CTwalk
A tool for mapping potential inter-population encounters In X-minute neighborhoods

Milias, V.; Psyllidis, A.

Publication date
2025

Document Version
Final published version

Citation (APA)
Milias, V., & Psyllidis, A. (2025). *CTwalk: A tool for mapping potential inter-population encounters In X-minute neighborhoods*. Paper presented at 19th International Conference on Computational Urban Planning and Urban Management (CUPUM 2025), London, United Kingdom.

CTwalk: A tool for mapping potential inter-population encounters In X-minute neighborhoods

Milias, V.; Psyllidis, A.

Publication date
2025

Published in
Proceedings of the 19th International Conference on Computational Urban Planning and Urban Management (CUPUM 2025)

Citation (APA)
Milias, V., & Psyllidis, A. (2025). CTwalk: A tool for mapping potential inter-population encounters In X-minute neighborhoods. In *Proceedings of the 19th International Conference on Computational Urban Planning and Urban Management (CUPUM 2025)* https://osf.io/jmt8w

CTwalk: A tool for mapping potential inter-population encounters in X-minute neighborhoods

Vasileios Milias *[1] and Achilleas Psyllidis †[2]

[1]Laboratory of Transportation Engineering, School of Rural, Surveying, and Geoinformatics Engineering, National Technical University of Athens
[2]Urban Analytics Lab, Department of Sustainable Design Engineering, Delft Unversity of Technology

CUPUM 2025

Summary

Proximity-oriented planning aims to promote active transportation and reduce car dependence by ensuring essential services are within a short walking or cycling distance. While often seen as promoting social interactions, models like the "15-minute city" risk reinforcing spatial segregation by limiting interactions among diverse demographic groups. Addressing the lack of tools to analyze these effects, CTwalk is a data-driven software tool that maps the encounter potential of urban destinations across population groups within 5- and 15-minute walks. The tool identifies access inequities and evaluates how different destinations are mutually accessible to diverse populations.

KEYWORDS: Accessibility, Proximity, Segregation, Access equity, 15-minute city

1 Introduction

Proximity-oriented planning has gained renewed attention in recent years as a strategy to promote active transportation and reduce car dependence. A notable example is the "15-minute city" model—a concept reminiscent of earlier models like the "neighborhood unit" and "compact city"—which envisions essential services, goods, healthcare, and leisure activities accessible within a 15-minute walk or bike ride, occasionally incorporating public transit (Moreno et al. 2021; Pozoukidou and Chatziyiannaki 2021; Weng et al. 2019). Although such models are often assumed to promote social interactions, encouraging people to spend most of their time near their residences could inadvertently reinforce spatial segregation by limiting interactions between diverse demographic groups, particularly marginalized communities. Existing tools for analyzing and visualizing segregation effects remain limited. To address this gap, we present *CTwalk*, a data-driven software tool that maps the encounter potential of urban destinations across population groups within 5- and 15-minute walking distances. CTwalk uncovers access inequities and assesses the co-accessibility of destinations, measuring the extent to which they are mutually accessible to diverse population groups (Milias, Psyllidis, and Bozzon 2024).

*vmilias@mail.ntua.gr
†a.psyllidis@tudelft.nl

2 Data input

The data and methodology for measuring the encounter potential of urban destinations build on previous research (Milias and Psyllidis 2022). Our approach consists of two main steps. First, we assess pedestrian accessibility by delineating 5- and 15-minute walksheds from residential locations, based on street segment lengths and an average walking speed of 1.26 m/s (Schimpl et al. 2011). Within these walksheds, we calculate the total number of destinations accessible from each residence. Second, we evaluate the encounter potential of each destination by determining: (1) the total number of people who can access it within the 5- and 15-minute walksheds, (2) the number of individuals from distinct population groups with access, and (3) the diversity of these groups, quantified using Shannon's Equitability Index (Shannon 1948).

The openly accessible online version of CTwalk currently covers the five largest cities in the Netherlands: Amsterdam, Rotterdam, The Hague, Utrecht, and Eindhoven. The tool can be adapted for other cities and countries, provided pedestrian street network, point of interest (POI), and demographic data are available.

