# How Considering Equity in Optimization Impacts Urban Planning

Drew Horton[1], Tom Logan[2], Daphne Skipper[3], Emily Speakman[1]

[1] University of Colorado Denver, [2] University of Canterbury, [3] United States Naval Academy

Motivation

- Emissions from 100 cities account for 20% of humanity's overall carbon footprint
- Approximately 1/3 of an urban resident's footprint is determined by the city's public transportation and building infrastructure

Moving away from automobile-oriented development is crucial to *reducing emissions*

WALKING
CYCLING
PUBLIC TRANSPORT
PRIVATE CARS

WALKING
CYCLING
PUBLIC TRANSPORT
PRIVATE CARS
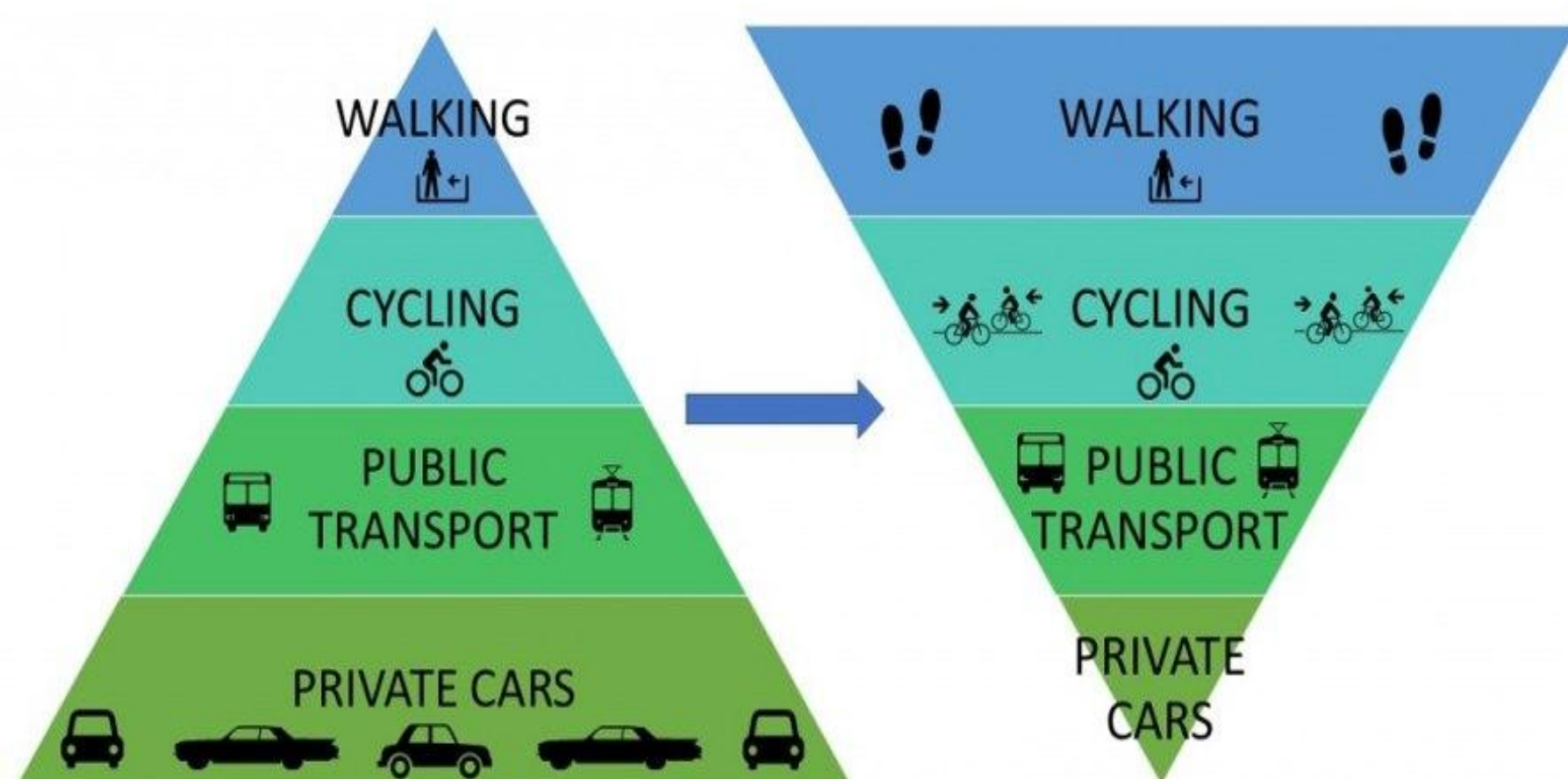
Cities can promote active transport by providing easy and *equitable* access to services

Crucial to be proactive during planning of new amenities

- Access to amenities is unequal, exacerbating hardships of low-income residents and other disadvantaged groups.
- Historically, urban development without careful planning benefits the wealthy and increases existing inequities.

