BioComplex
bio-inspired computing and complex networks lab

University of Exeter

Universidade Federal do Ceará

Transport and Mobility Segregation in Urban Spaces

Nandini Iyer[1], Prof. Ronaldo Menezes[1,2], Dr. Hugo Barbosa[1]

Digital Footprints 2023

[1] BioComplex Laboratory, Computer Science, University of Exeter, UK
[2] Computer Science, Federal University of Ceará, Brazil

Segregation

The Experience

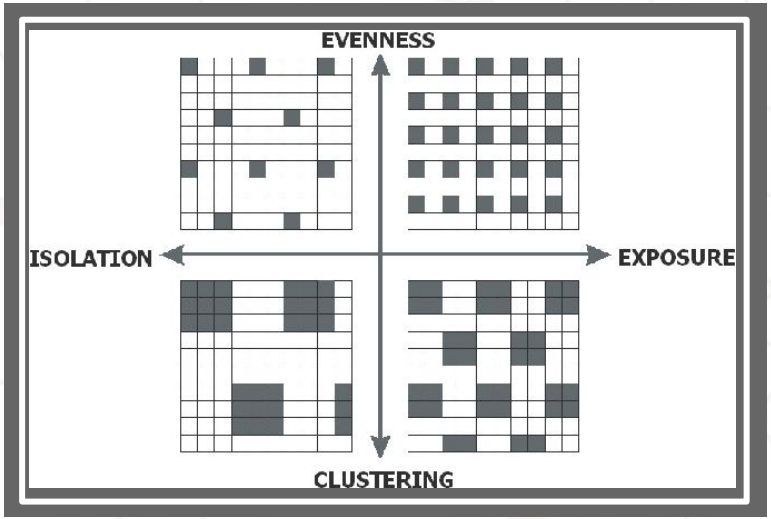
Segregation

The Experience

Segregation

The Experience

The Estimation



Segregation

Residential

Income & Race

Segregation

Residential

Income & Race

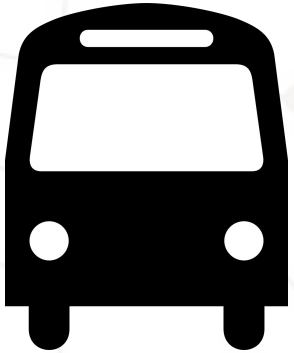
Amenities

visitors' SES

Segregation

Residential

Income & Race



Public Transport

travellers' SES

**assuming uniform usage*

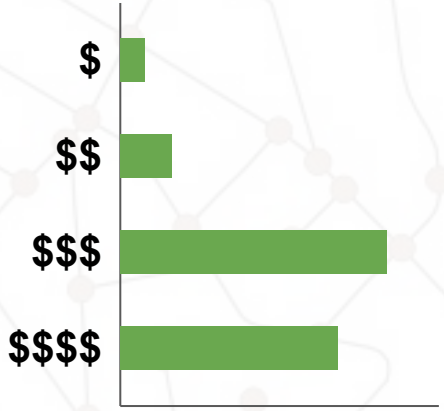
Amenities

visitors' SES

Data

Socioeconomic

2020 American Community Survey (*Median Household Income*)



Index of Concentration at the Extremes (ICE)

-1 0 +1

$$ICE_i = \frac{H_i - L_i}{T_i}$$

for a region **i**…

H_i: high-income population

L_i: low-income population

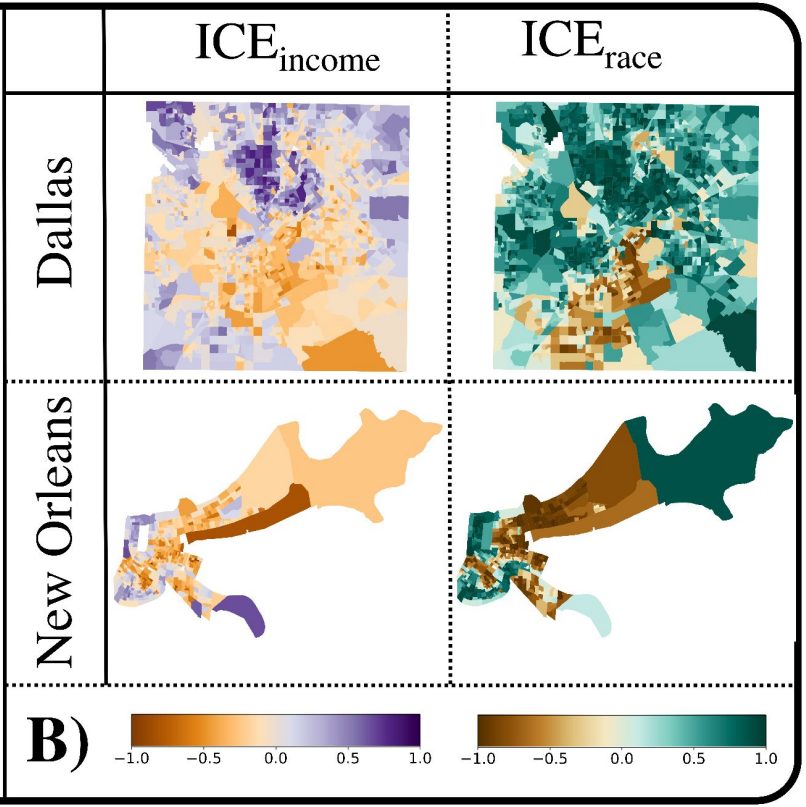
T_i: total population

Residential Segregation

City	Income-Race
Houston	**0.404*** **
Fort Worth	**0.419*** **
Dallas	**0.421*** **
Albuquerque	**0.461*** **
Las Vegas	**0.476*** **
Greenville	**0.532*** **
Hartford	**0.533*** **
Boston	**0.539*** **
Columbus	**0.547*** **
Philadelphia	**0.560*** **
Cincinnati	**0.609*** **
San Francisco	**0.623*** **
Cleveland	**0.637*** **
Bridgeport	**0.748*** **
New Orleans	**0.754*** **
Charleston	**0.766*** **

***p<0.001

A)

