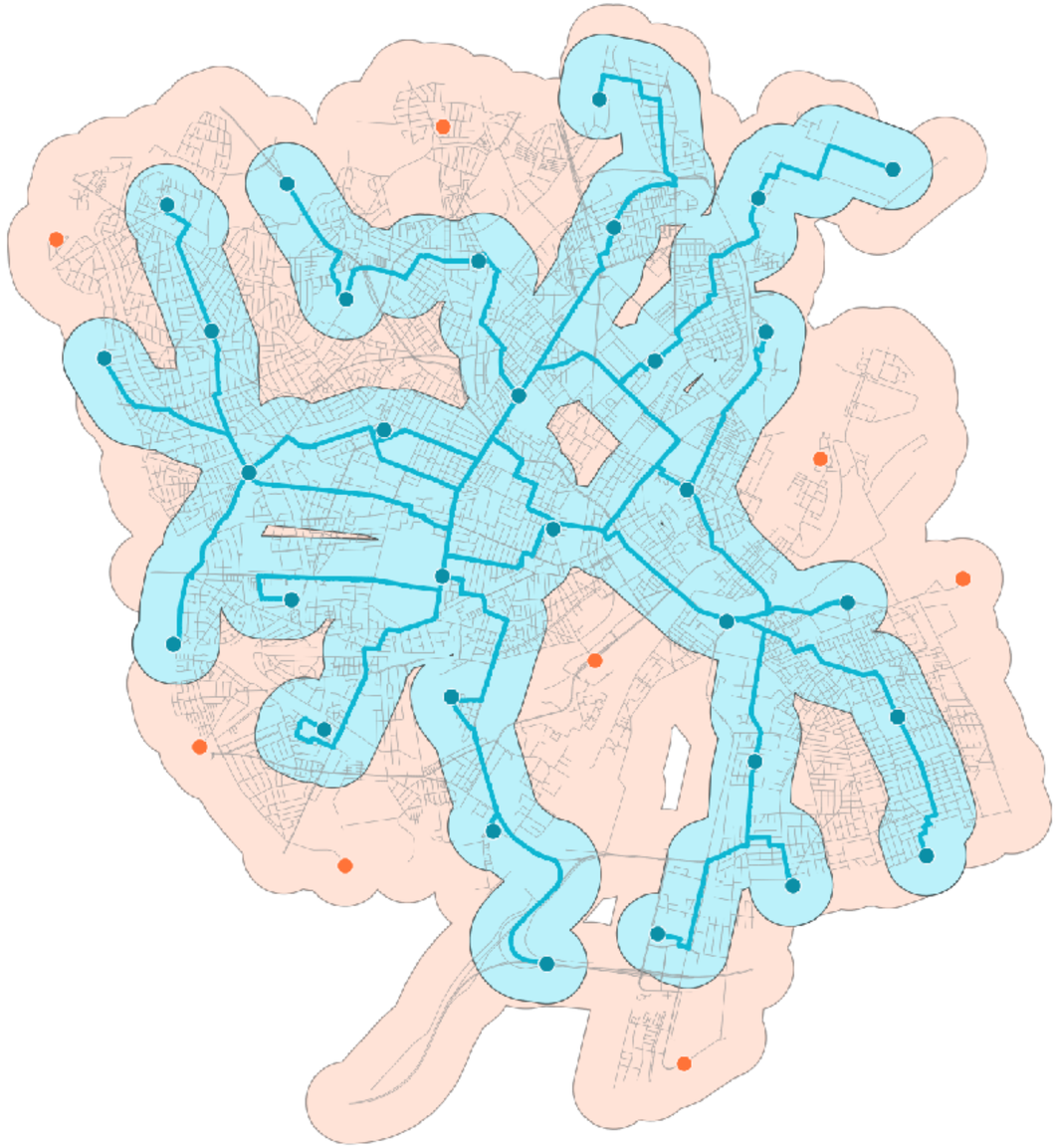
Vulnerable road users, and towards a science of bicycle networks

Michael Szell



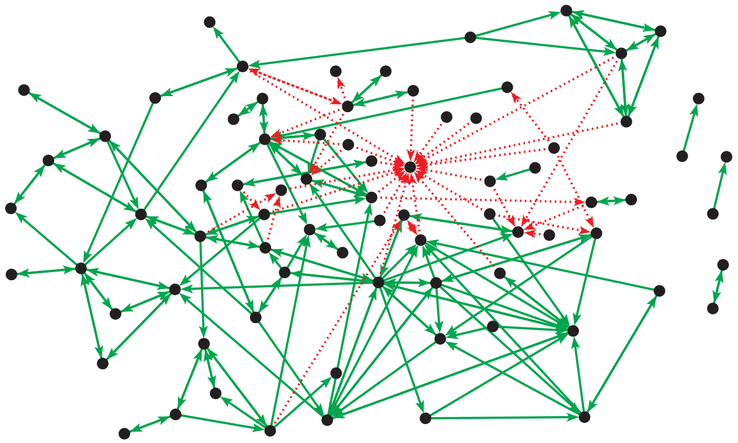
NEtwoRks, Data, and Society (NERDS)

IT UNIVERSITY OF COPENHAGEN

City Interaction Lab, May 6, 2021

Interdisciplinarity is key for solving complex issues

Network Science



Interdisciplinarity is key for solving complex issues

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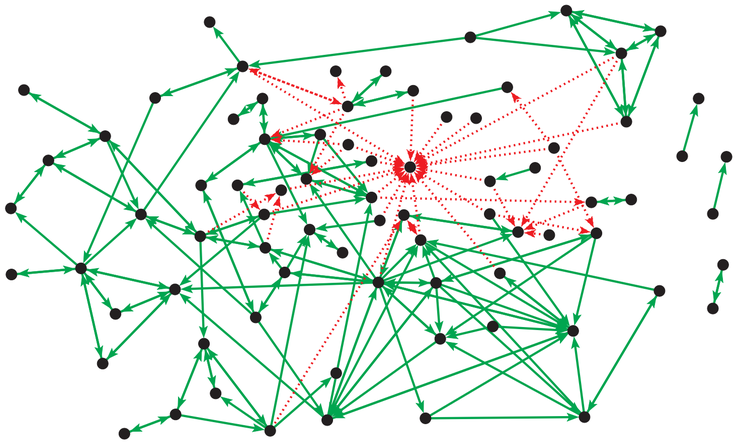
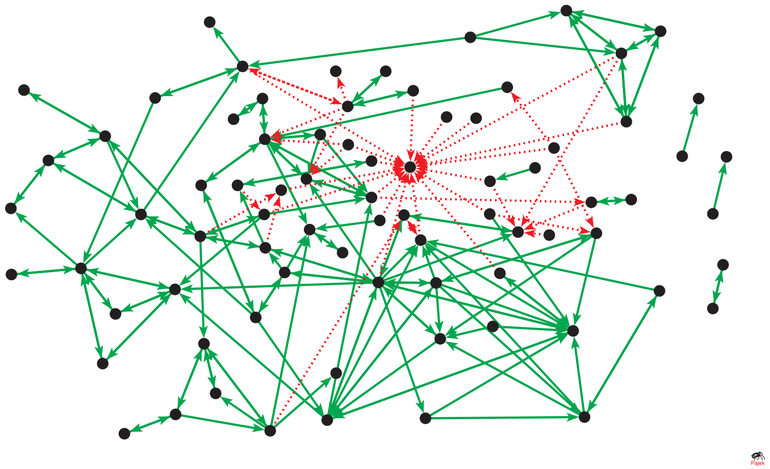


Tech Approach

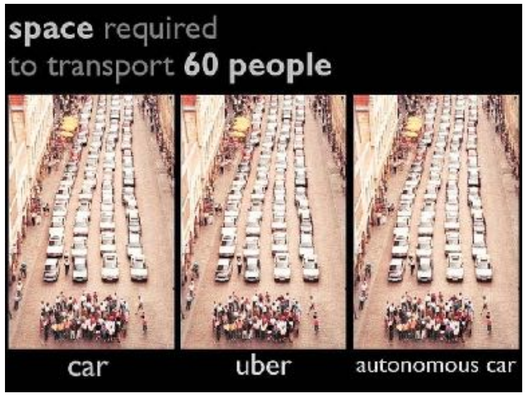
Interdisciplinarity is key for solving complex issues

Network Science



Tech Approach

Human Approach



1) Vulnerable road user safety in Europe

2) Towards a science of bicycle network design

Identifying urban features for vulnerable road user safety in Europe

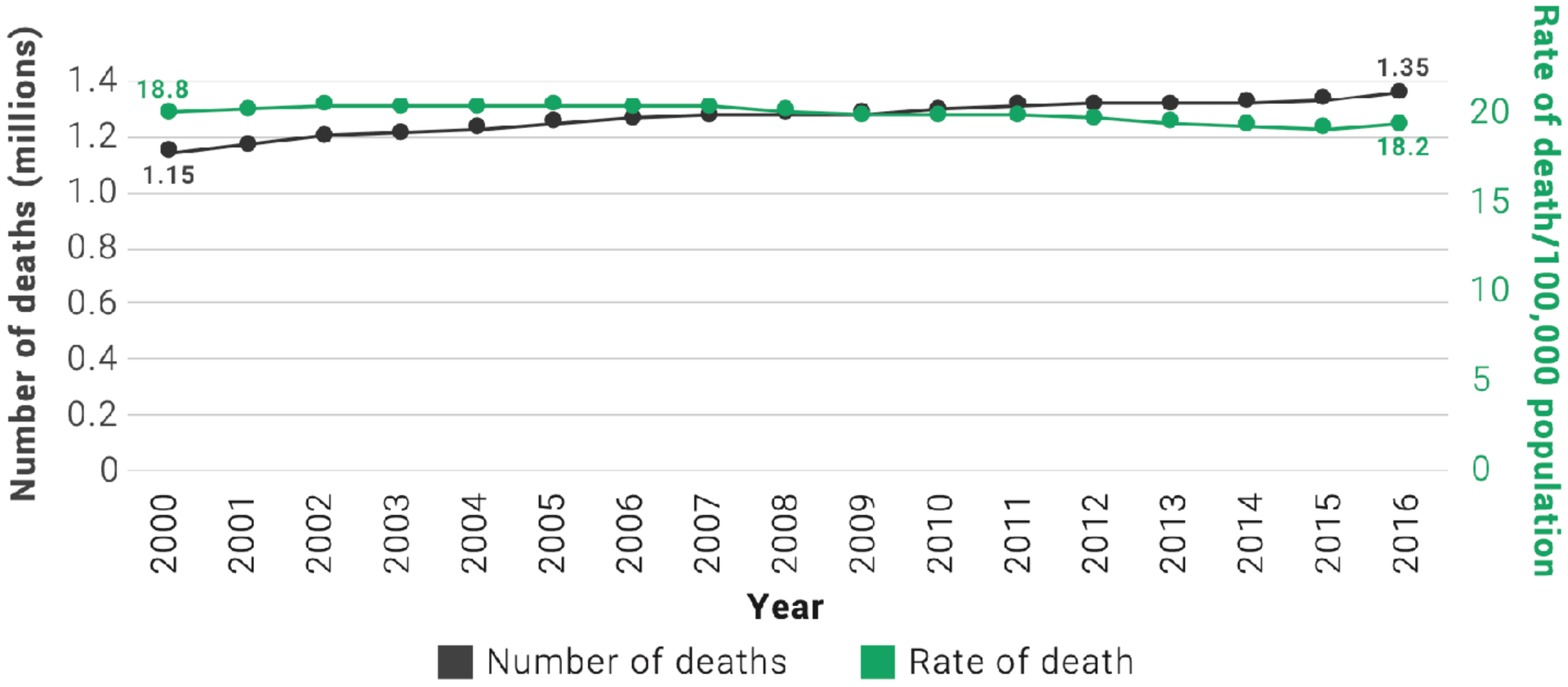
Marina Klanjčić[a], Laetitia Gauvin[a], Michele Tizzoni[a], and Michael Szell*[a,b]

[a] *ISI Foundation, Via Chisola 5, 10126 Torino, Italy*
[b] *Computer Science Department, IT University of Copenhagen, Rued Langgaards Vej 7, 2300 København, Denmark*

April 14, 2021

SocArXiv: http://osf.io/89cyu

The problem: 1.35 Mio people die on the road every year



WHO Global Status Report on Road Safety 2018

The solution: Set a goal

UNITED NATIONS

3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents

United Nations General Assembly. The 2030 agenda for sustainable development

~~The solution: Set a goal~~

3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents

Unfortunately, global levels stayed the same

United Nations General Assembly. The 2030 agenda for sustainable development

Who is dying and why?

