THE OHIO STATE UNIVERSITY
COLLEGE OF ARTS AND SCIENCES

Inclusive Sidewalk Planning With Perceived Constraints

A Multi-objective Optimization Approach

Armita Kar[1,2], Ningchuan Xiao[2], Huyen T.K. Le[2], and Harvey J. Miller[1, 2]

1. Center for Injury Research and Policy, Abigail Wexner Research Institute at Nationwide Children's Hospital
2. Department of Geography, The Ohio State University

Widespread Sidewalk Shortage Discourages Walking in U.S. Cities

Inclusive Accessibility

*Addresses heterogeneous **travel willingness and safety perceptions**...*

across individuals and social groups...

in evaluating their access to a multimodal transportation system.

Study Objectives

- To design high-quality sidewalk network solutions that augment perceptual aspects of walking (safety, comfort, and willingness) for socio-economically diverse communities.
- To evaluate trade-offs among the alternative sidewalk network solutions concerning their benefits and opportunity costs across the social groups.

Primary Data

- Study area: Columbus, OH
- Mobility survey
  - Google Street Views
  - ArcGIS Field Maps Mobile app
- Total 477 participants
- Street photo ratings on
  - Safety, comfort, and willingness
- Traveler-specific walking perception score
  - A composite score

Speed limit: **30**
Number of lanes: **2**
Direction: **Bi-directional street**
Sidewalk availability: **Yes**
Type of bike facility: **Multi-use path**

Sample Google Street View displayed to participants

Walking Perceptions by Social groups

- ✓ 12 mutually-exclusive social groups categorized by -
  - Income
  - Race
  - Gender
- ✓ Walking perception scores predicted for each group
  - Within the existing road environment
  - In the future, after installing sidewalks

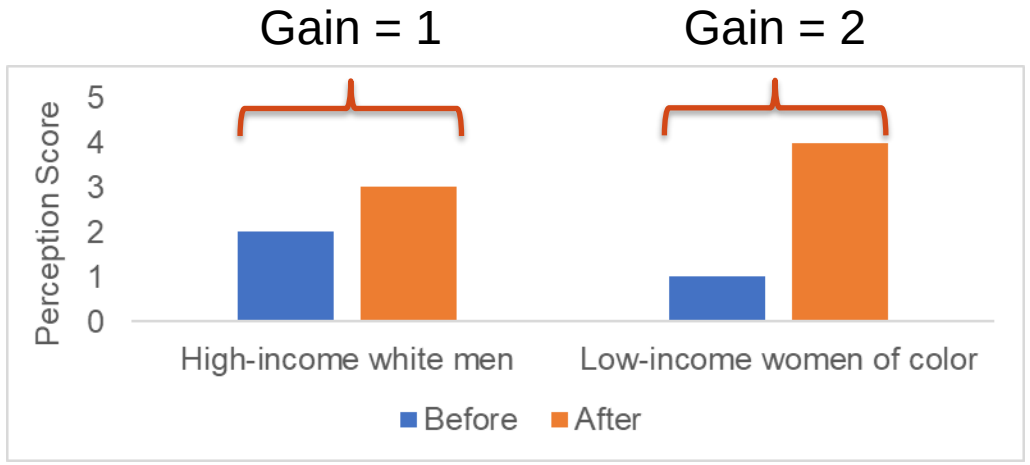
Walking perception score **Very low** **Low** **Moderate** **High** **Very high**