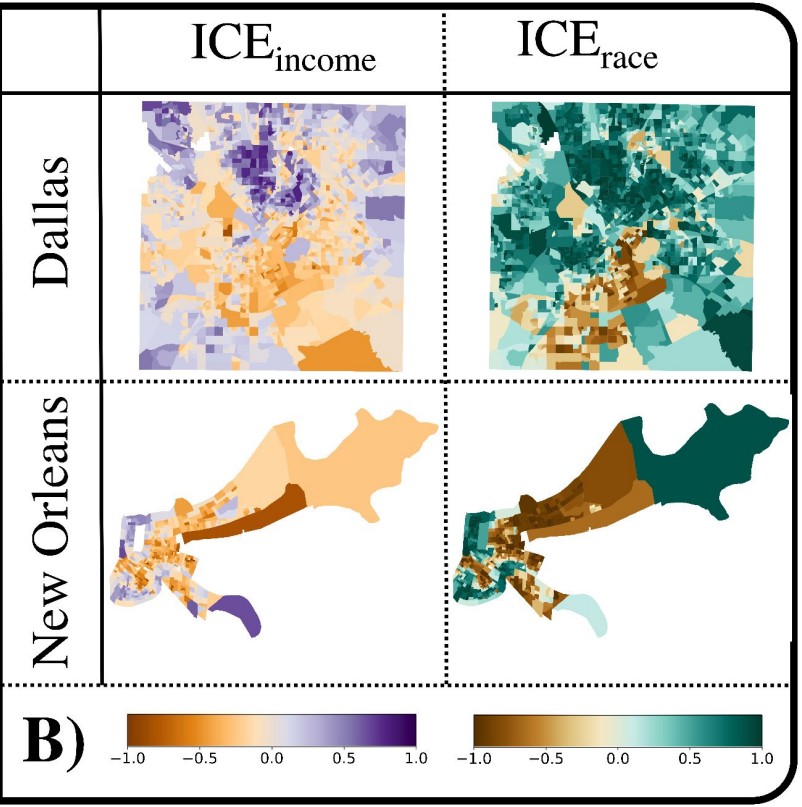


Residential Segregation

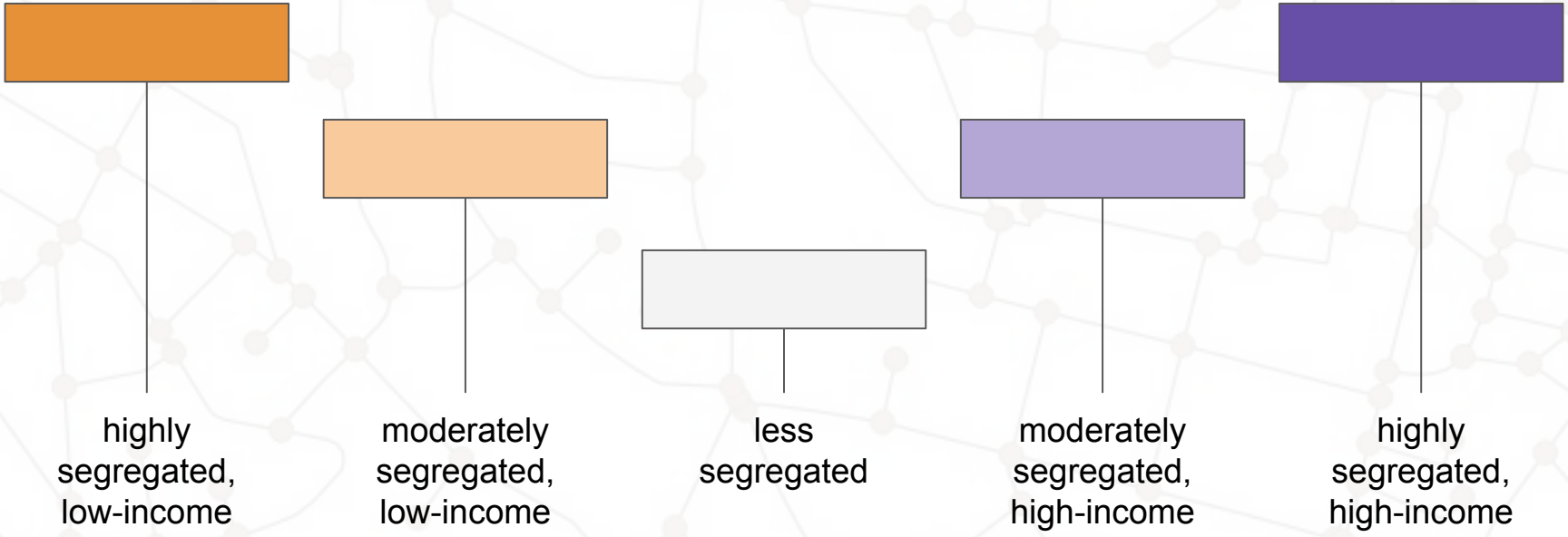
City	Income-Race
Houston	**0.404*** **
Fort Worth	**0.419*** **
Dallas	**0.421*** **
Albuquerque	**0.461*** **
Las Vegas	**0.476*** **
Greenville	**0.532*** **
Hartford	**0.533*** **
Boston	**0.539*** **
Columbus	**0.547*** **
Philadelphia	**0.560*** **
Cincinnati	**0.609*** **
San Francisco	**0.623*** **
Cleveland	**0.637*** **
Bridgeport	**0.748*** **
New Orleans	**0.754*** **
Charleston	**0.766*** **