If a city can open additional amenities, where should they go to best improve access?

Traditional tools to optimally locate facilities were designed around profit and provide solutions that do not improve access for the most vulnerable groups in the community, *we deviate from traditional approaches and incorporate equity into our models*
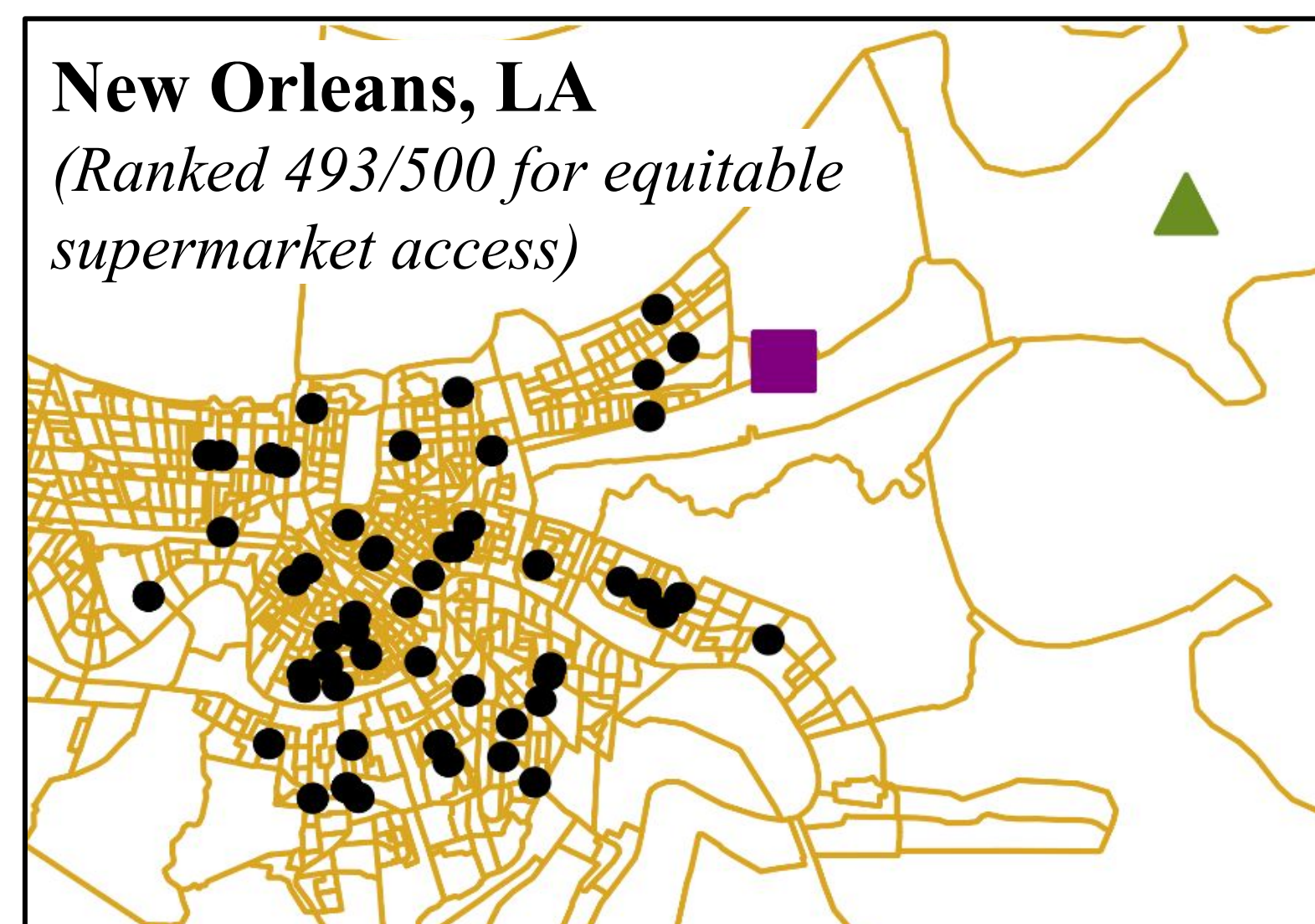
New Orleans, LA
(Ranked 493/500 for equitable supermarket access)