Vulnerable road users
disproportionately impacted

WHO Global Status Report on Road Safety 2018

Who is dying and why?

Thalia **VERKADE** + *Marco* **TE BRÖMMELSTROET**

Verkade, T., & Te Brömmelstroet, M. (2019). Het grootste taboe in het verkeer: we kunnen elkaar doodrijden. De Correspondent

The OECD recommends:

1) Analyze such casualty matrices

2) Collect data from many cities

3) Investigate relation between urban shape, modal share, and road risk

ITF. Road Safety in European Cities: Performance Indicators and Governance Solutions. OECD Publishing, Paris, 2019

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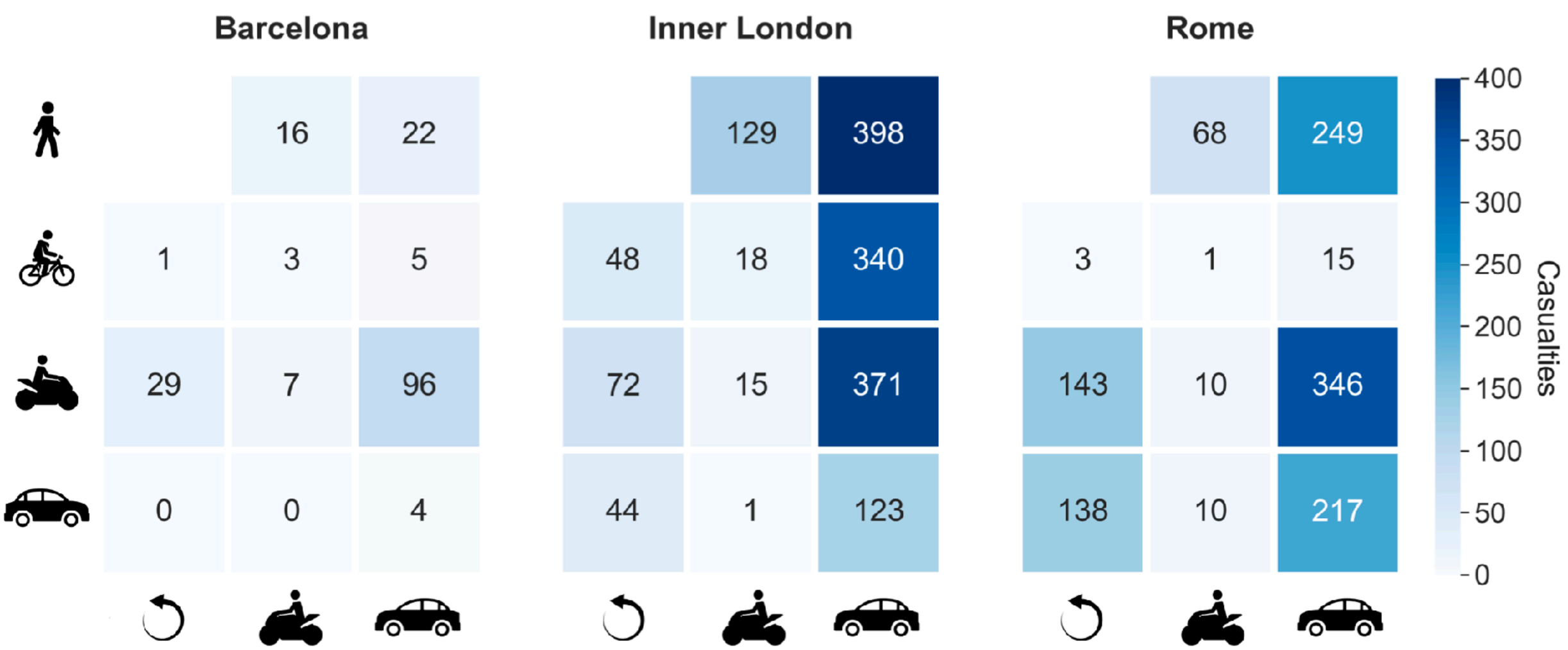
ITF. Road Safety in European Cities: Performance Indicators and Governance Solutions. OECD Publishing, Paris, 2019


MANY
MONTHS LATER

We collected data from 24 European cities / 5 countries

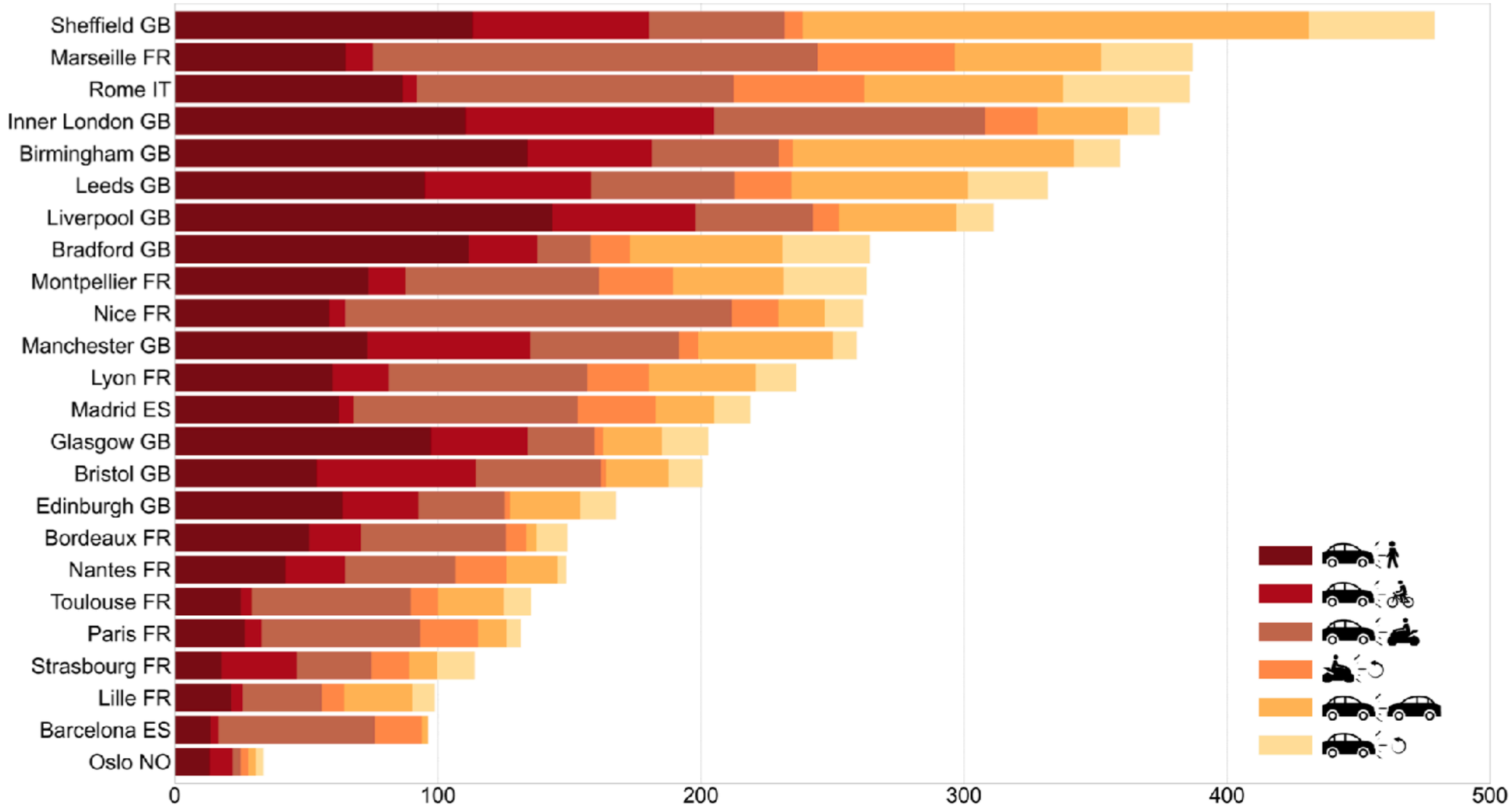
Klanjcic et al, socarxiv: http://osf.io/89cyu (2021)

Casualty matrices are heterogeneous



Klanjcic et al, socarxiv: http://osf.io/89cyu (2021)

Normalized casualties are also heterogeneous



Killed or seriously injured (KSI) per 1 Mio. inhabitants

Klanjcic et al, socarxiv: http://osf.io/89cyu (2021)

We also collected urban indicators

OpenStreetMap + OSMnx

Cycling share: How long are the protected cycle tracks compared to streets

Speed limited streets: Share of streets with ≤30km/h

EPOMM
European Platform on Mobility Management

Modal shares of different transport modes

Our analysis can be at most as good as the data quality

Crash underreportings, esp. for cycling

OpenStreetMap data issues, esp. for cycling infrastructure

Different national data collection or injury standards

ROAD ACCIDENT DATA COLLECTION	Belgium	Denmark	Germany	Netherlands	Poland	Spain	Sweden
Applicability of CARE definition to:							
• Road accident/injury accident	Yes	Yes	Yes	No	Yes	Yes	No
• Killed/fatally injured	Yes	Yes	Yes	Yes	Yes	Yes	No
• Injured	Yes	No	Yes	No	No	Yes	No
• Seriously injured	Yes	No	Yes	No	No	Yes	No
• Slightly injured	Yes	No	Yes	No	No	Yes	No
• Not injured	Yes	Yes	Yes	Yes	Yes	No	Yes
Data collection procedure							
From paper form to computer database	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Source of information about victim's injuries							
• ambulance	X	X	X			X	
• emergency room/admissions		X	X		X		X
• other hospital departments			X				X
• road users involved in accidents			X	X		X	
• other sources	X	X					
Verification of information on injuries							
Verification of information about victim's injuries	Yes	Yes	Yes	Yes	Yes	No	Yes
Classification of injury severity							
Classification of injury severity by the police	Yes	Yes	Yes	Yes	Yes	Yes	No
• based on doctor's opinion		X			X	X	
• using MAIS3+ classification							
• using AIS 2005 classification				X			
• other	X	X	X		X		

Olszewski et al. Journal of Safety Research, 68:49–57, 2019.