***p<0.001

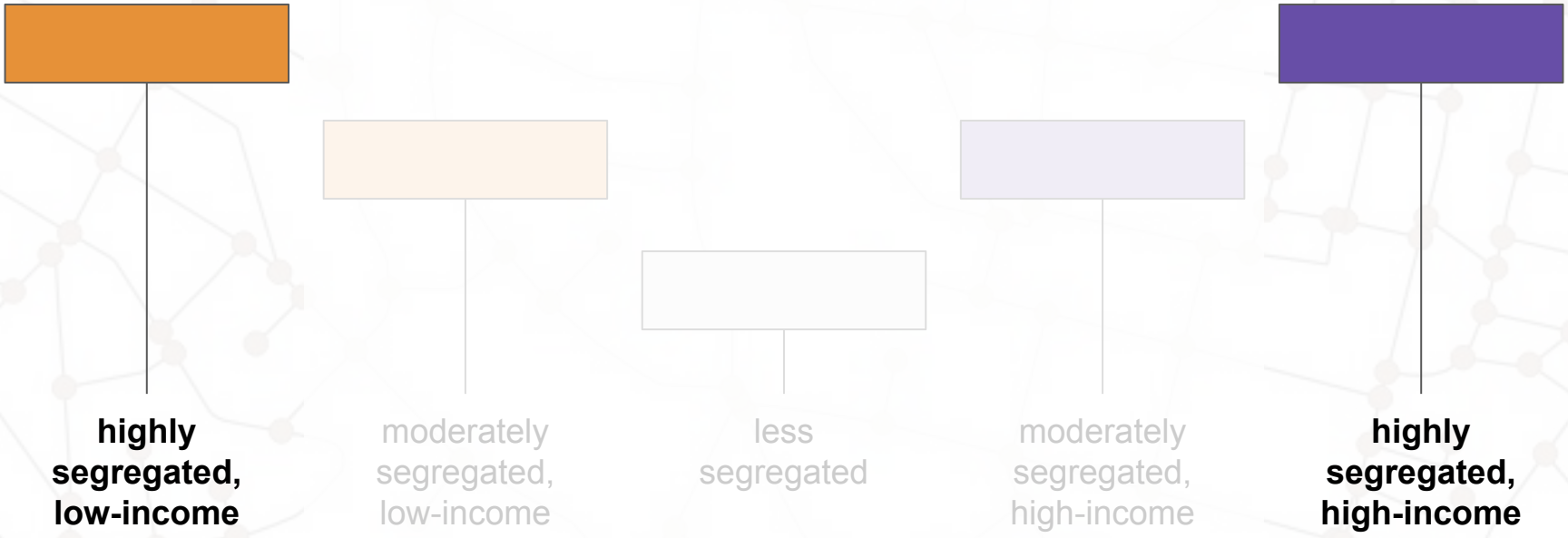
A)



Segregation Groups



Segregation Groups



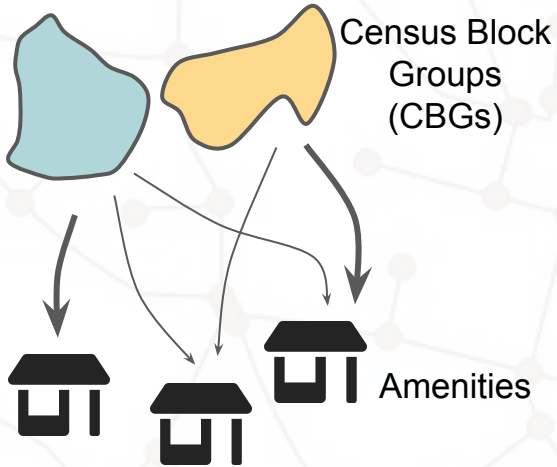
Data

Socioeconomic

2020 American Community Survey (*Median Household Income*)

Mobility

SafeGraph Weekly Patterns (2020-2021)



Traveler Amenity Segregation (TAS)

Amenity Segregation

$$ICE_{amenity}$$

Traveler Amenity Segregation (TAS)

Amenity Segregation

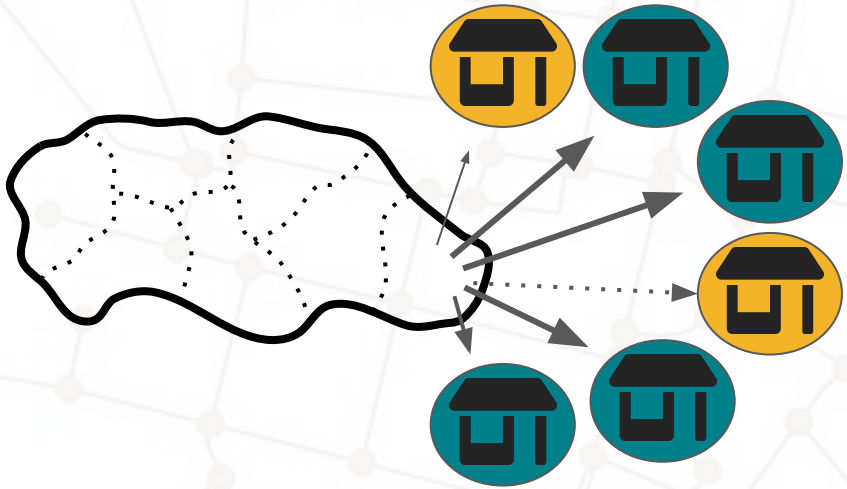
$$ICE_{amenity}$$

Traveler Amenity Segregation (TAS)

Amenity Segregation

$ICE_{amenity}$

Traveler Amenity Segregation

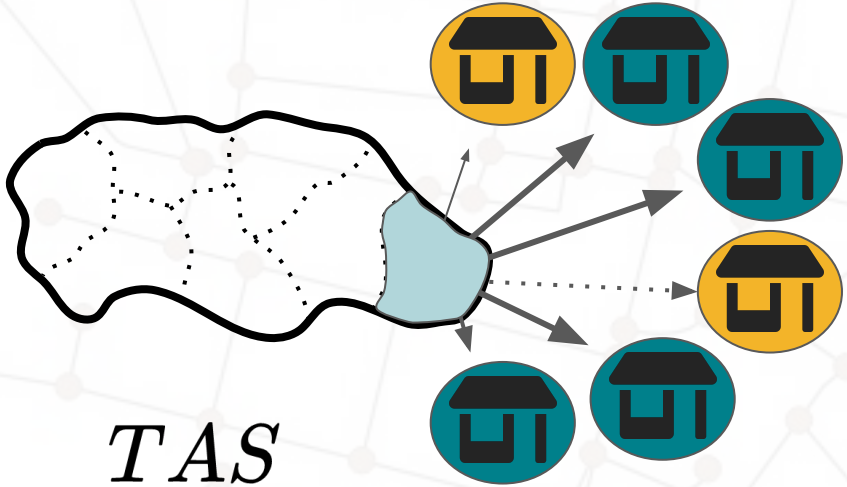


Traveler Amenity Segregation (TAS)