Walking perception scores predicted for high-income white men

Walking perception scores predicted for low-income women of color

Application in Sidewalk Infrastructure Design

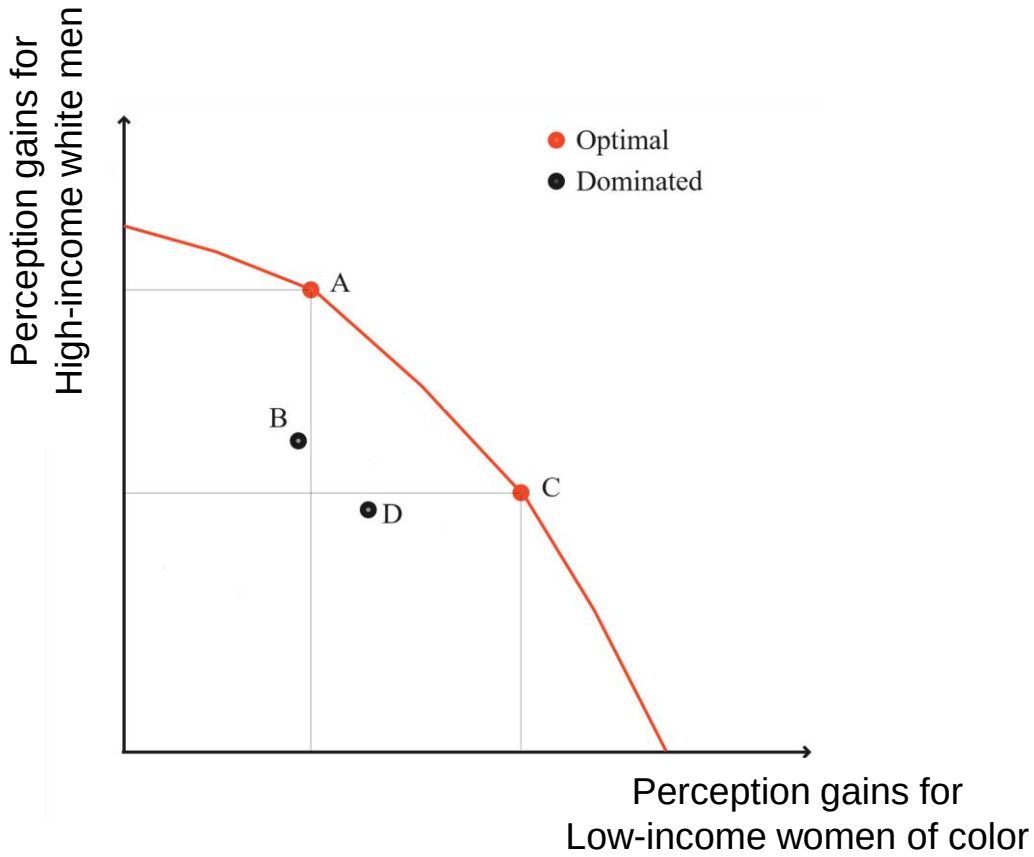
- ✓ Sidewalk construction project for an improved walking environment for all.
- ✓ Benefits/Gains = Before-after changes in walking perception scores of a community



Community-specific benefits/gains as an outcome of sidewalk construction in this example street

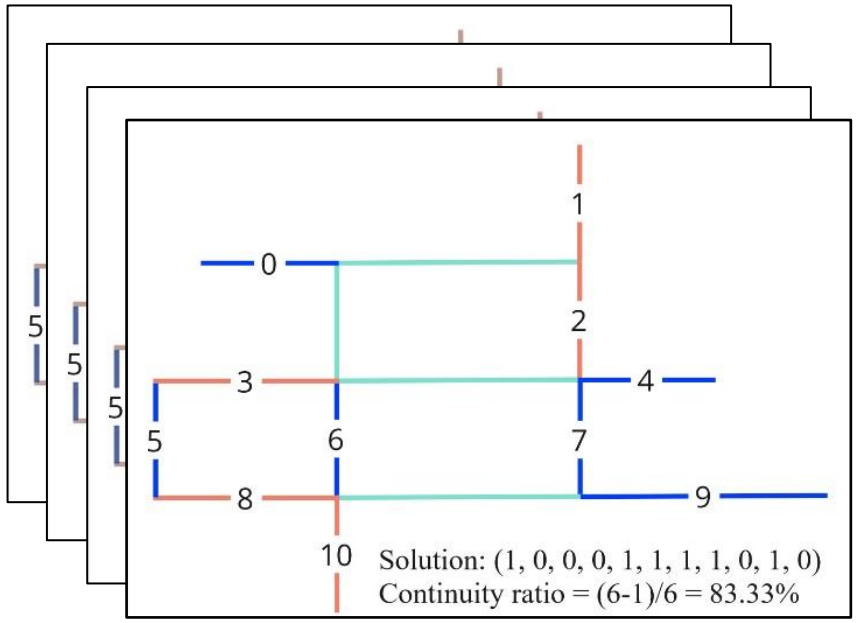
Application in Sidewalk Infrastructure Design

- ✓ A multi-objective optimization problem to identify high-quality network solutions that -
  - Maximizes gain across all communities
  - Given a fixed sidewalk construction length
  - A criteria of partial connectivity
- ✓ Non-dominated Sorting Genetic Algorithm (NSGA) - II