Data on pedestrian networks and POI destinations are sourced from OpenStreetMap (OSM), a global open source mapping platform. Using the OSMnx package, we extracted walkable streets by setting the network type to "walk," thereby excluding street categories unrelated to pedestrian activity, such as motorways, service roads, and cycleways (Boeing 2017). The current version of the tool focuses on destinations such as parks, cafes, or playgrounds that encourage informal, voluntary, and diverse social interactions beyond home and work. These are locations where individuals of various ages can engage in activities and encounter one another. This selection can be customized to suit different contexts. OSM data for this version were collected in November 2021.

While our current implementation focuses on different age groups, the approach can be extended to incorporate other demographic characteristics, such as ethnicity, income, or level of education. For demographic data, we used granular population statistics from the Dutch Central Bureau of Statistics (Centraal Bureau voor de Statistiek, 2020), which provides data at a 100 × 100 m grid resolution. Our analysis is based on population demographics from the year 2020, categorizing residents into three age groups: children (0–15 years), adolescents and adults (16–64 years), and the elderly (65 years and older).

3 Implementation of the software tool

The backend of CTwalk, responsible for data collection and analysis, was implemented using Python and a PostgreSQL database. The associated code is open source and is available on GitHub[1]. The frontend, developed using Mapbox and JavaScript, is open-access and can be accessed via https://miliasv.github.io/CTwalkMap/.

CTwalk presents three main layers of information, which users can toggle on and off via the map's interface, as shown in Fig. 1.

Pedestrian street network and walkable areas: The first layer displays the pedestrian street network along with 5- and 15-minute walkable areas. This allows users to explore how the pedestrian network structure affects the areas accessible on foot from a given residence. Buttons in the top-left

[1] https://github.com/MiliasV/coaccessibility

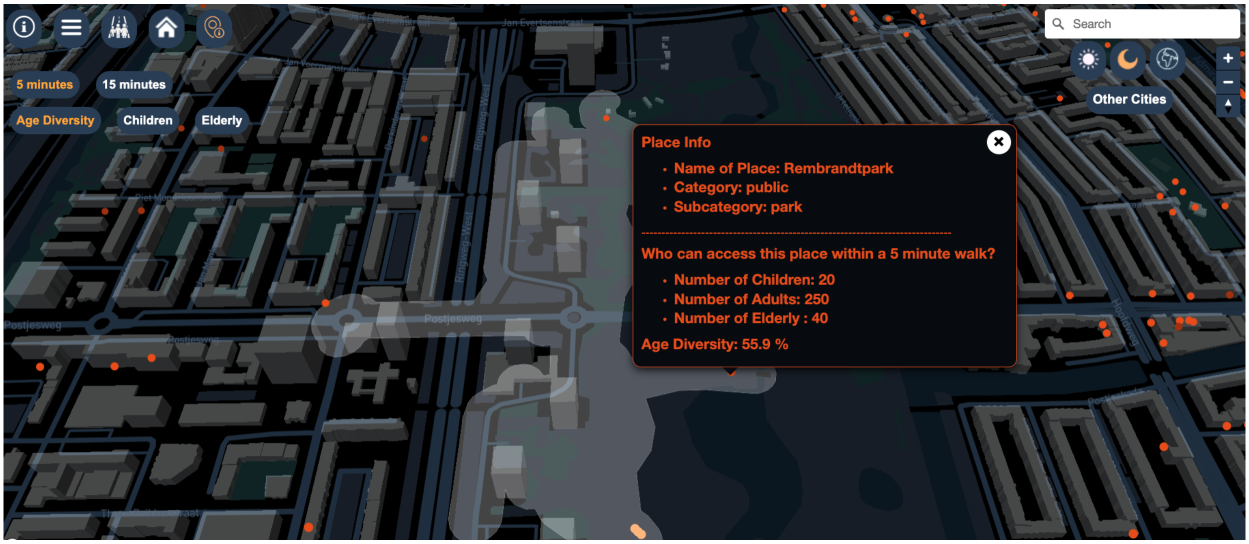

Figure 1: CTwalk's user interface.

corner of the interface enable users to switch between the 5- and 15-minute walksheds. Hovering over the map dynamically highlights the corresponding walksheds, as depicted in Fig. 2.