We built a statistical model using LASSO regression

$$\hat{\beta}_{\text{lasso}}(\alpha) = \text{argmin}_{\beta}||\mathbf{y} - X\beta||_2^2 + \alpha||\beta||_1$$

Predictors:


area share

area share

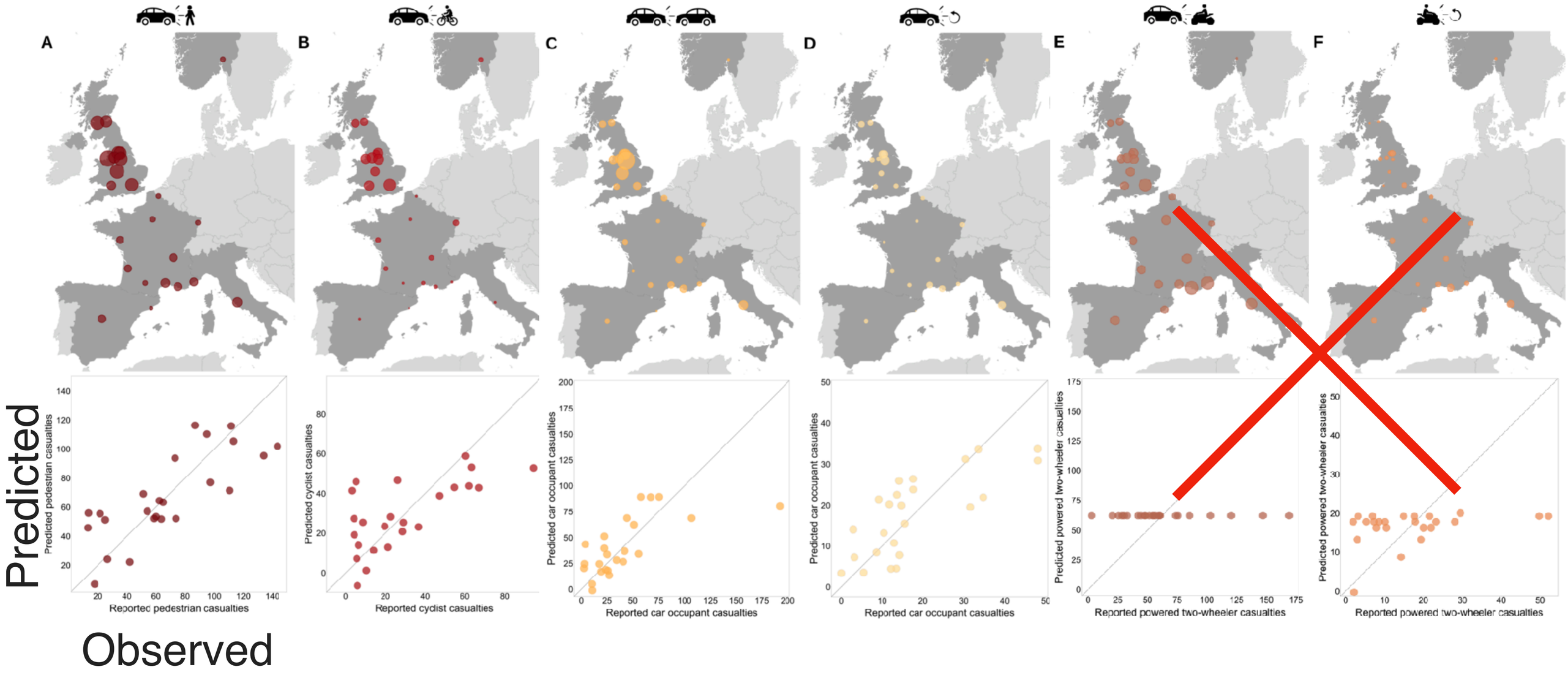

mode share


mode share


mode share

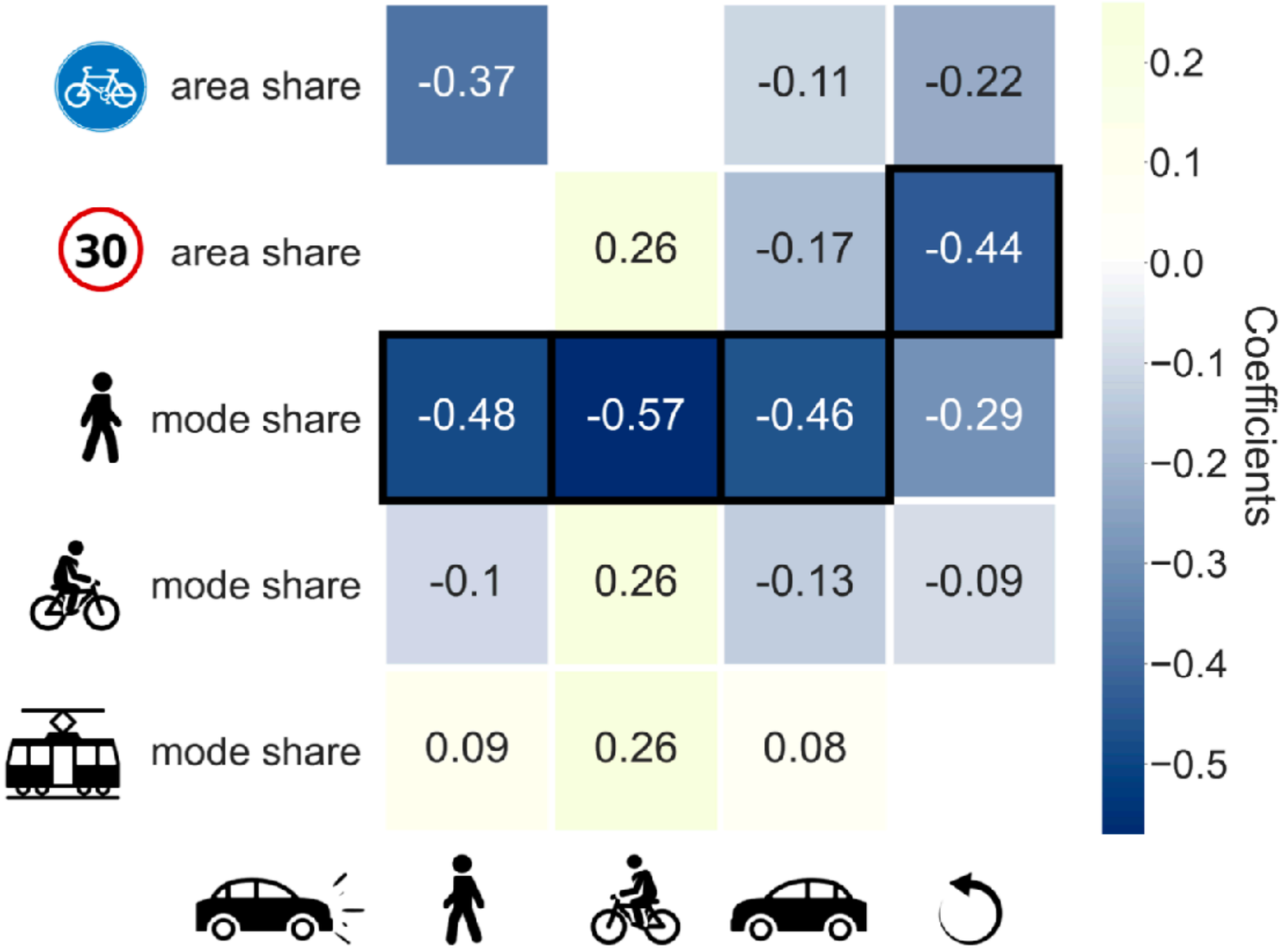
Klanjcic et al, socarxiv: http://osf.io/89cyu (2021)

Our model predicts reasonably (except for motorbikes)



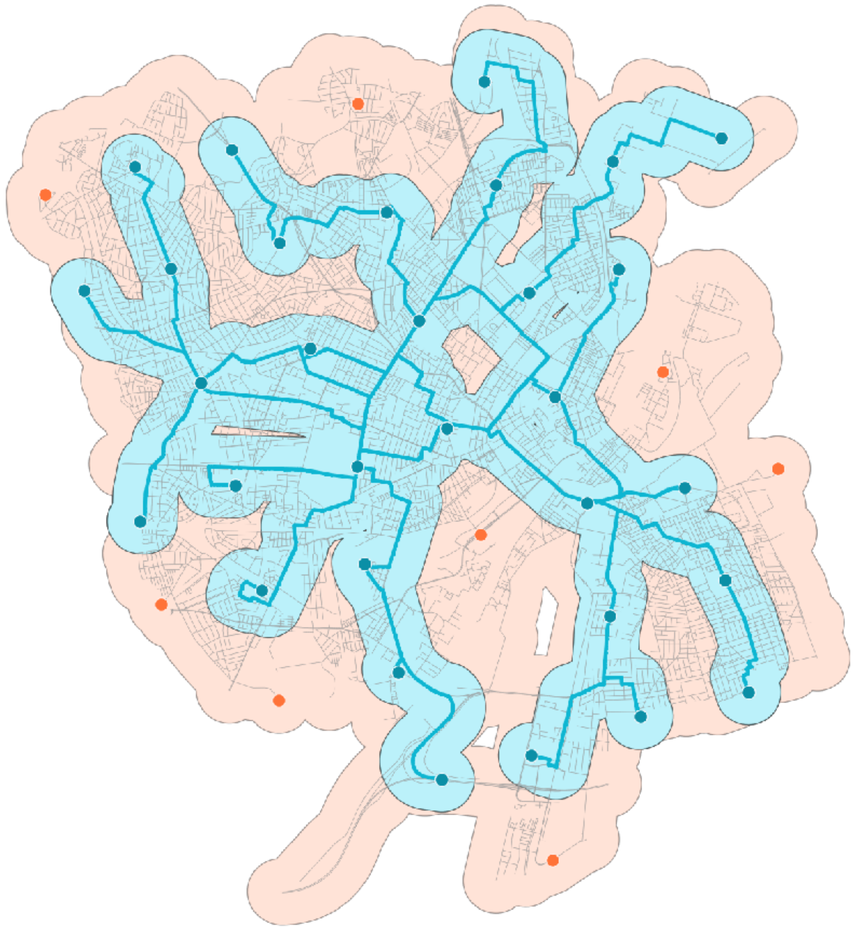
Klanjcic et al, socarxiv: http://osf.io/89cyu (2021)

In conclusion: More walking = Safer cities for all!