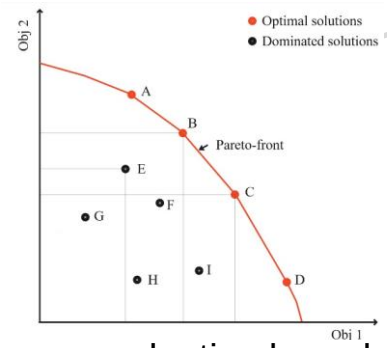


Alternative solutions have multiple beneficiaries with varying benefits

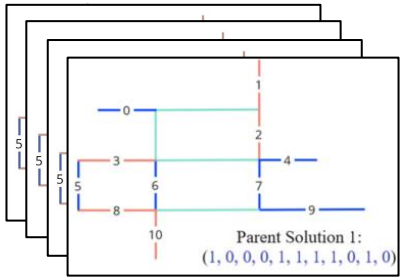
Non-dominated Sorting Genetic Algorithm (NSGA) - II



Randomly generated network solutions

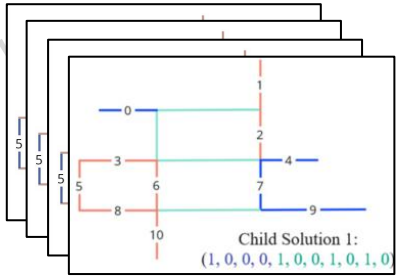


Fitness evaluation based on perception gains across 12 social groups



Selection of best-fitted parent solutions

Reproduction

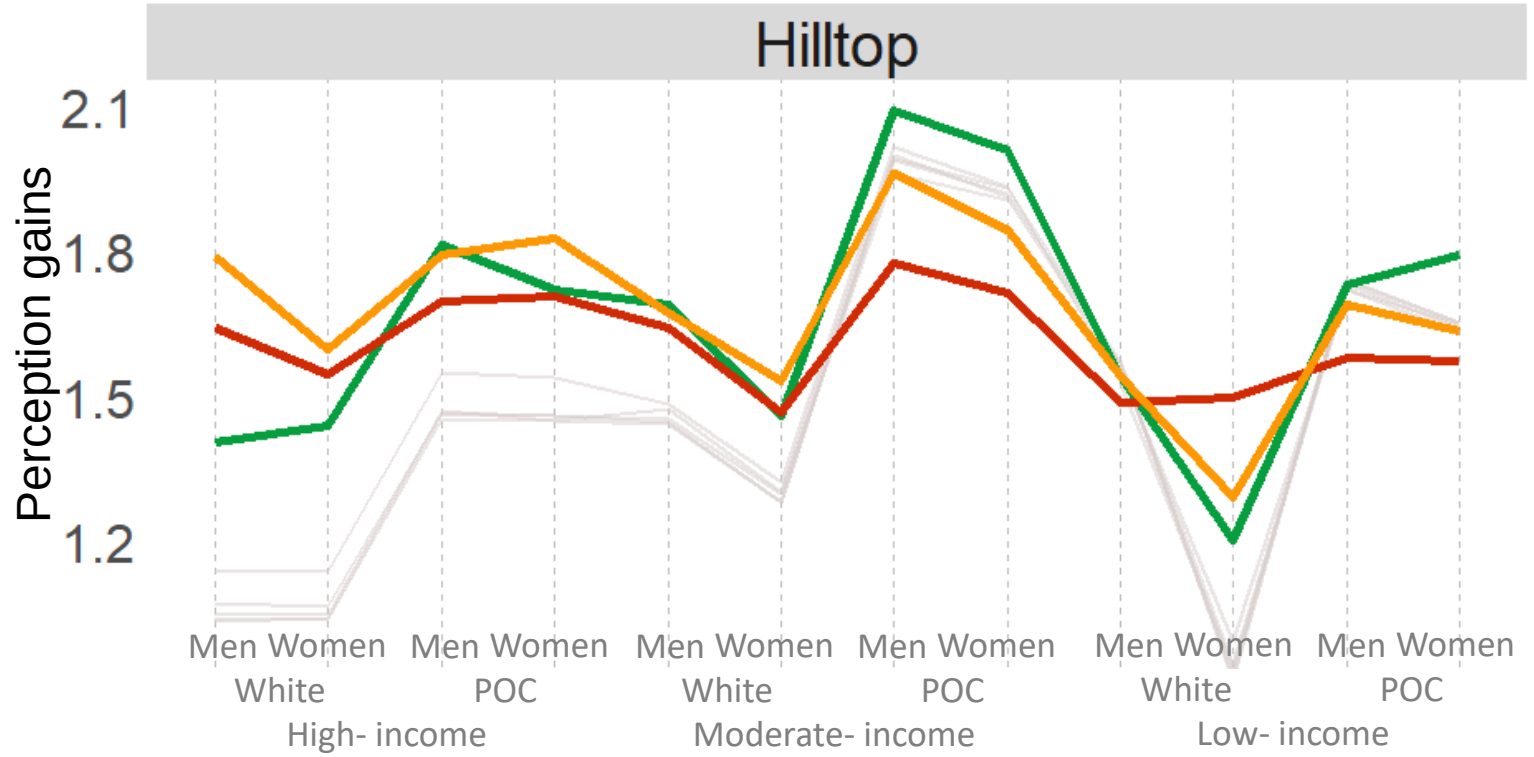


New generation of child solutions

Roads with sidewalks