Accessibility inequities: The second layer highlights inequities in accessibility by showing the number of destinations accessible within a 5- or 15-minute walk from residential locations. Residences are represented as a grid with a spatial resolution of 100 × 100 m. Activating the population demographics layer colors each grid cell based on the number of accessible destinations, as illustrated in Fig. 3. Clicking on a specific grid cell opens a pop-up displaying detailed information, including the total number of accessible destinations, the breakdown by category (e.g., public places, cultural venues, food and drink establishments, and shops), and the size of the walkshed, as shown in Fig. 4. The map's coloring scheme—ranging from deep purple (below average) to yellow (above average)—is indicative and can be customized for different thresholds.

Encounter potential of urban destinations: The third layer visualizes urban destinations and their encounter potential. Fig. 5 illustrates the destination layer in Amsterdam. Clicking on a destination reveals detailed information, including (1) the destination's characteristics, (2) the total number of people and population groups (e.g., by age) who can access it within a 5- or 15-minute walk, and (3) the age diversity of these individuals. Each destination is color-coded to indicate whether the age diversity (or the proportion of children or elderly individuals) of its visitors is below, near, or above the national average. Users can customize the coloring scheme by selecting "Age Diversity," "Children," or "Elderly" in the top-left menu (Fig. 1). This visualization highlights the extent to which destinations foster interactions among diverse individuals and groups.

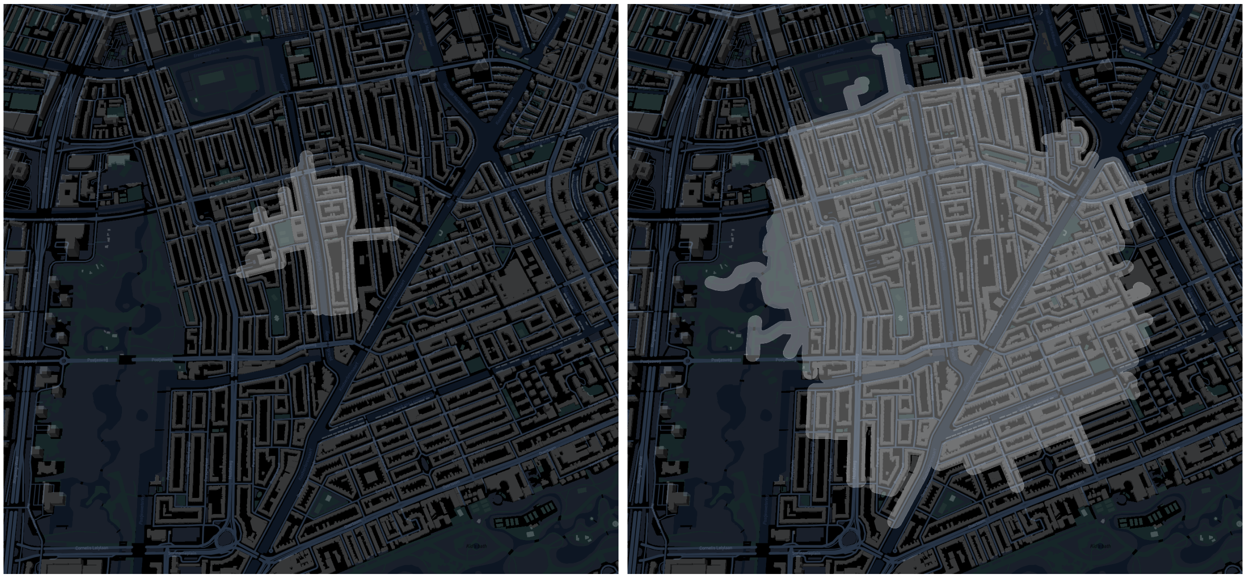

Figure 2: Snapshot from CTwalk depicting the 5 and 15-minute walksheds.