Klanjcic et al, socarxiv: http://osf.io/89cyu (2021)

2) Towards a science of bicycle network design



ROYAL SOCIETY OPEN SCIENCE

royalsocietypublishing.org/journal/rsos

Data-driven strategies for optimal bicycle network growth

Luis Guillermo Natera Orozco[1], Federico Battiston[1], Gerardo Iñiguez[1,2,3] and Michael Szell[4,5,6]

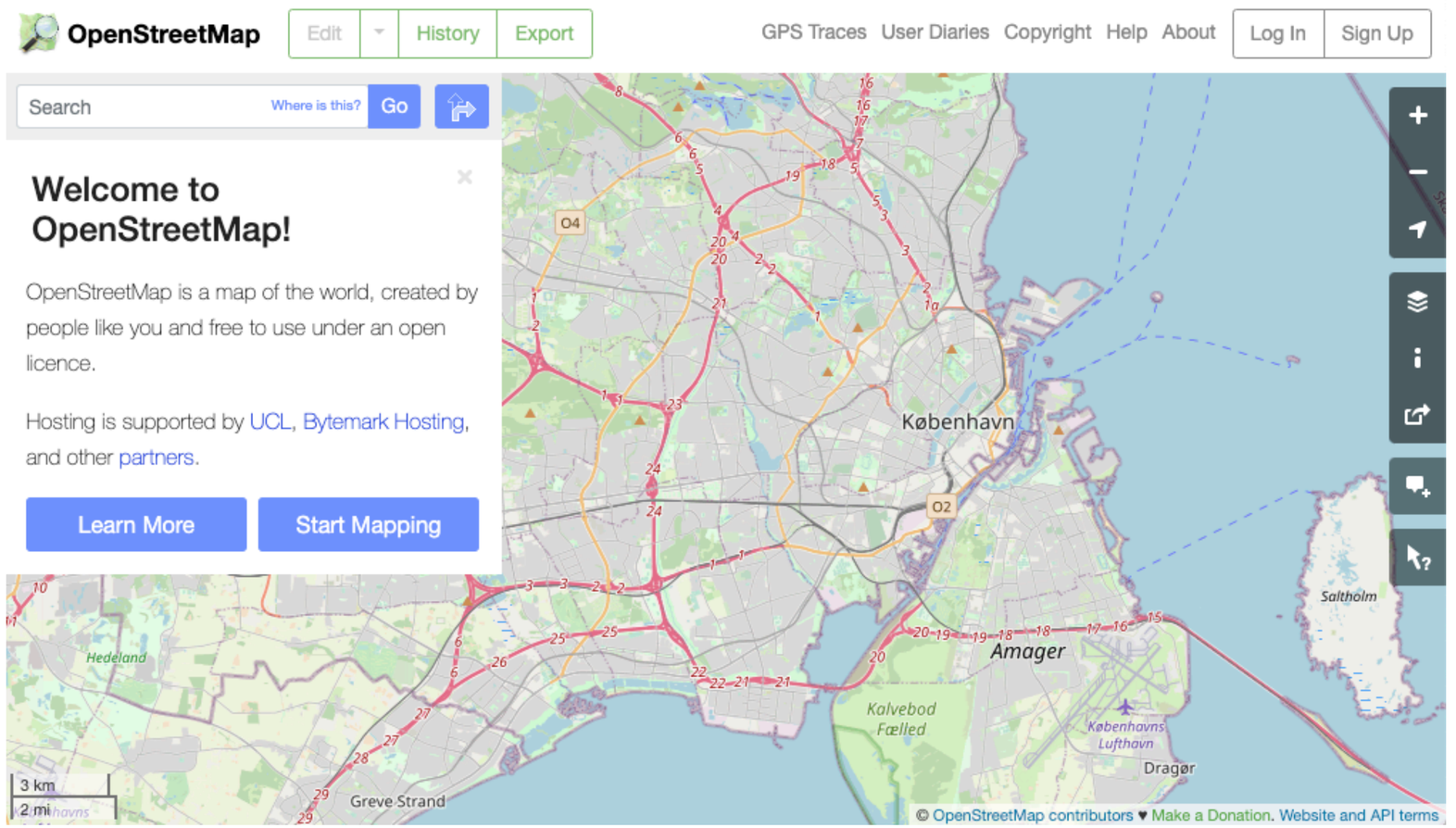
[1]Department of Network and Data Science, Central European University, 1100 Vienna, Austria
[2]Department of Computer Science, Aalto University School of Science, 00076 Aalto, Finland
[3]Centro de Ciencias de la Complejidad, Universidad Nacional Autonóma de México, 04510 CDMX, Mexico
[4]NEtwoRks, Data, and Society (NERDS), IT University of Copenhagen, 2300 Copenhagen, Denmark
[5]ISI Foundation, 10126 Turin, Italy
[6]Complexity Science Hub Vienna, 1080 Vienna, Austria

Research

Cite this article: Natera Orozco LG, Battiston F, Iñiguez G, Szell M. 2020 Data-driven strategies for optimal bicycle network growth. *R. Soc. Open Sci.* **7**: 201130.
https://doi.org/10.1098/rsos.201130

https://royalsocietypublishing.org/doi/10.1098/rsos.201130

We downloaded data from OpenStreetMap (OSM)

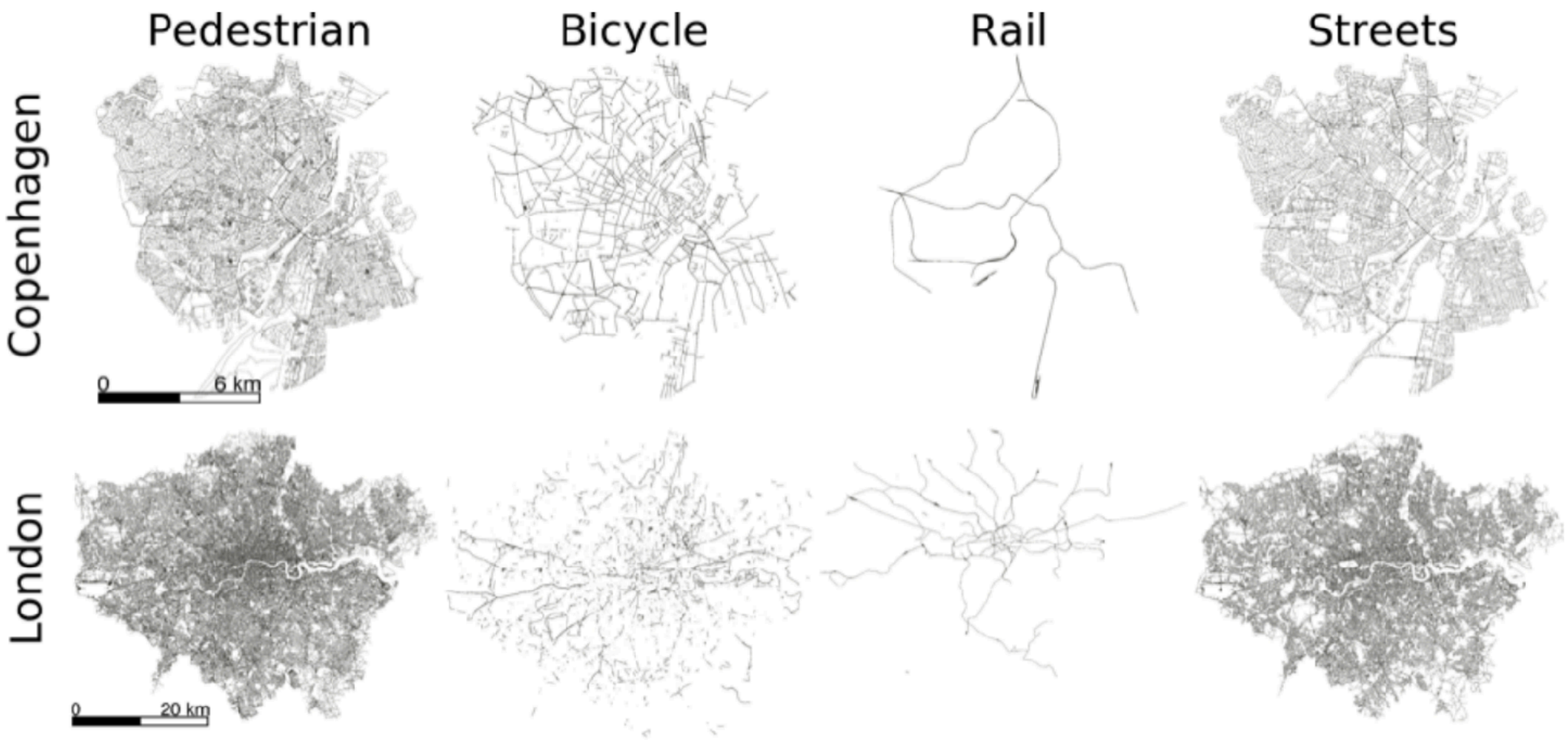


OSM data are quite reliable in western countries

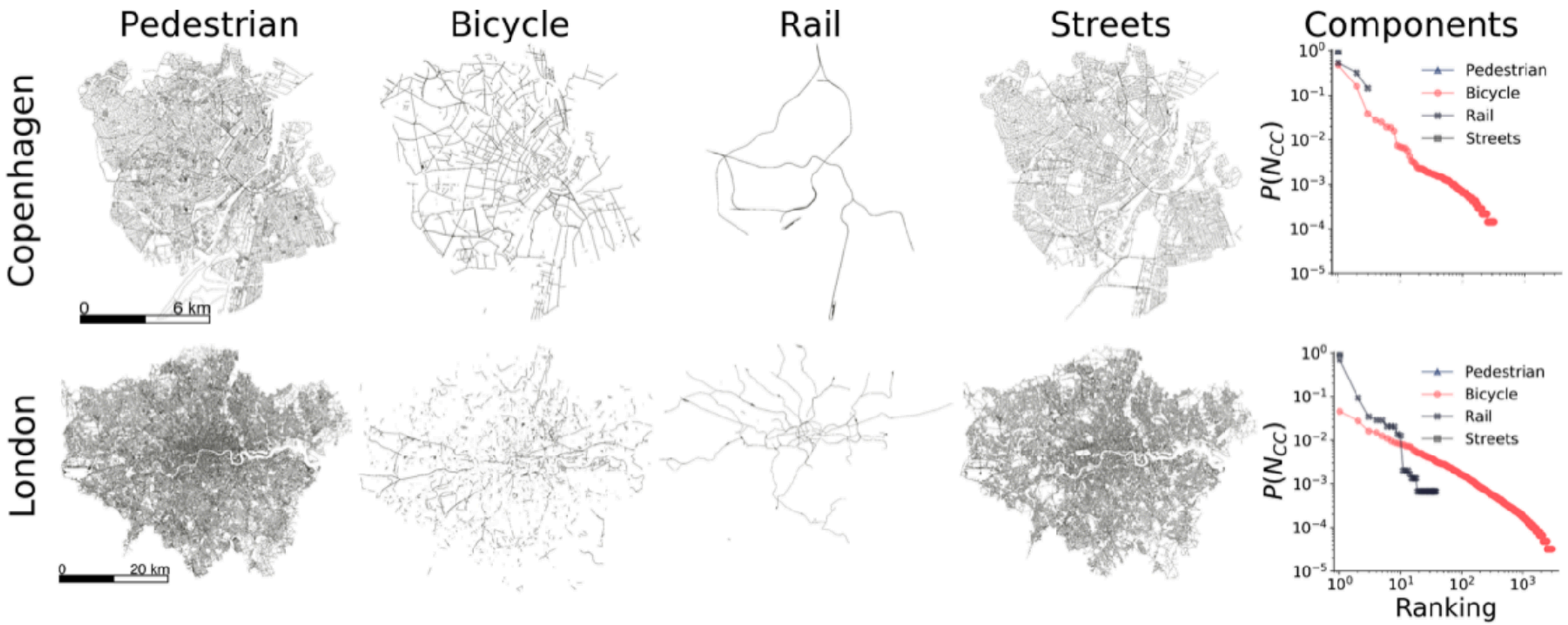
Haklay et al, Cart J 47 (2010)

Barrington-Leigh & Millard-Ball, PLOS ONE 12, (2017)

