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Mapping the social inequity of neighborhood visual environment in Los Angeles through computer vision and multi-model machine learning

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Abstract:

Aligned with the United Nations' Sustainable Development Goals, creating inclusive, safe, and sustainable cities has become a key objective in urban planning and environmental management. While prior studies have examined built environment characteristics and social disparities, few have explored how neighborhood visual environments—shaped by actual built features—differ across social and vulnerable groups at a large scale.

This study addresses this gap by developing a multi-modal machine learning framework to assess visual environmental inequity in Los Angeles County, a region notable for its ethnic diversity and socioeconomic contrasts (Figure 1). Using over 500,000 street view images from Mapillary and actual built environment data from OpenStreetMap and Google Earth Engine, we quantify neighborhoods in terms of 5D dimensions (density, diversity, design, distance, destination) and measure visual perceptions (beautiful, safe, wealthy, livable, boring, depressing) using a ResNet-based image classification model trained on crowd-sourced perception scores. Semantic segmentation is conducted using DeepLabV3+, and a gradient boosting ensemble model identifies the built features most associated with perceived soundness.

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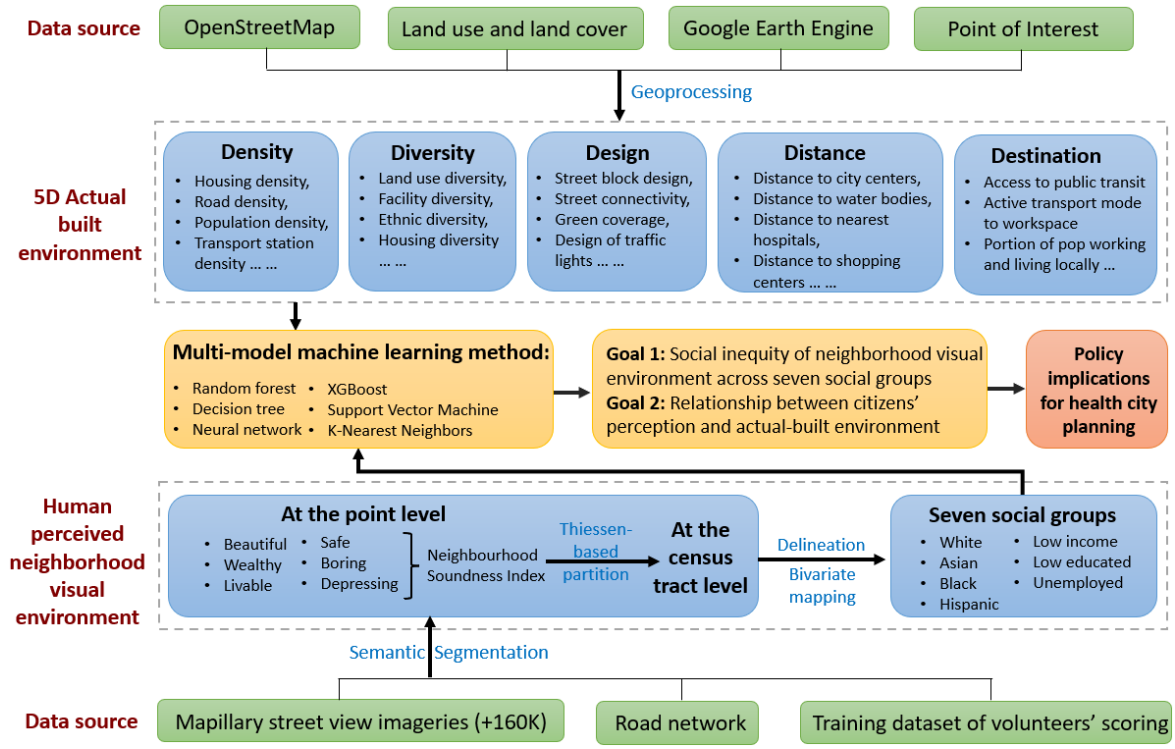

Figure 1. Conceptual framework and analytical workflow used in this study

Results reveal pronounced visual environmental disparities (Figure 2): neighborhoods with higher concentrations of Black, Hispanic, low-income, and unemployed populations exhibit lower perceived soundness. Key positive predictors of soundness include canopy density, multi-unit housing density, and proximity to central business districts. Findings suggest a need for urban policies that prioritize green coverage and improve built environment design in underserved neighborhoods to foster more equitable urban experiences.

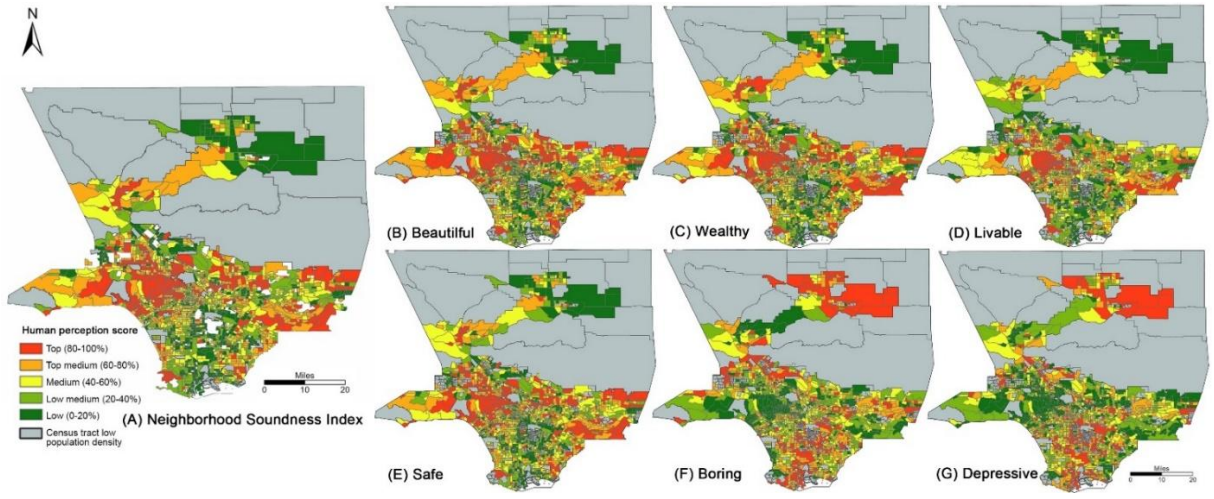

Figure 2. Spatial patterns of the neighborhood soundness index and six perceived neighborhood visual environment indices at the census tract level.

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