- ● Existing amenities (Supermarkets)
  current avg. distance: 1.07 miles, max distance: 20.51 miles

- ■ Solution using a **traditional method**
  avg. dist.: 1.02 miles, max dist.: 17.09 miles
  ○ *Leaves many community members still many miles from amenities*

- ▲ Solution using **equitable method**
  avg. dist.: 1.06 miles, max dist: 11.87 miles
  ○ *Prioritizes relief to those who need it the most*

Contribution: To address the existing inequities in the structure of cities, we developed a mathematical model to optimally locate new amenities that minimize both *how far the average individual must travel* to their closest service and the *disparity in travel distances*

To provide a given level of equitable access, what is the minimum number of additional amenities a city would need?

We evaluated supermarket access in the **largest 500 cities in the U.S.** and ranked them from 1 to 500.

We then used our model find the *minimum number of additional supermarkets necessary to achieve equitable access in each city.*
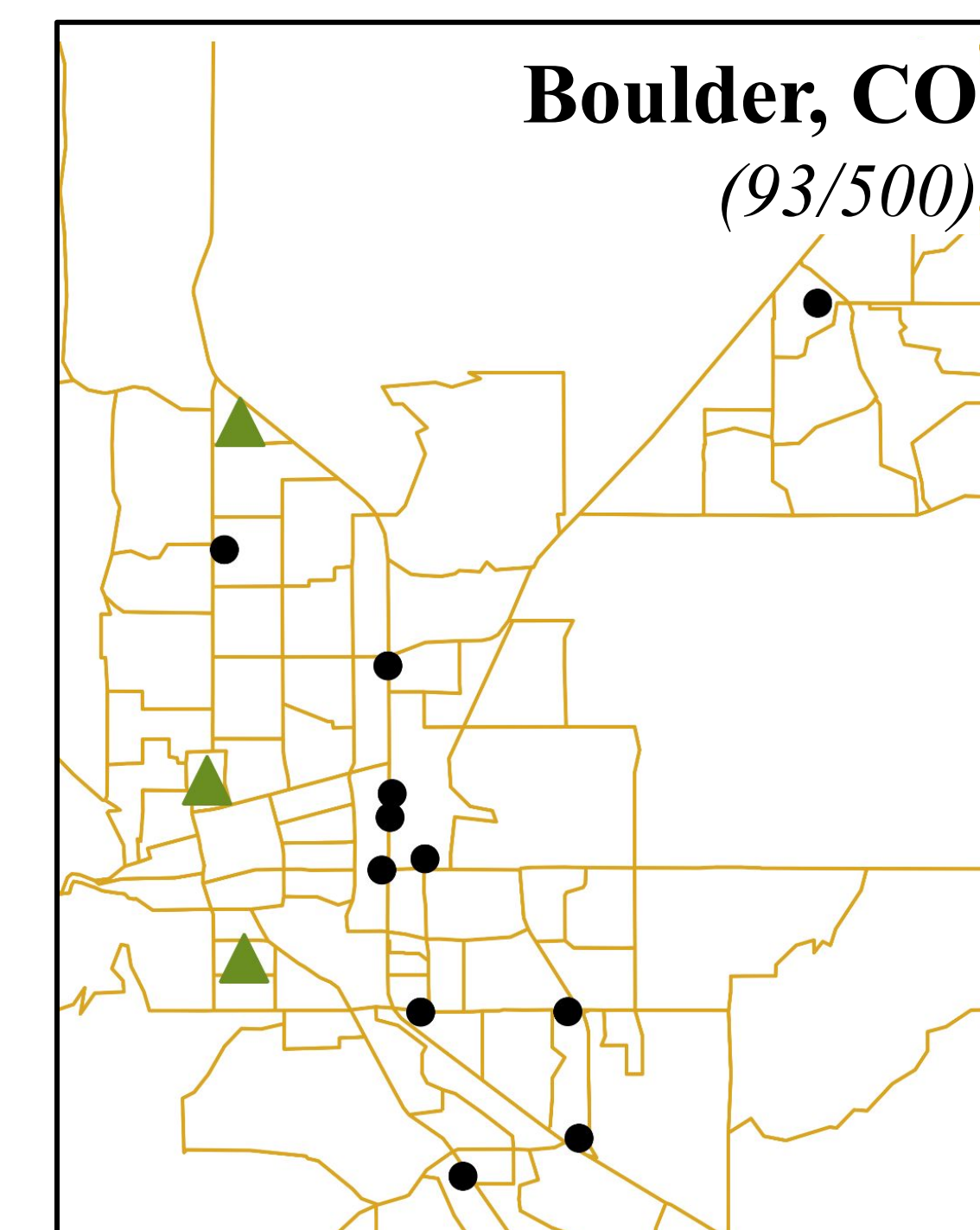
● Existing Supermarkets
▲ Additional Supermarkets