Cities have different transport network layers



Bicycle networks are highly fragmented



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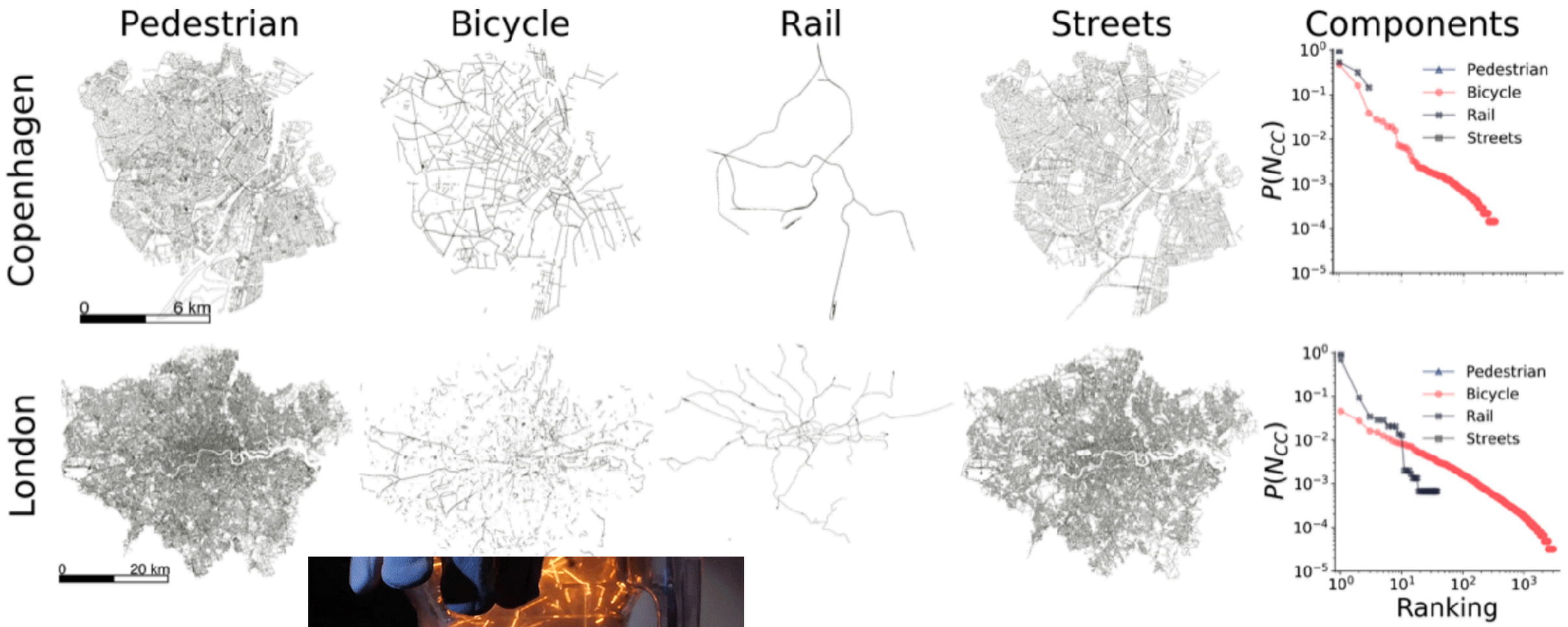
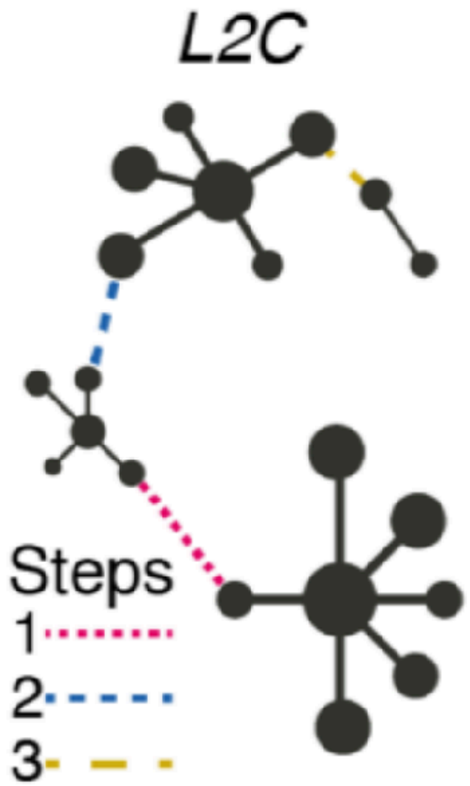


How should we connect the components?

Largest to closest



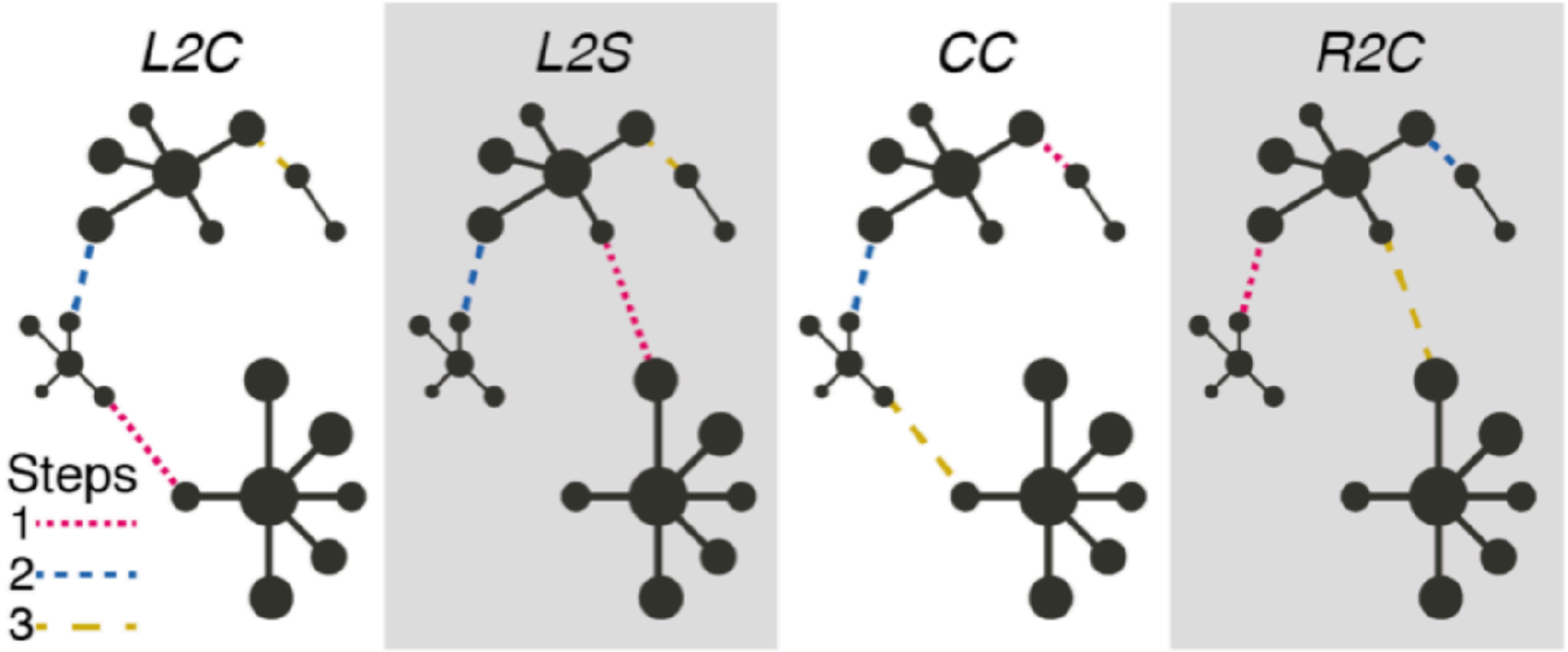
How should we connect the components?

