model urban location quality and support data-driven dormitory planning. Multi-modal geospatial datasets, including points of interest, public transportation networks, universities, and population characteristics, are integrated within a heterogeneous urban graph, from which a continuous Location Quality Index (LQI) is constructed and learned across all urban nodes. The STGAT model concurrently captures spatial dependencies and daily transport patterns through attention mechanisms, facilitating the scalability of location suitability. The framework is evaluated using spatially grouped cross-validation in Trabzon, Türkiye, achieving high predictive fidelity ($R^2 \approx 0.89$, RMSE ≈ 0.039). Results demonstrate discernible spatial continuities of LQI, interpretable latent patterns, and clear differences among urban entity types. Post-hoc validation reveals that a significant proportion of existing dormitories are in less favorable areas, necessitating systematic site re-evaluation. The proposed model further generates a ranked set of high-quality candidate locations for new dormitories and supports inference-only what-if analysis to explore transport- related policy scenarios. Overall, the study presents an interpretable, scalable, and decision-support tool-oriented planning approach for data-driven student housing planning and urban facility optimization.

keywords:
Smart Cities, University Dormitories, Spatial–Temporal Graph Attention Network (STGAT), Urban Location Quality Index