Urban Space embedding based on Street-Level Images and perceived urban similarity

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In an age of rapid urbanization and evolving urban challenges, such as social inequalities and resilience, gaining a comprehensive understanding of urban spaces is paramount for urban planners and policymakers to enhance the well-being of citizens. Urban spaces serve as the canvas upon which transportation networks are built, defining accessibility, connectivity, and the overall mobility experience for residents. Effective neighborhood planning, prioritization of interventions, and resource allocation must account for these transportation dynamics.

Traditional methods of characterizing neighborhoods often fall short in capturing the multidimensional nature of urban spaces and their transportation infrastructure. They often neglect to incorporate human perceptions and feelings, which are vital for understanding how people interact with the urban environment, especially in the context of transportation experiences.

To bridge this gap, our research proposes an innovative method for creating urban embeddings that integrate human perceptions about those spaces. This method comprises four key steps. First, we collect street-level imagery from a particular city, offering an extensive visual record of its urban landscape. Second, the city is subdivided into small spatial units, each representing a neighborhood, considering the visual appearance of transportation infrastructure, land use and urban equipment visible in the images. Third, a survey is conducted where participants evaluate and compare neighborhoods based on what they see in the images. This survey allows us to capture how humans perceived the places based on similarity judgments. Fourth, urban vectors are generated through a deep-embedding model, incorporating both observable transportation and urban features and human-perceived aspects related to infrastructure and visual appearance.

The resulting urban embeddings provide context-aware representations that encompass the spatial, visual, and socio-economic complexities of neighborhoods, with a specific emphasis on their transportation infrastructure and urban visual appearance. Our preliminary findings reveal the ability to differentiate various types of neighborhoods, such as residential, commercial, and transit-oriented areas, offering nuanced insights into urban dynamics.

Beyond its theoretical value, our research has practical implications for urban planning and policymaking. By offering insights about city structures and how different type of urban spaces are allocated in cities, our research aims to support urban planners and policymakers in making evidence-based decisions to address the multifaceted challenges that cities face today. We believe that this approach, which bridges the gap incorporating human perceptions in urban characterization, is crucial for developing cities for humans who live in them and enhancing the overall livability of urban areas.

Working progress result:

Figure 1 presents the output of a simpler urban embedding model applied to the frequency of Points of Interest (POIs) as a proof of concept for the model we are working. The color representation in the figure signifies the similarity between urban spaces. In this context, regions with closely matched colors indicate greater similarity in their urban characteristics. To illustrate this concept further, let's focus on the city of Delft as an example. Within Delft, we can identify three distinct zones marked by the colors. Zones 1 and 2 share a predominantly blue tone, indicating their similarity. These areas correspond to locations with abundant greenery, resembling countryside settings. Zone 3 stands out with a distinct color, representing the city center characterized by its 'old infrastructure'. Surrounding Zone 3, we observe green tonalities, representing the residential areas. It's important to note that these results offer a simplified visual representation of the output generated by our visual embedding model. The intention is to use this approach to characterize various types of neighborhoods more comprehensively.

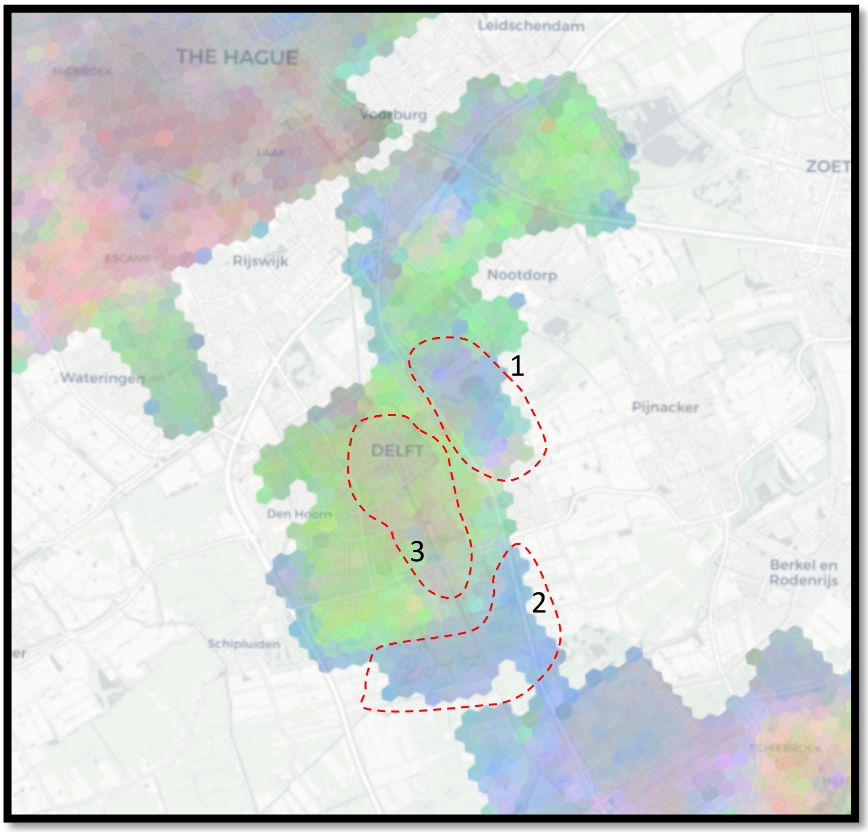

Figure 1. Visualization of an urban space embedding applied over Delft, the Hague and Rotterdam using some POIs frequency. Similar colors indicate similar neighborhoods.