Largest to closest

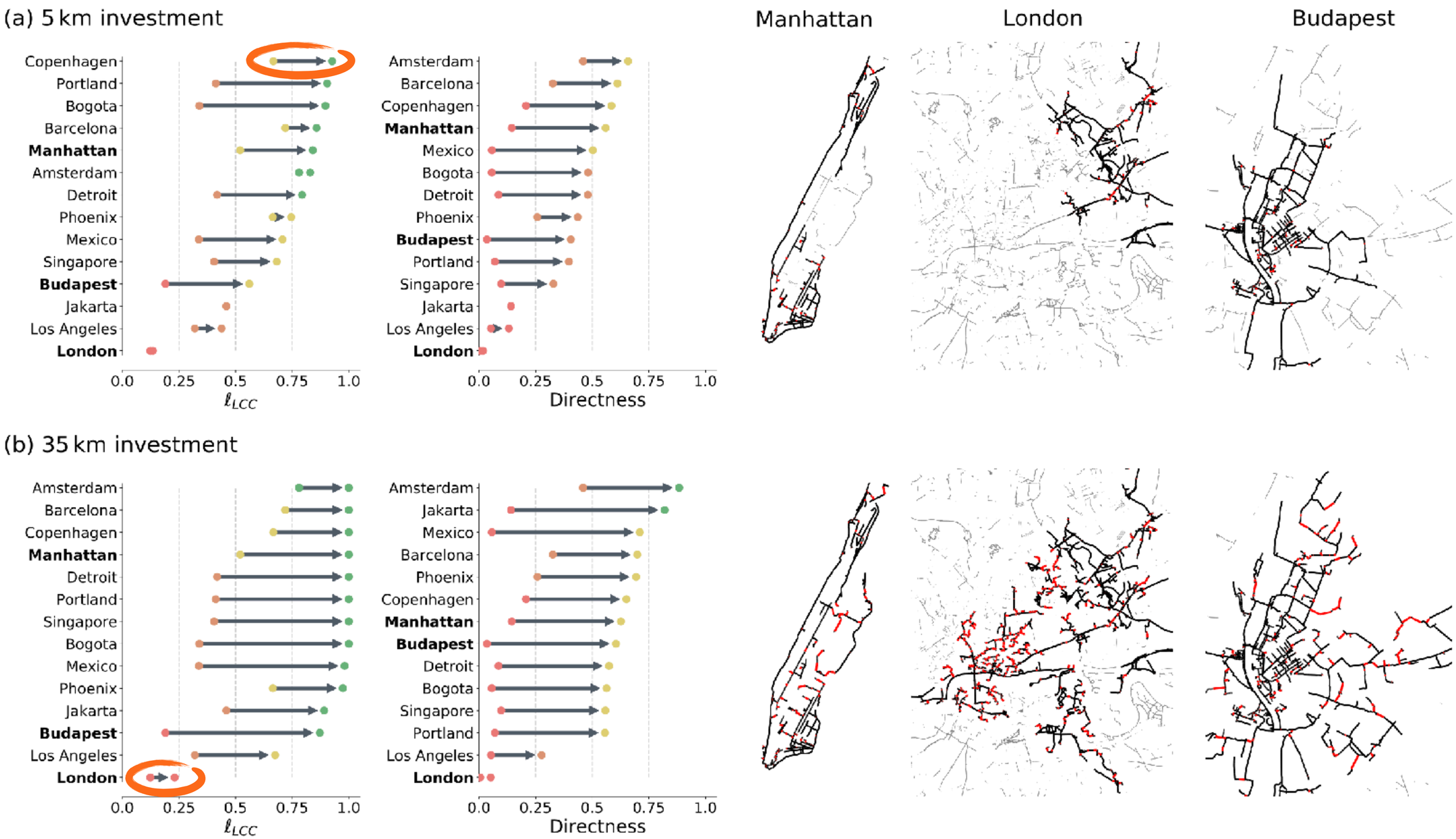
Largest to second largest

Closest components

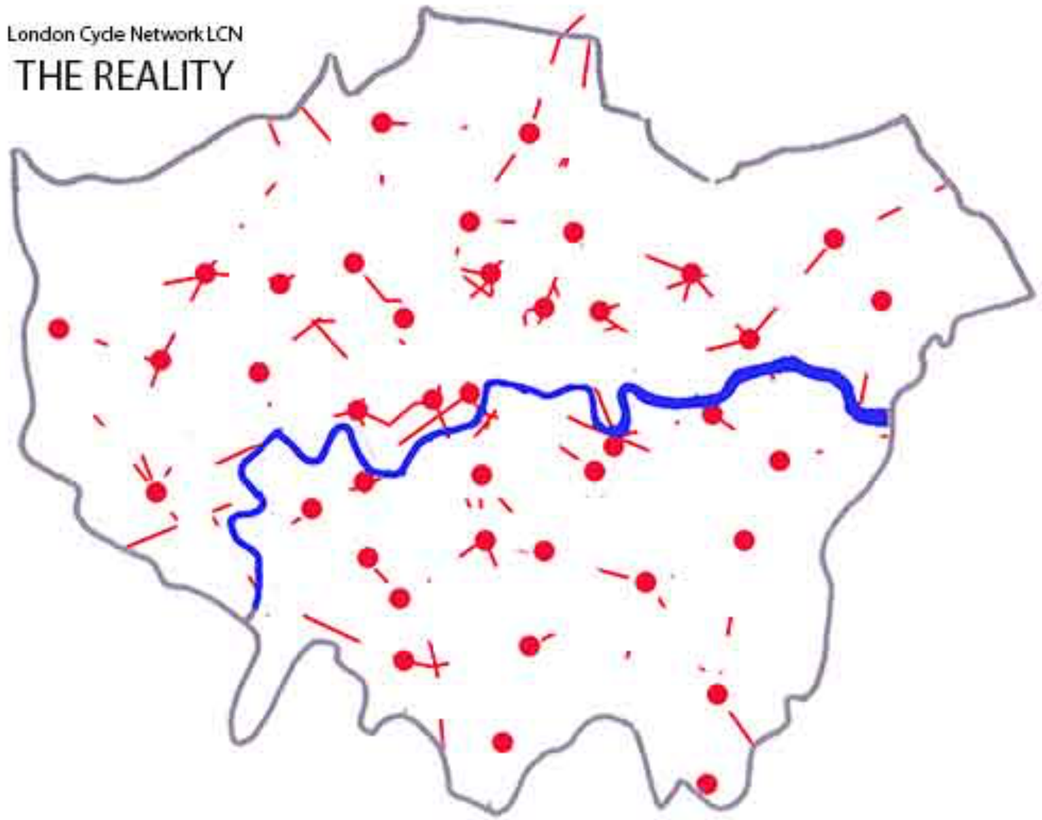
Random to closest

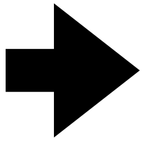


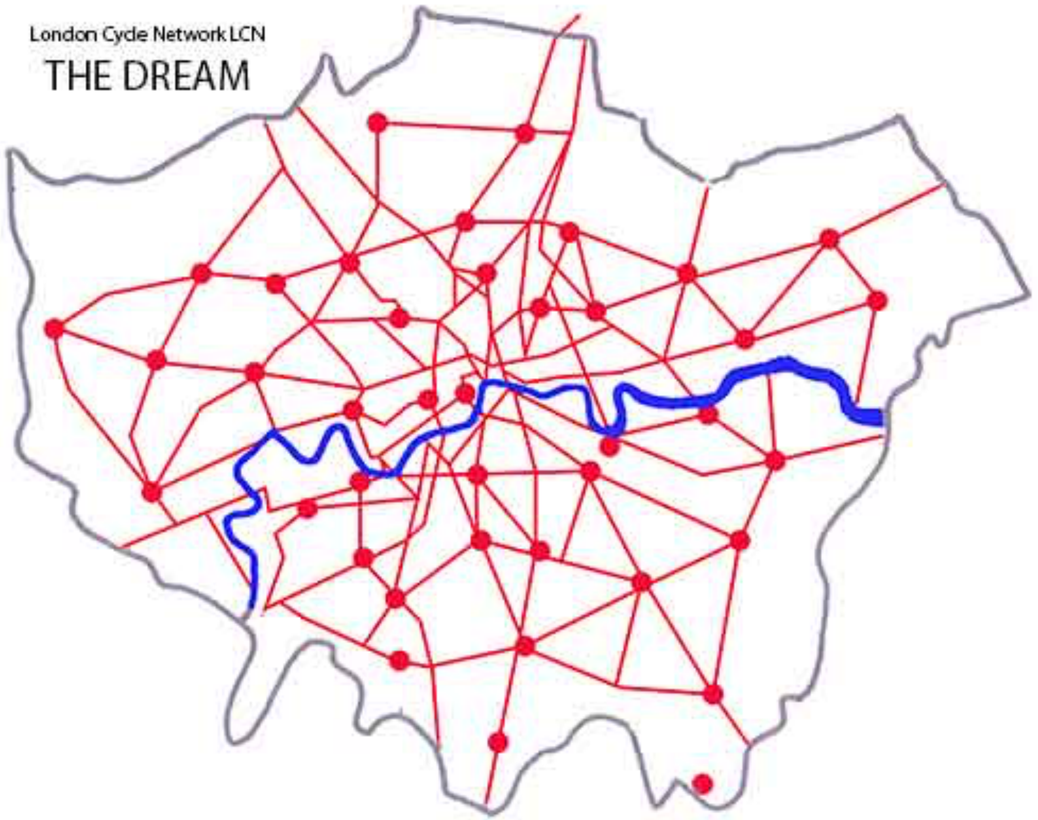
Investing in connections makes sense in well developed cities



For most cities it makes more sense to start from scratch





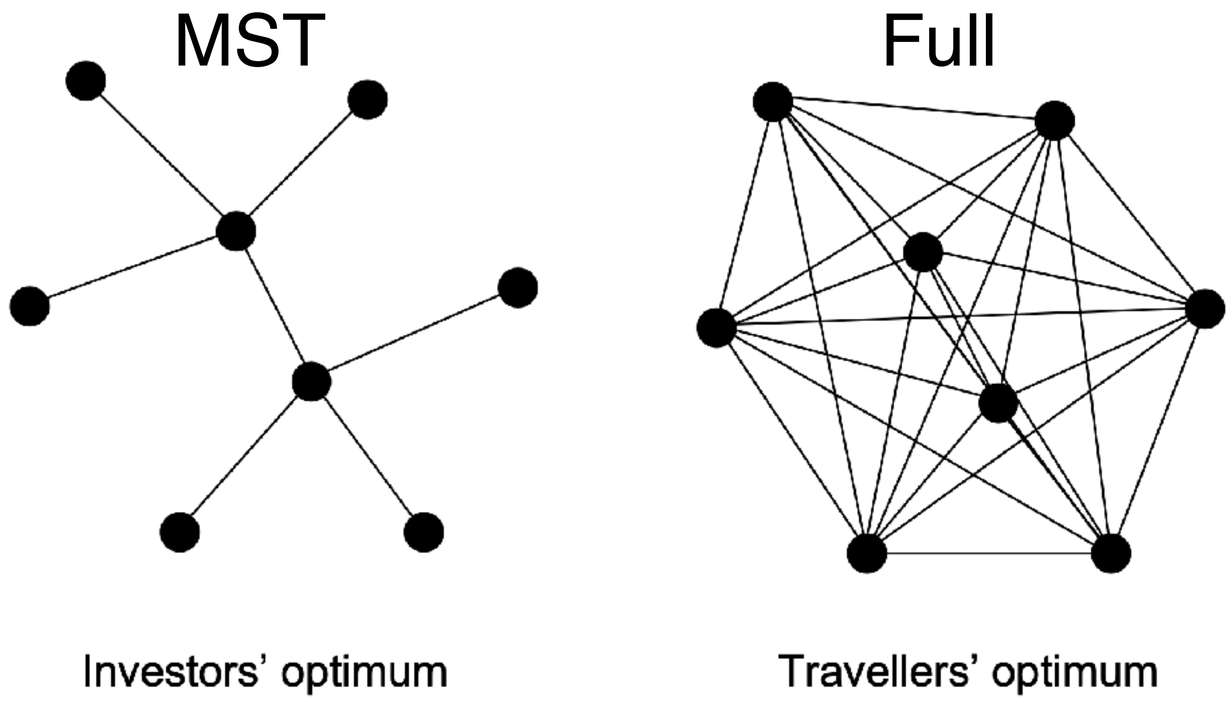


http://www.landscapearchitecture.org.uk/london-cycle-network-or-london-cycleway-network-plan/

It is not enough to just connect components

A minimum spanning tree has no redundancy, and no:

- Fault tolerance (roadworks, traffic)
- Directness



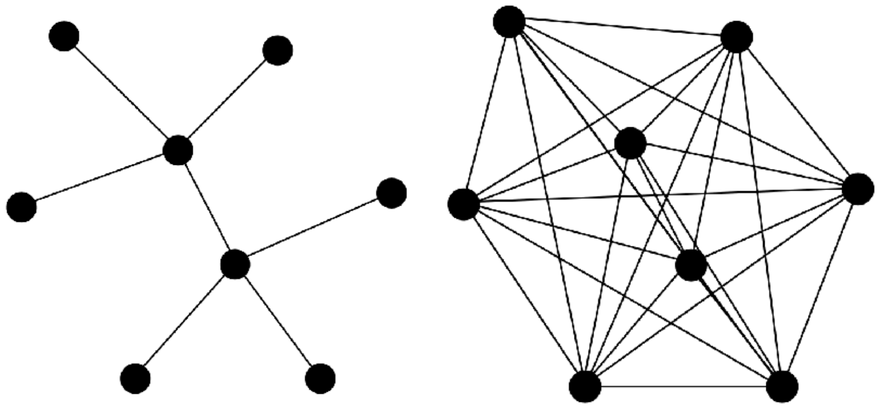
van Nes, Univ of Delft (2002)

This is not the end of the story

So far we focused ONLY on 1) connectedness, 2) directness

Our current research extends to:

Efficiency / Redundancy



Investors' optimum

Travellers' optimum

van Nes, Univ of Delft (2002)