Amenity Segregation

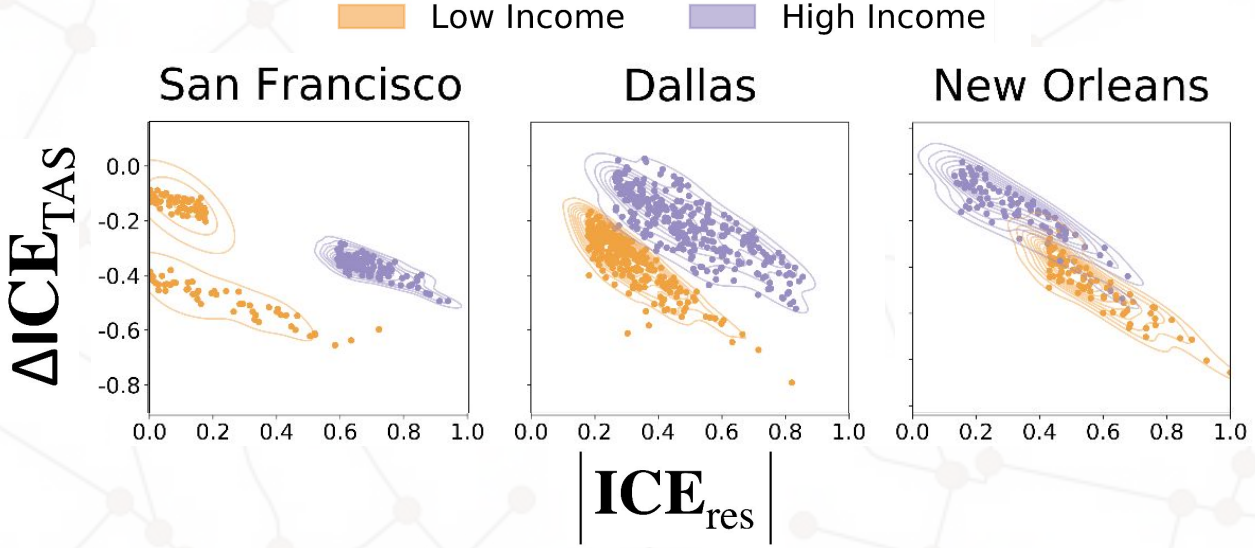
$ICE_{amenity}$

Traveler Amenity Segregation



TAS

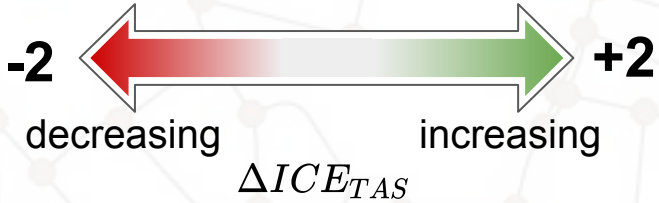
Mobility Segregation



Residential Segregation

Change in Segregation

(Residential → Mobility)



Data

Socioeconomic

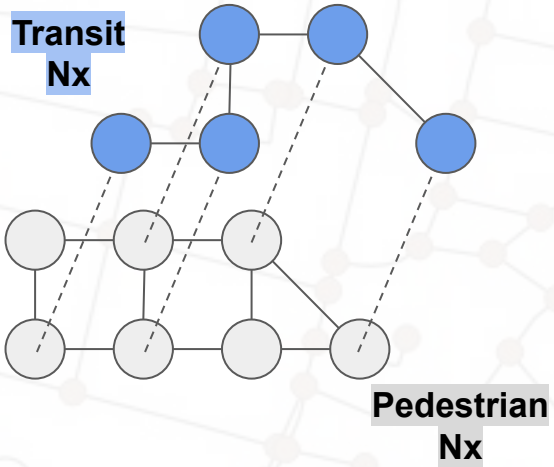
2020 American Community Survey (*Median Household Income*)

Mobility

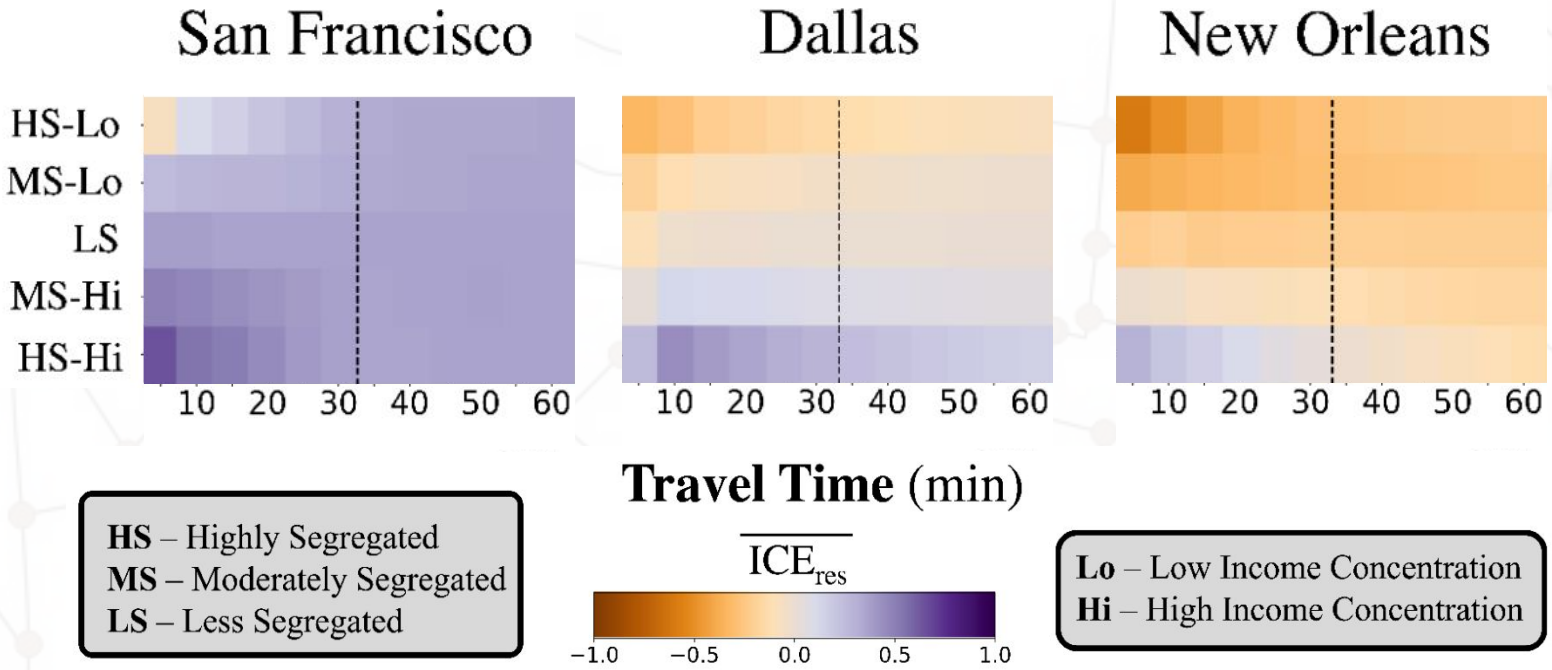
SafeGraph Weekly Patterns (2020-2021)