Roads without sidewalks
Roads chosen for sidewalk construction

Within-neighborhood Trade-offs

Improving travel environment for a community compromises betterment of others.



Moderate-to-low income people of color

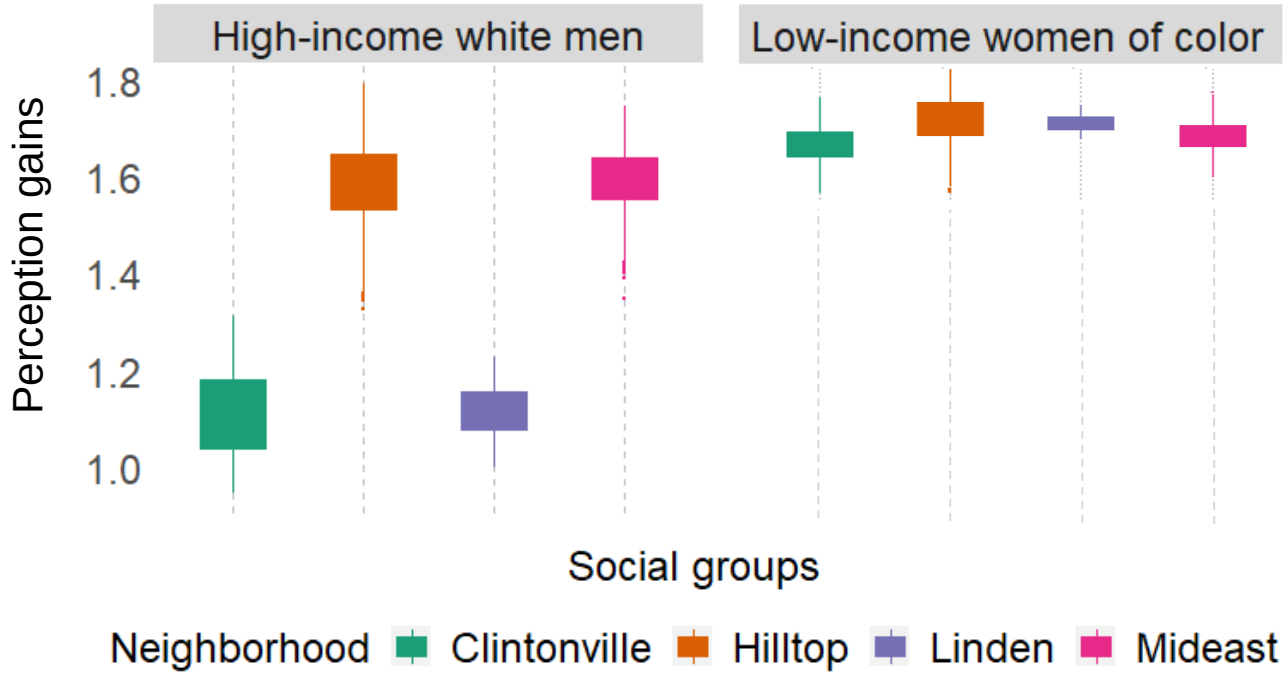
High-income populations

Low-income white women

No sidewalk Existing sidewalks New sidewalks

Cross-neighborhood Comparison

The beneficiaries and level of benefits of any transportation investments are contingent upon the neighborhood's existing infrastructural condition.