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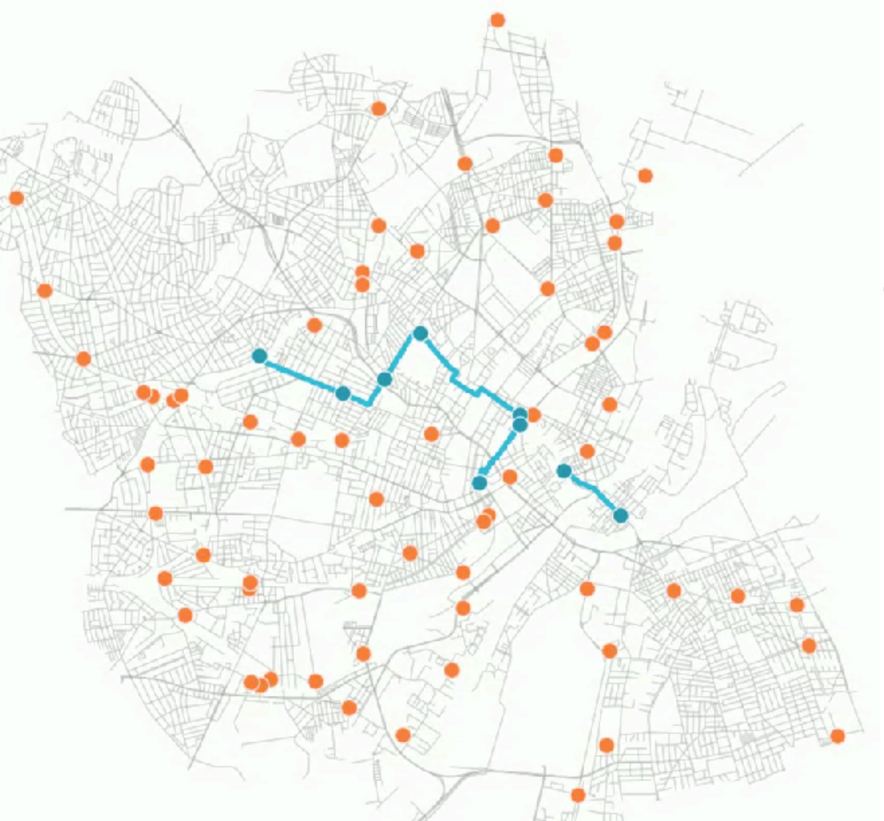
Growth



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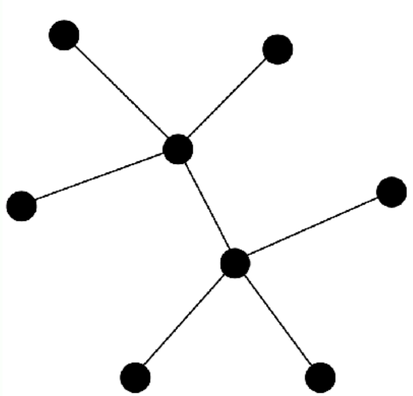

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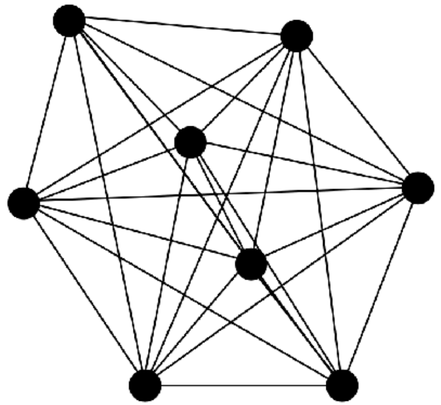
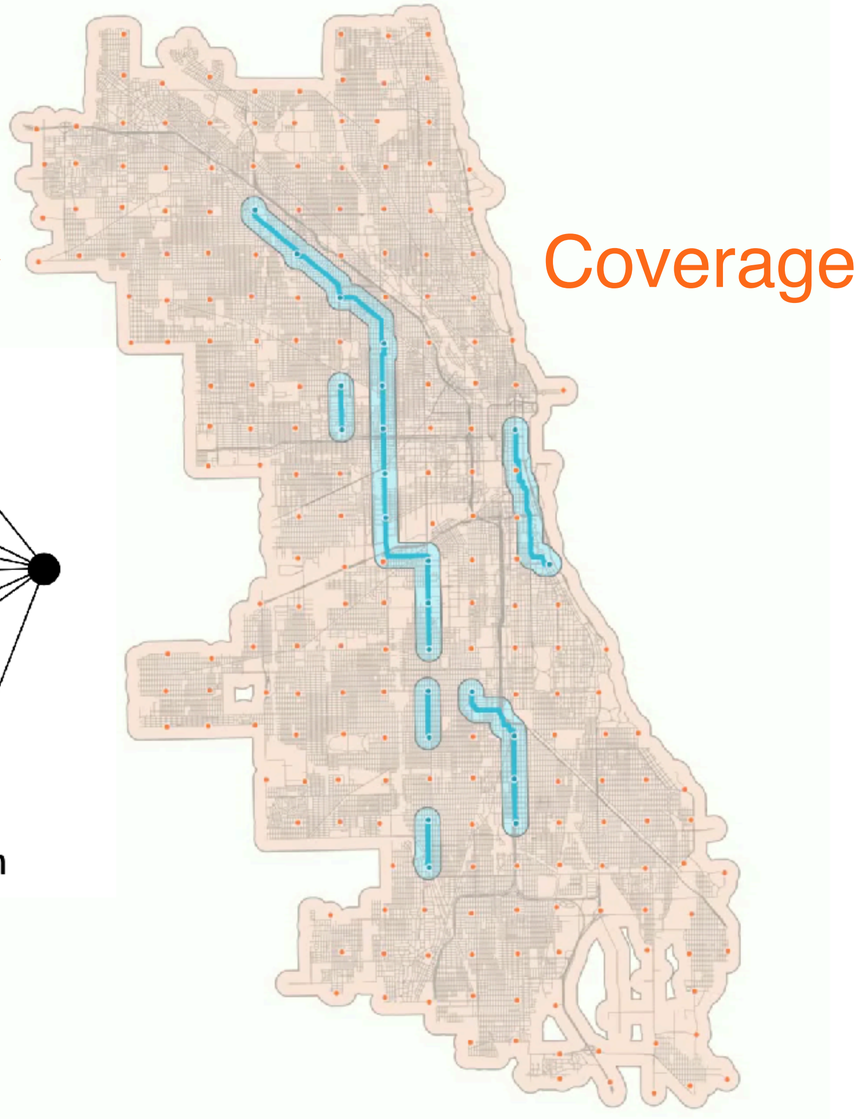


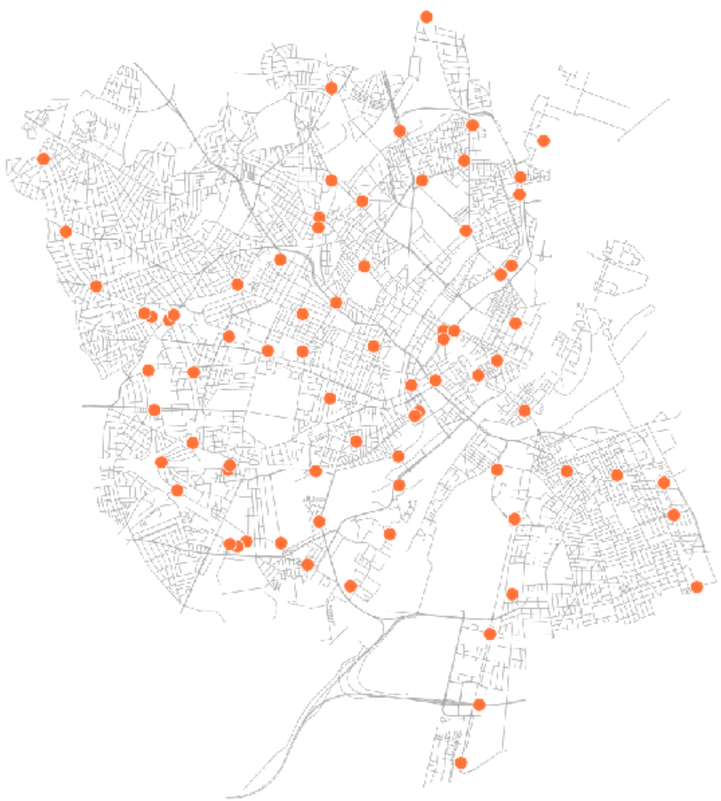
Travellers' optimum

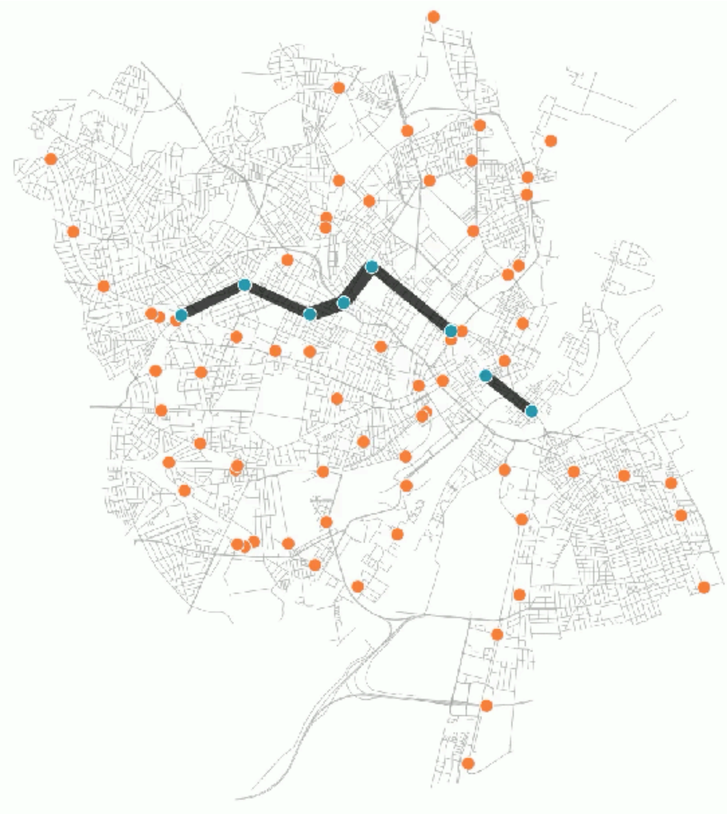
Coverage

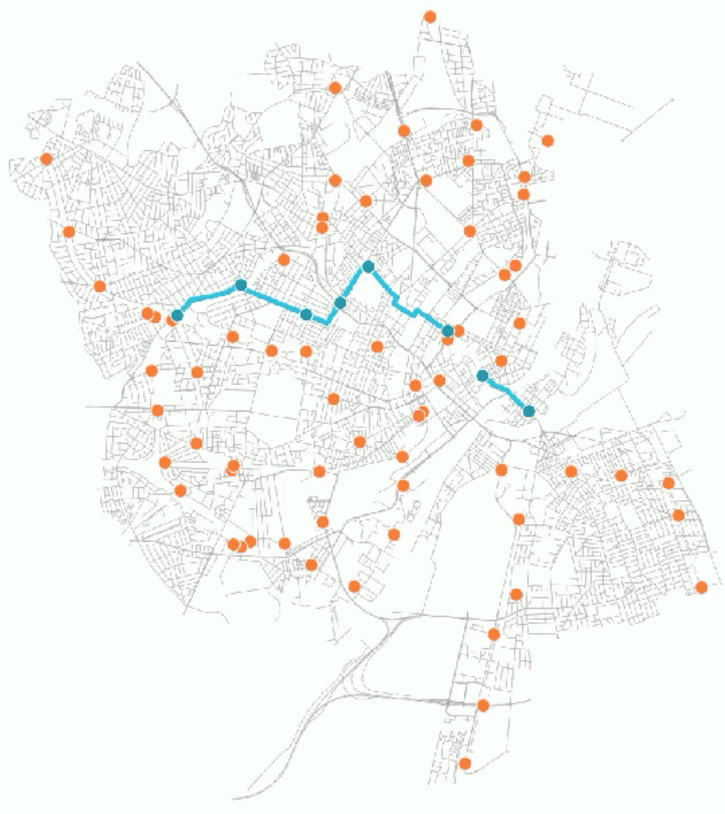


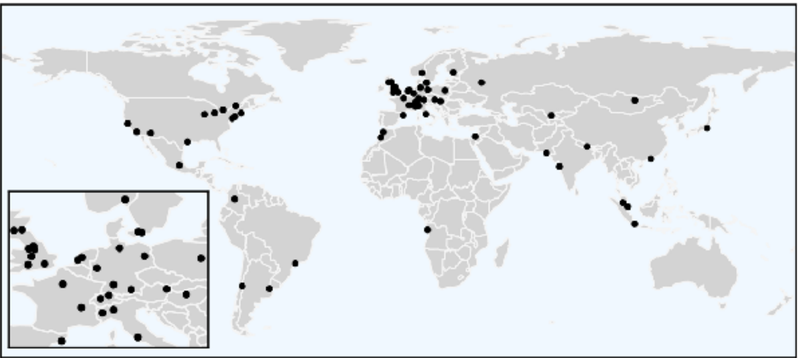
van Nes, Univ of Delft (2002)