Transport

OpenMobilityData (*GTFS Feeds*) & UrbanAccess (*Transit Nx*)



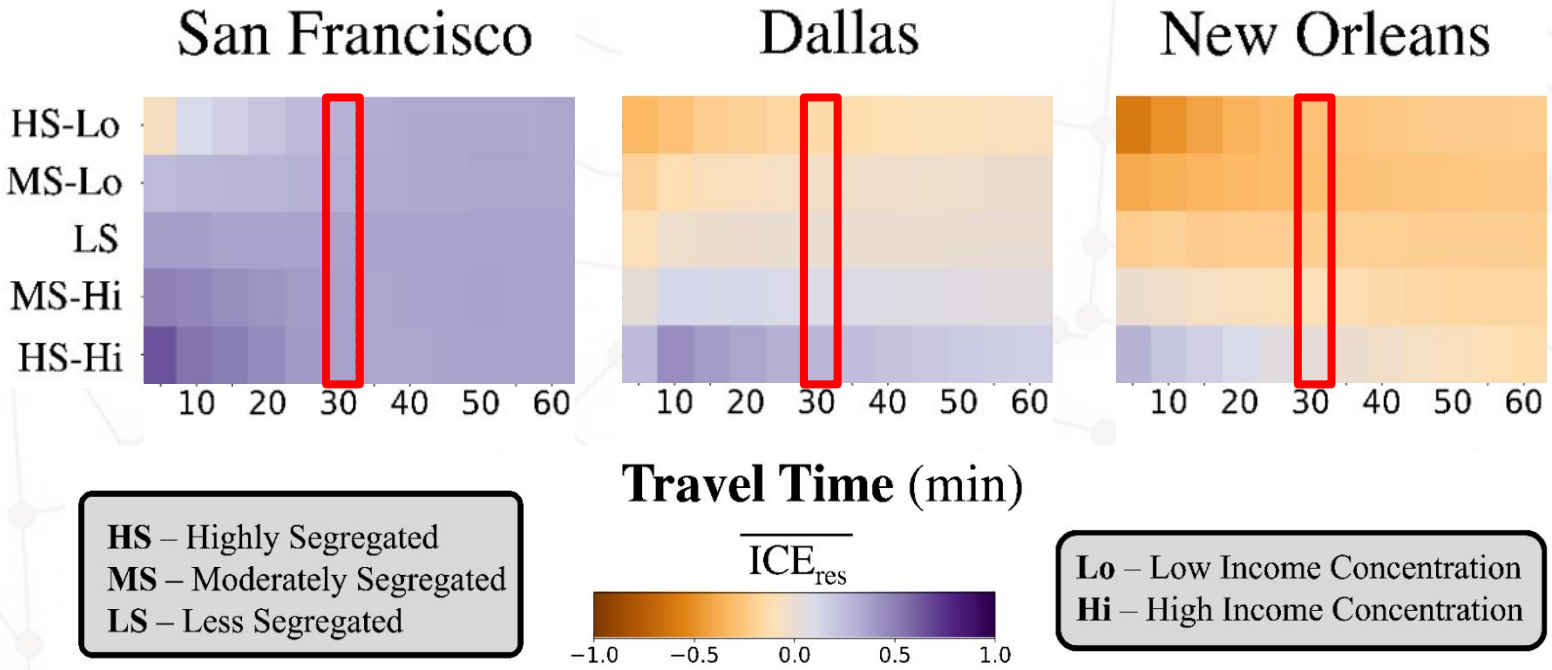
Segregation of Accessible Neighbourhoods