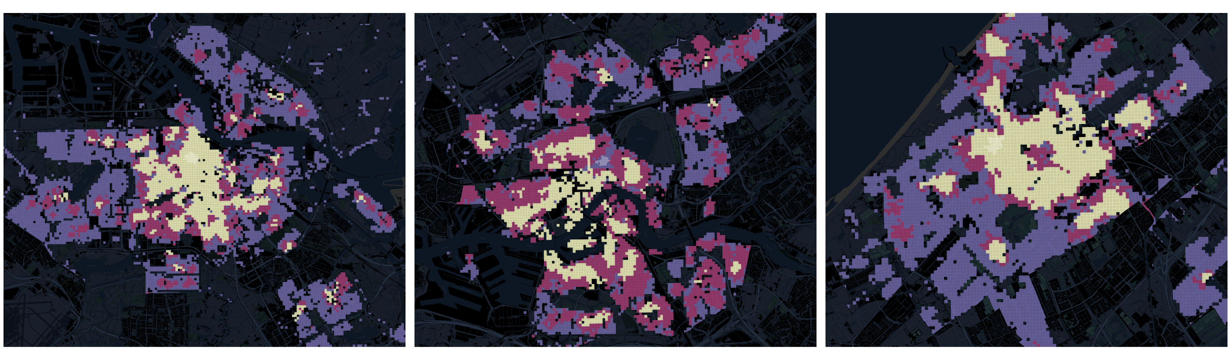

Figure 3: Snapshot from CTwalk Map depicting the population demographics layer for Amsterdam (left), Rotterdam (middle), and The Hague (right).

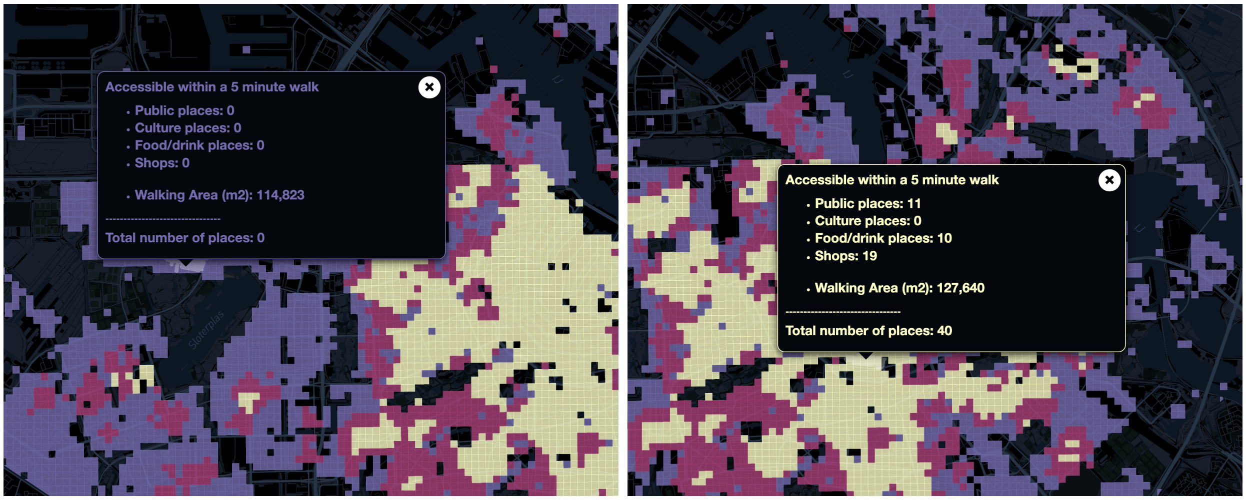

Figure 4: Snapshot from CTwalk depicting the residences with a low (left) and high (right) number of accessible destinations (Amsterdam).