The comparison of gains from high-quality network solutions across all neighborhoods

Findings and Implications

- ✓ One solution does not work for all
- ✓ A data-driven and socially-sensitive urban planning approach
  - Incorporating people's concerns and needs into decision-making
  - Tradeoff in potential beneficiaries and opportunity costs
  - A tool for equity-oriented, need-specific transportation interventions
- ✓ Future directions
  - Efficacy of need-specific interventions in improving active travel behavior and health

Thank you!

Questions/Comments?

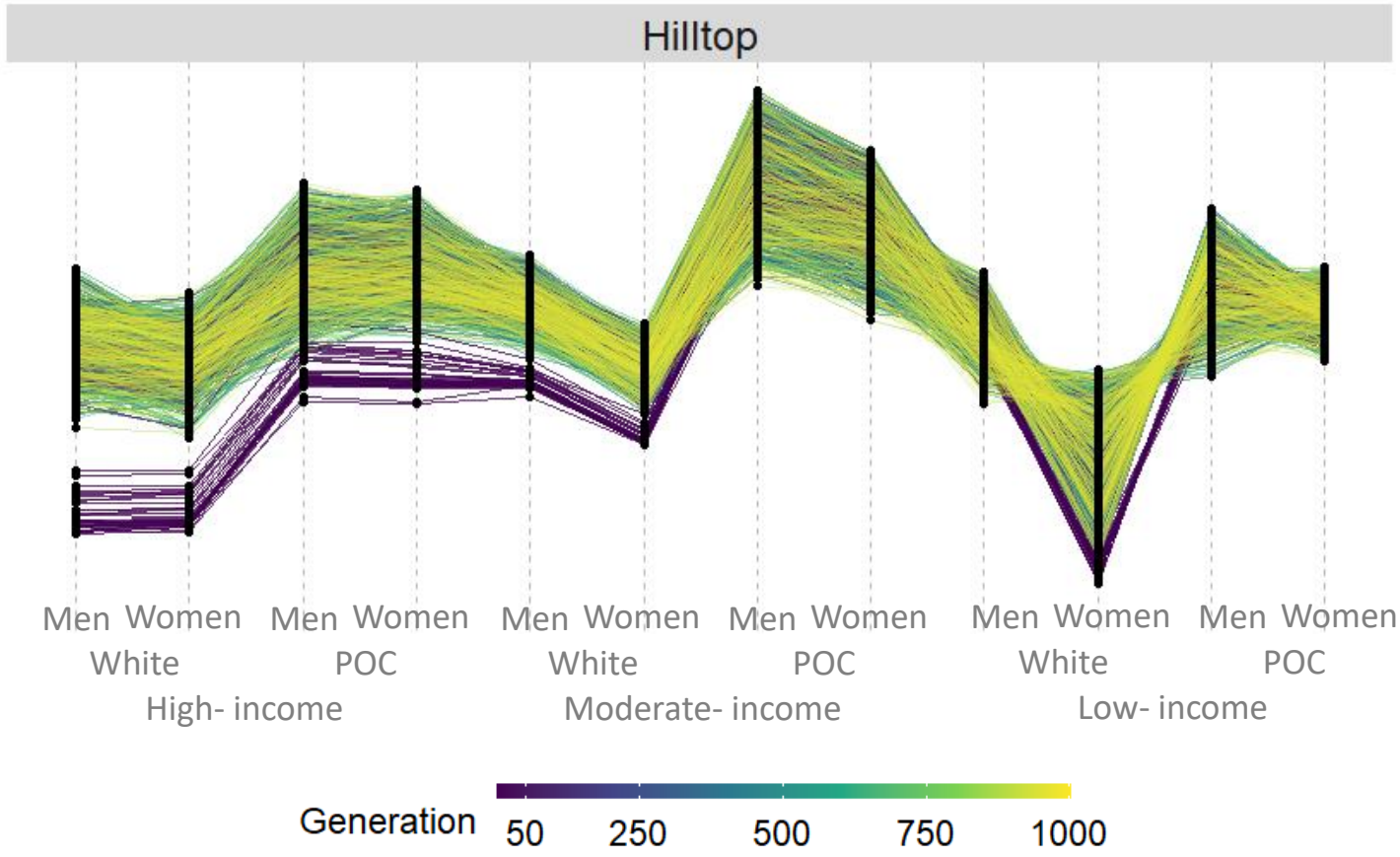
Armita Kar

Email: kar.34@osu.edu

Appendix

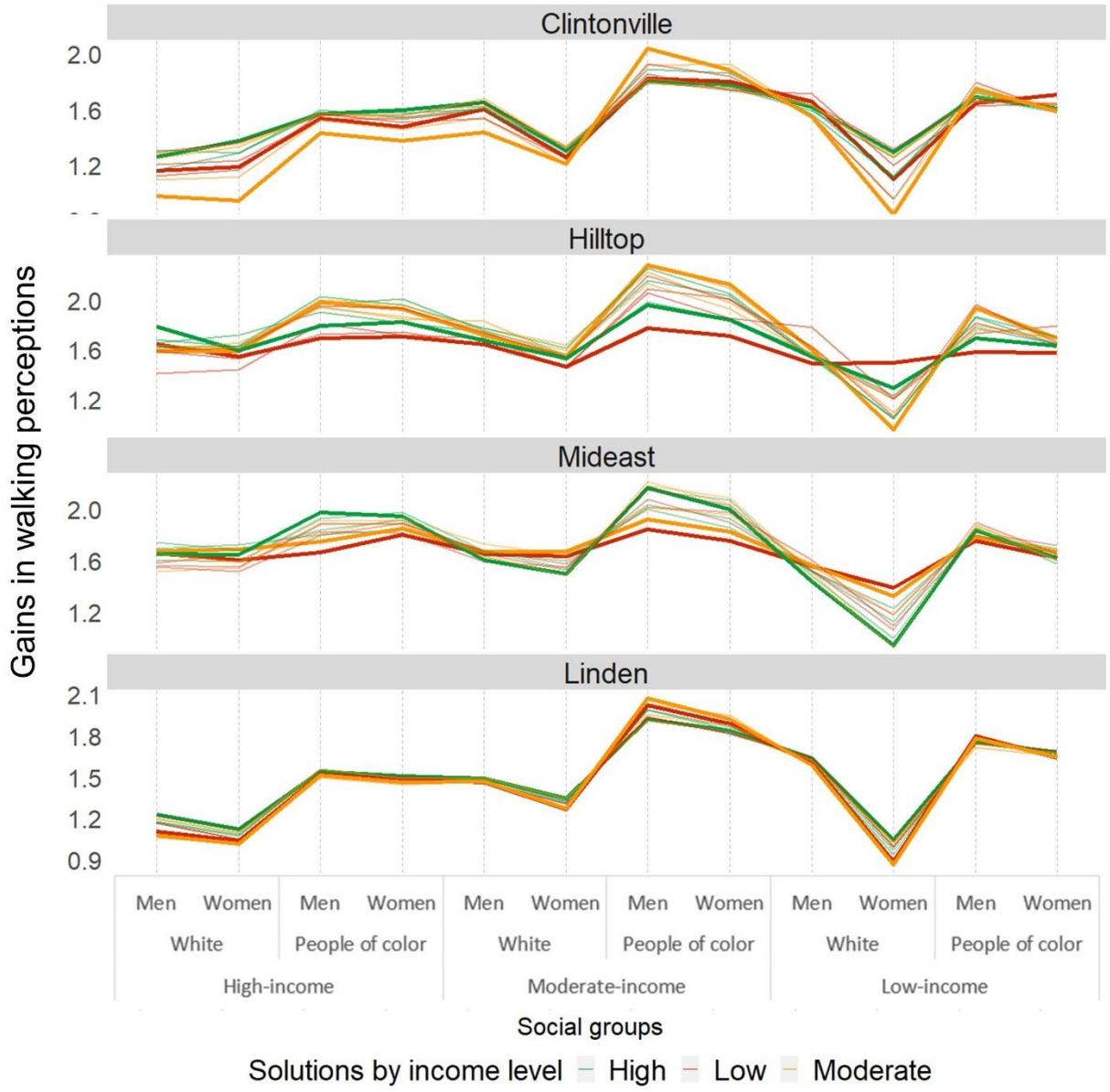
Model Convergence

The newer generation yields superior solutions than the previous generations, indicating model convergence.