HS – Highly Segregated
MS – Moderately Segregated
LS – Less Segregated

Lo – Low Income Concentration
Hi – High Income Concentration

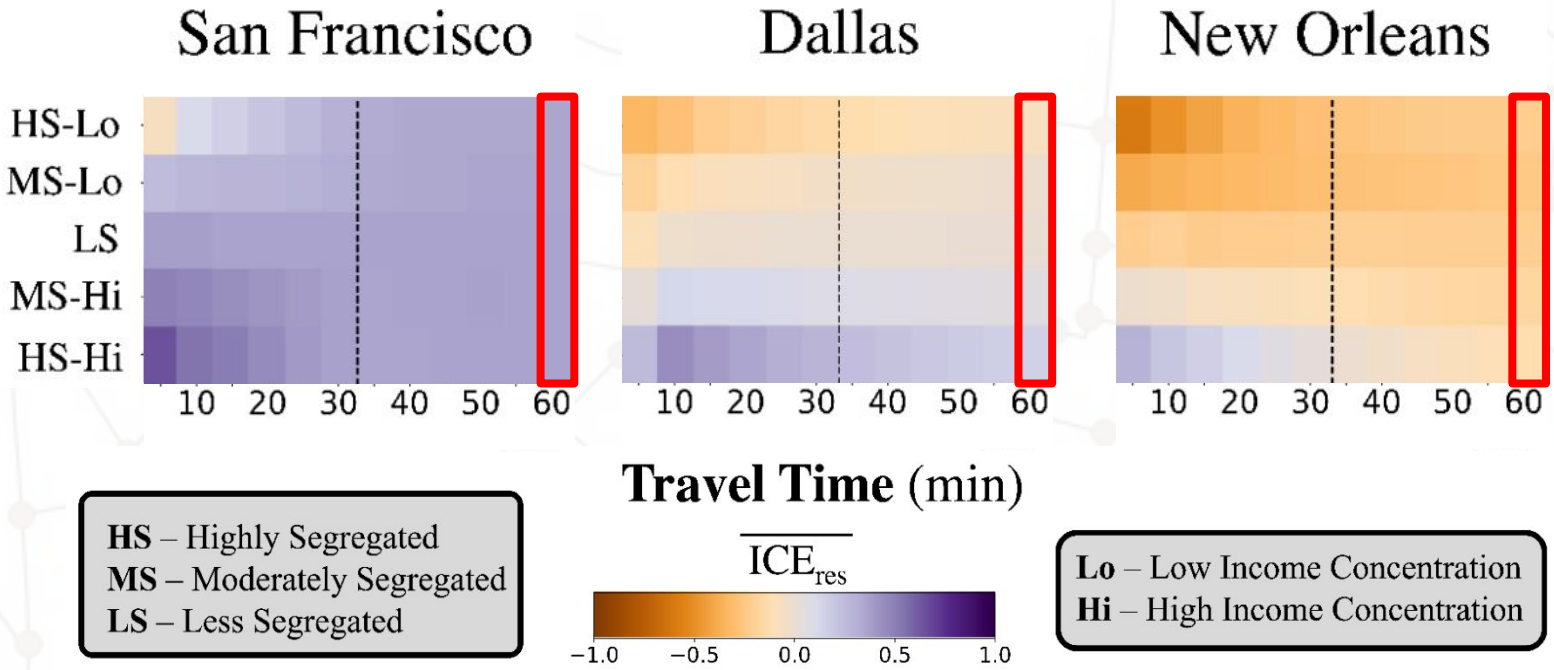
Segregation of Accessible Neighbourhoods



HS – Highly Segregated
MS – Moderately Segregated
LS – Less Segregated

Lo – Low Income Concentration
Hi – High Income Concentration

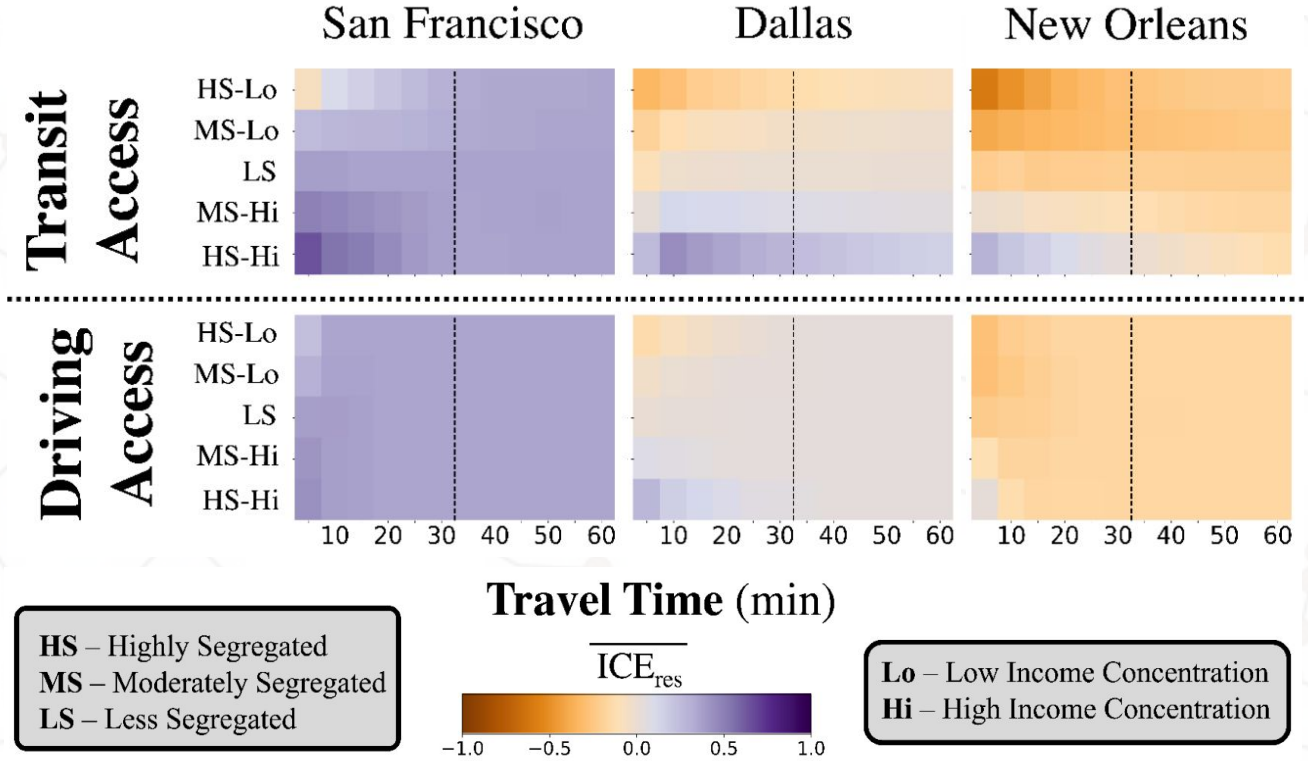
Segregation of Accessible Neighbourhoods