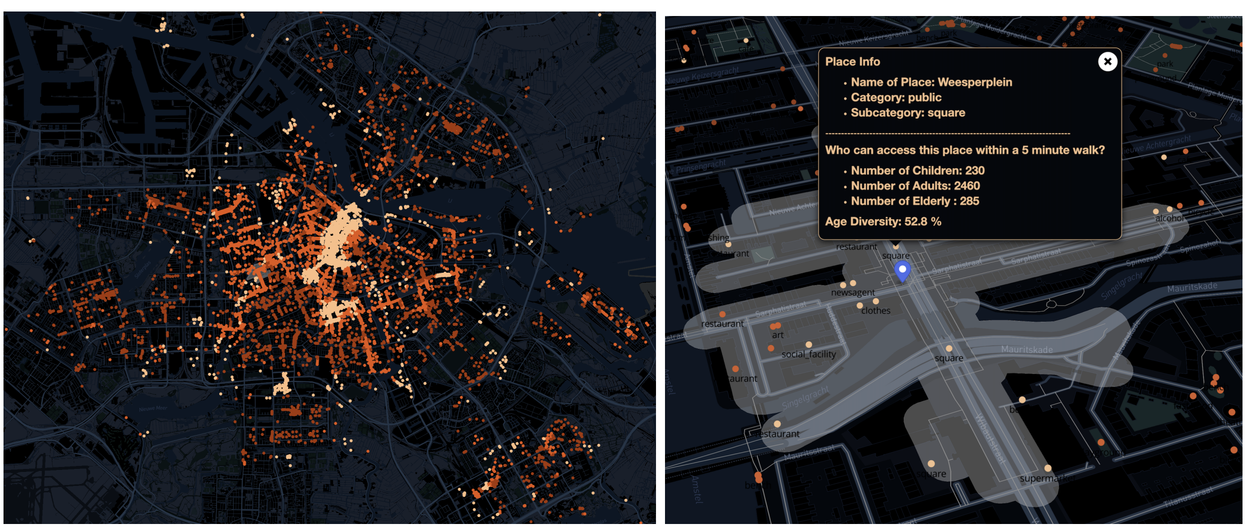

Figure 5: Snapshot from CTwalk depicting the destinations layer (left) and the co-accessibility measurements (right) (Amsterdam).

4 Discussion

CTwalk is a versatile tool for evaluating encounter potential and spatial segregation in X-minute neighborhoods that can be adapted to diverse contexts, applications, or research projects by customizing its three core elements. The first involves how accessibility is measured. The methodology for assessing accessibility can be tailored to include additional factors, such as perceived safety, physical barriers, or the specific needs of particular groups, like women or children. The second refers to population group characteristics. The tool can be modified to analyze other demographic dimensions, such as income, ethnicity, or level of education, offering insights into accessibility disparities across different populations. The third involves the selection of destinations. Destinations can be refined to focus on specific categories, such as parks, playgrounds, or other essential amenities.

The primary challenge in adapting CTwalk for use in other cities is data availability. For locations covered by OpenStreetMap—which provides open-access data on location-based amenities and pedestrian street networks—this challenge largely centers on obtaining high-resolution demographic data. However, the most significant opportunity lies in advancing how accessibility is measured. By integrating more nuanced methods that account for variations in accessibility across different population groups, future tools inspired by CTwalk can provide deeper insights into the potential for social encounters at urban destinations, ultimately supporting more inclusive and equitable urban planning.

Acknowledgments

This research has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 874724.

References

Boeing, G (2017). "OSMnx: New Methods for Acquiring, Constructing, Analyzing, and Visualizing Complex Street Networks". In: *Computers, Environment and Urban Systems* 65, pp. 126–139. URL: `https://geoffboeing.com/publications/osmnx-complex-street-networks/`.

Milias, Vasileios and Achilleas Psyllidis (2022). "Measuring spatial age segregation through the lens of co-accessibility to urban activities". In: *Computers, Environment and Urban Systems* 95, p. 101829.

Milias, Vasileios, Achilleas Psyllidis, and Alessandro Bozzon (2024). "Bridging or separating? Co-accessibility as a measure of potential place-based encounters". In: *Journal of Transport Geography* 121, p. 104027.

Moreno, Carlos et al. (2021). "Introducing the "15-Minute City": Sustainability, resilience and place identity in future post-pandemic cities". In: *Smart cities* 4.1, pp. 93–111.

Pozoukidou, Georgia and Zoi Chatziyiannaki (2021). "15-Minute City: Decomposing the new urban planning eutopia". In: *Sustainability* 13.2, p. 928.

Schimpl, Michaela et al. (2011). "Association between walking speed and age in healthy, free-living individuals using mobile accelerometry—a cross-sectional study". In: *PloS one* 6.8, e23299.

Shannon, Claude Elwood (1948). "A mathematical theory of communication". In: *The Bell system technical journal* 27.3, pp. 379–423.

Weng, Min et al. (2019). "The 15-minute walkable neighborhoods: Measurement, social inequalities and implications for building healthy communities in urban China". In: *Journal of Transport & Health* 13, pp. 259–273.