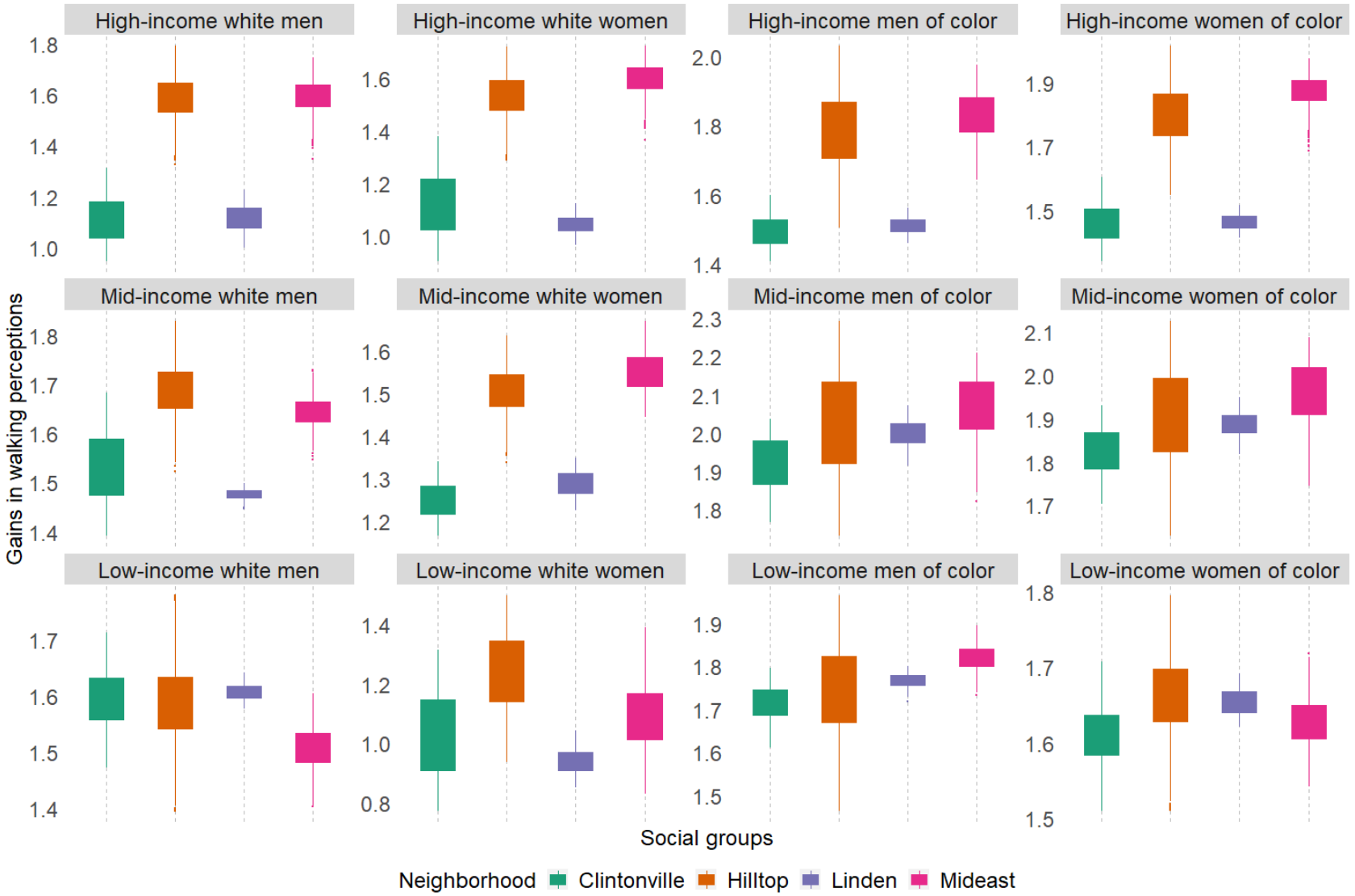
Convergence of models over multiple generations

Cross-neighborhood Comparison



Optimal solutions and their group-specific gains in walking perceptions. The solutions are color-coded by the income-level of the population group. Some contrasting solutions are highlighted with thicker lines.

Cross-neighborhood Comparison



The comparison of gains from high-quality network solutions across all neighborhoods