HS – Highly Segregated
MS – Moderately Segregated
LS – Less Segregated

Lo – Low Income Concentration
Hi – High Income Concentration

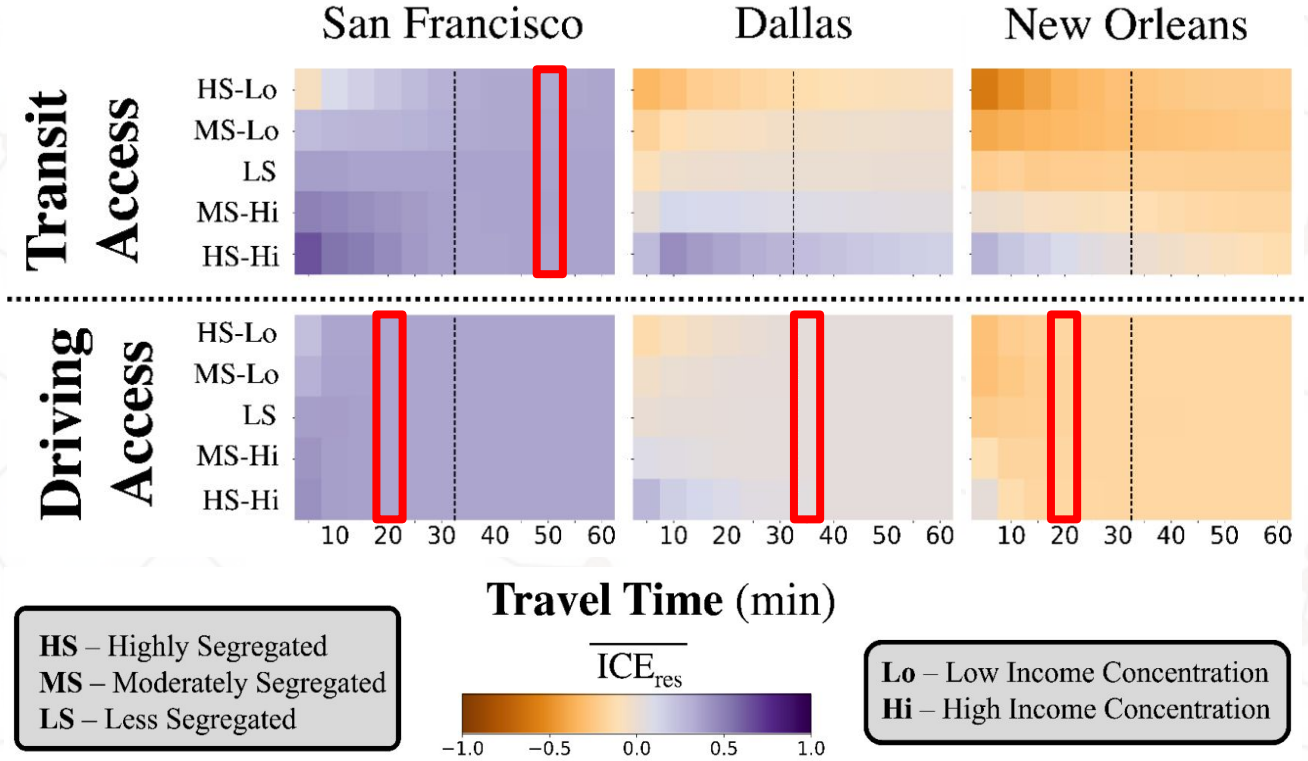
Segregation of Accessible Neighbourhoods



HS – Highly Segregated
MS – Moderately Segregated
LS – Less Segregated

Lo – Low Income Concentration
Hi – High Income Concentration

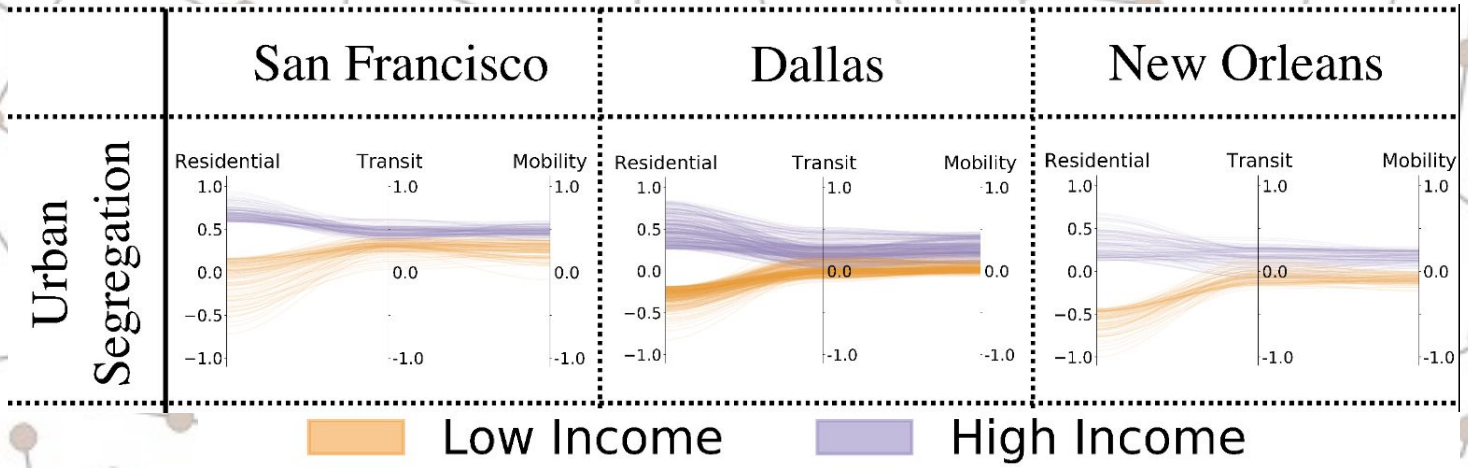
Segregation of Accessible Neighbourhoods