Colorado's *lowest* ranked city
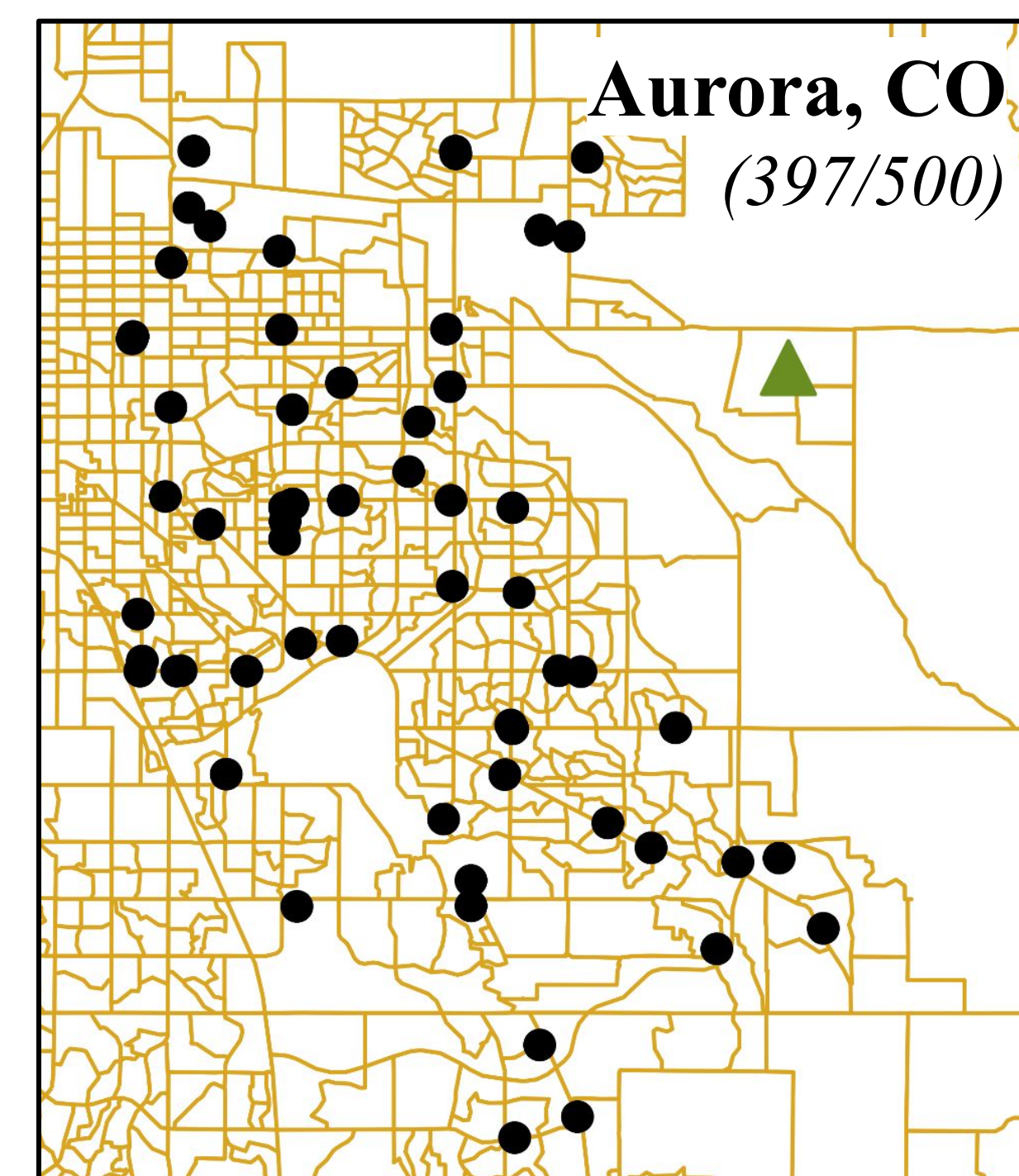
Aurora, CO
(397/500)

1 additional supermarket
to reach average equitable access of 500 largest U.S. cities (1.6 miles)

Colorado's *highest ranked* city

Boulder, CO
(93/500)

3 additional supermarkets
to reach equitable access of 15 minute walk (0.75 mile)