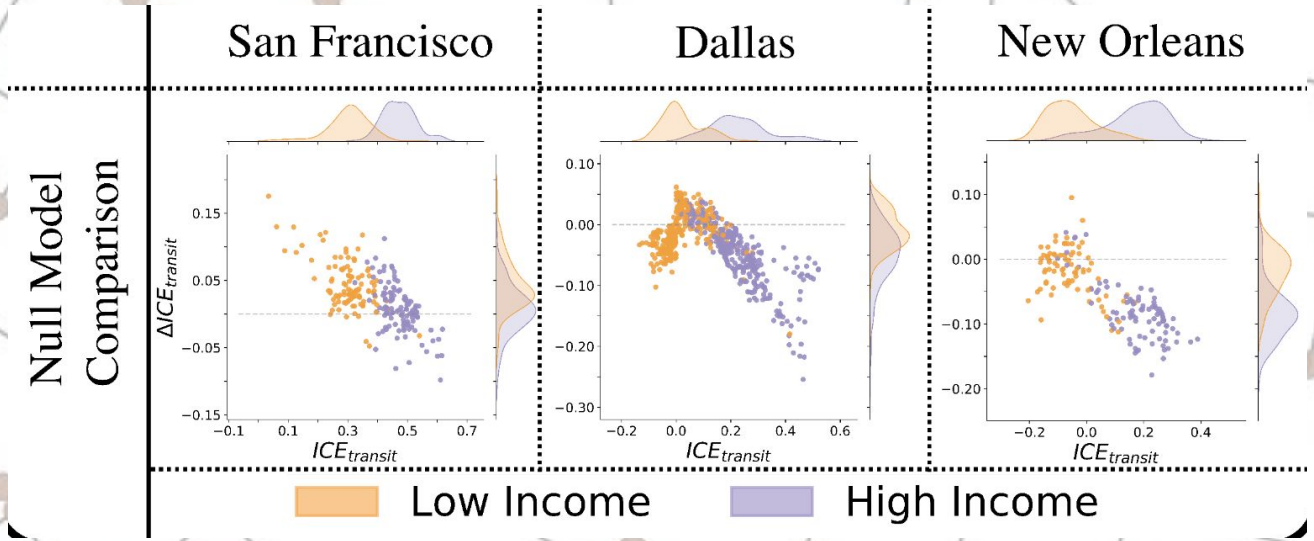
HS – Highly Segregated
MS – Moderately Segregated
LS – Less Segregated

Lo – Low Income Concentration
Hi – High Income Concentration

Segregation Across Urban Dimensions



The Role of Destinations in Urban Segregation



Transit Segregation with Empirical vs Uniform Destinations

Take-home Messages

- Mobility data plays a key role for defining **more dynamic forms of segregation**
- Mobility provides a means for **overcoming residential inequalities**
  - **inequalities in transport service** and the amenity landscape pose limitations
- Digital footprints can unveil differences in mobility patterns for various demographics
  - Distinguishing if differences are due to **choice vs. constraint**

Thank You!

BioComplex
bio-inspired computing and complex networks lab

University of Exeter

Universidade Federal do Ceará

arXiv **preprint:**

Collaborators

University of Exeter
Lecturer in Human Dynamics and Urban Systems

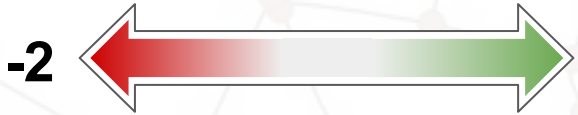
University of Exeter
Professor of Data and Network Science

$$\Delta ICE(x,y) = \begin{cases} x - y, & if \;\; x < 0 \\ -(x - y), & if \;\; x \geq 0 \end{cases}$$

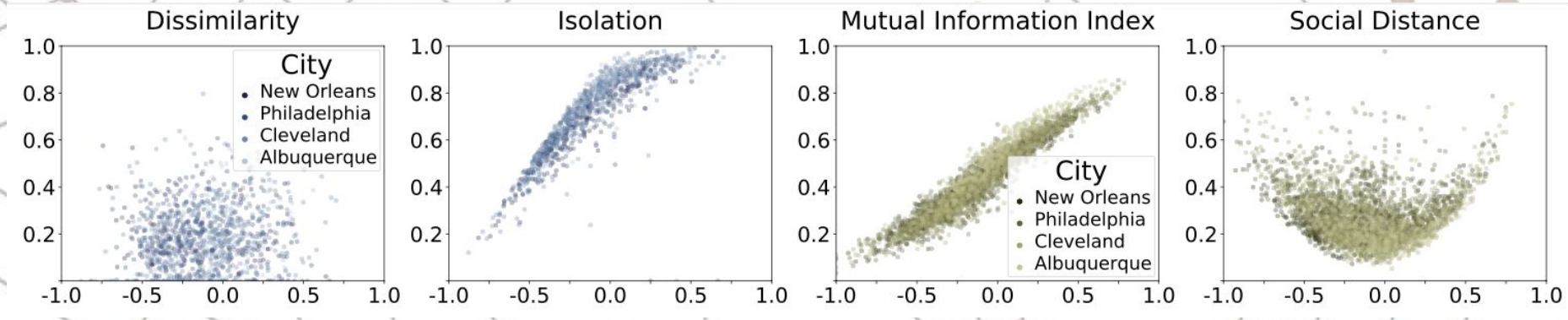
x, y ∈ {residential, mobility, transit}

Change in Segregation

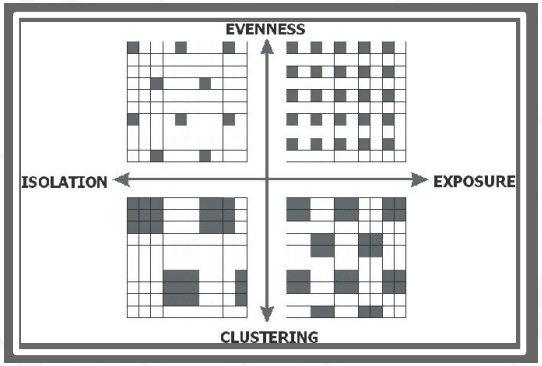
*(Dimension **x** → Dimension **y**)*



$\Delta ICE(x,y)$


Dissimilarity
Isolation
Mutual Information Index
Social Distance
City
New Orleans
Philadelphia
Cleveland
Albuquerque
1.0
0.8
0.6
0.4
0.2
-1.0
-0.5
0.0
0.5
1.0

Segregation

The Experience

The Estimation