Our idea: POIs → Greedy Triangulation → Routing



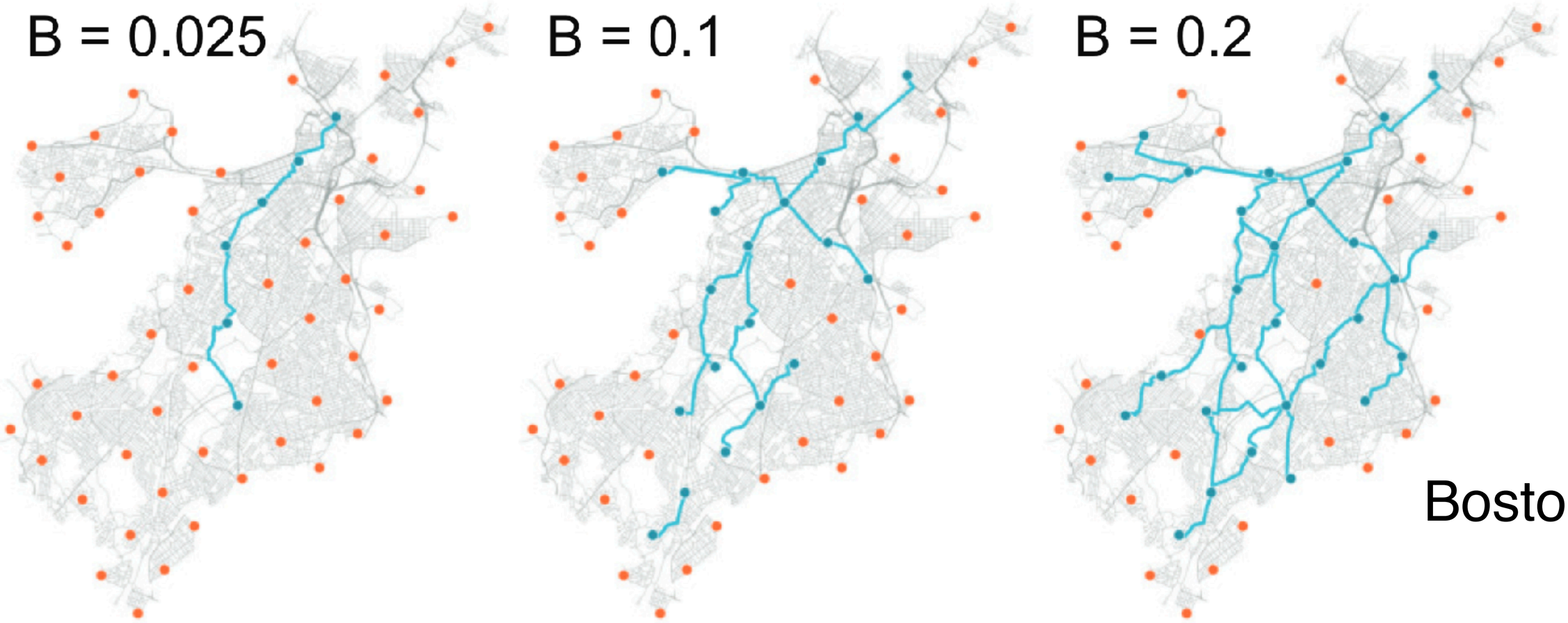






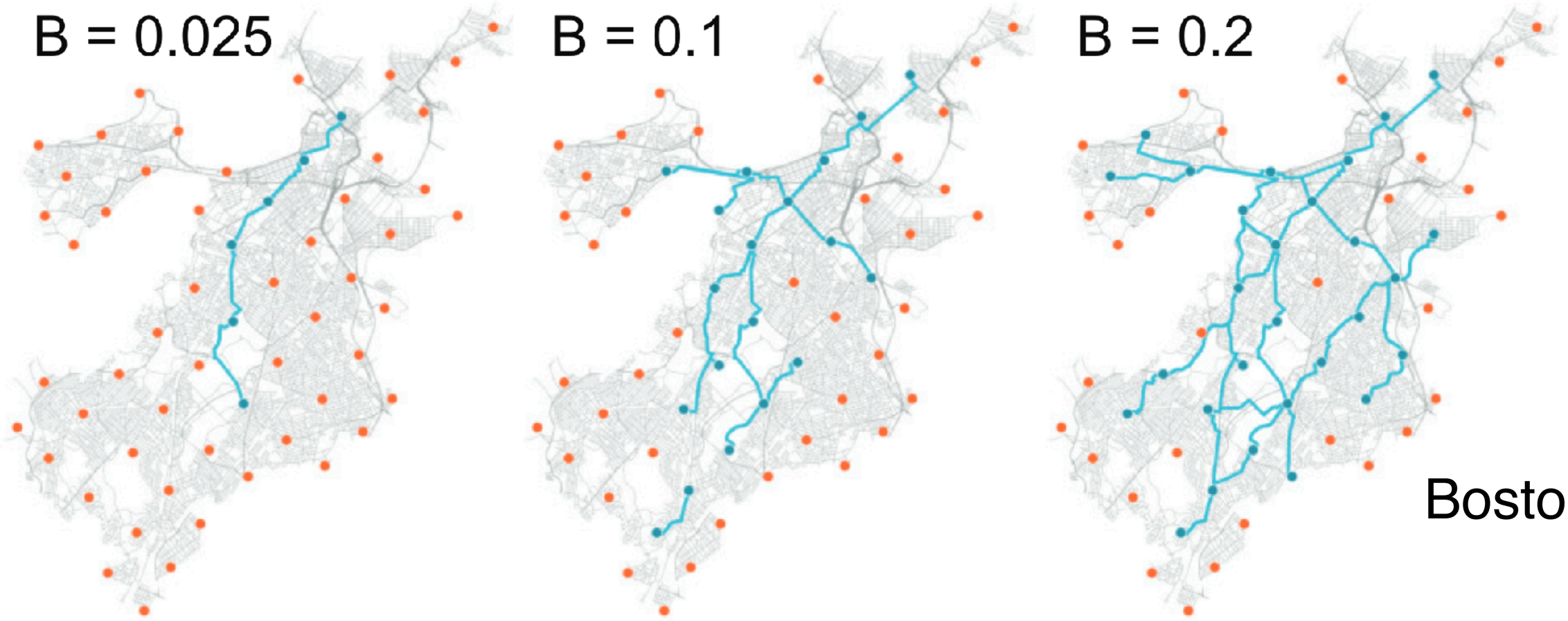
Growth metric quantiles 0→1

"Surprise": We grow networks and find percolation thresholds



Erdős, P. & Rényi, A. Publicationes Mathematicae. 6: 290–297 (1959)

"Surprise": We grow networks and find percolation thresholds

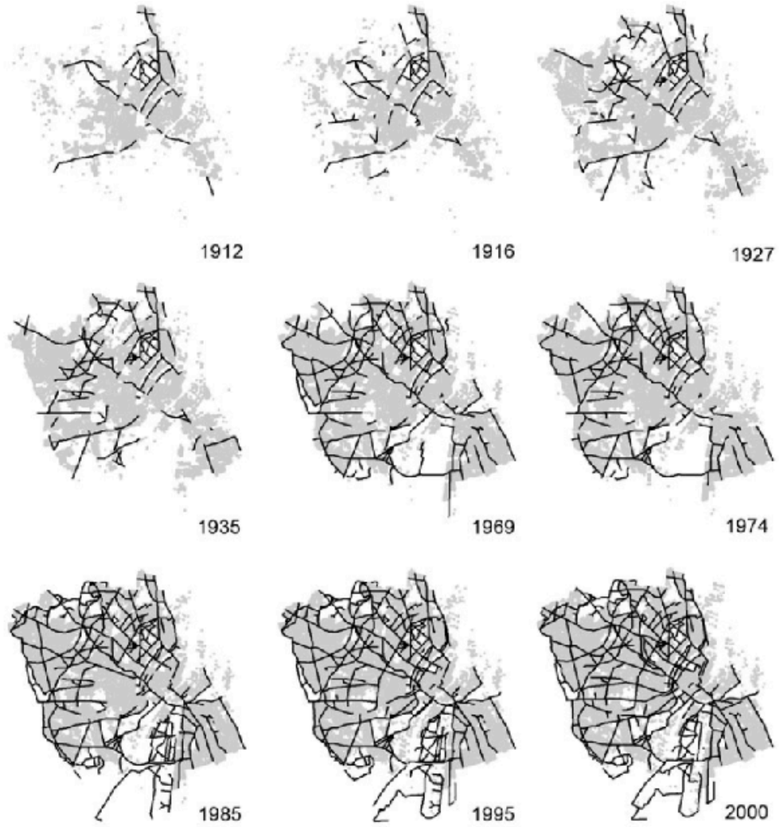


Boston

2 Fundamental implications on bicycle network planning:

1) We need to grow with the right strategy
2) We need to invest **boldly** to reach a critical mass

The leading manuals suggest slow, local growth



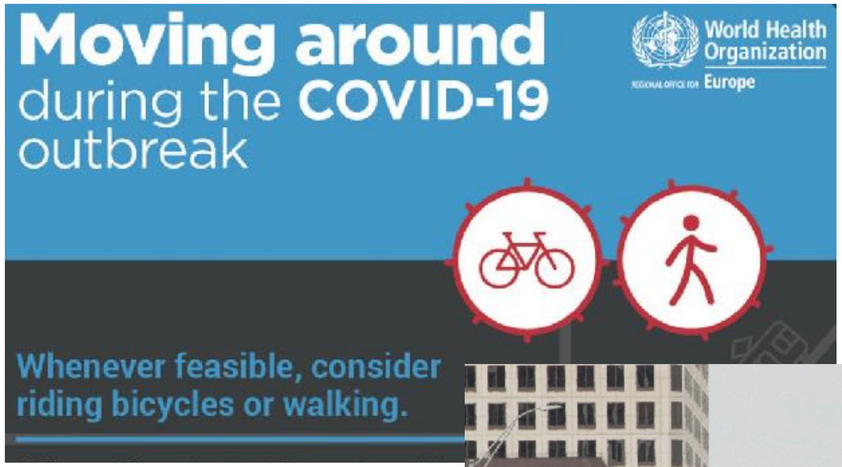
It took Copenhagen many decades of political struggles to grow a cohesive network. Can we even plan for a whole city?

de Groot, CROW Media 28, 2016
copenhagenize, 2018

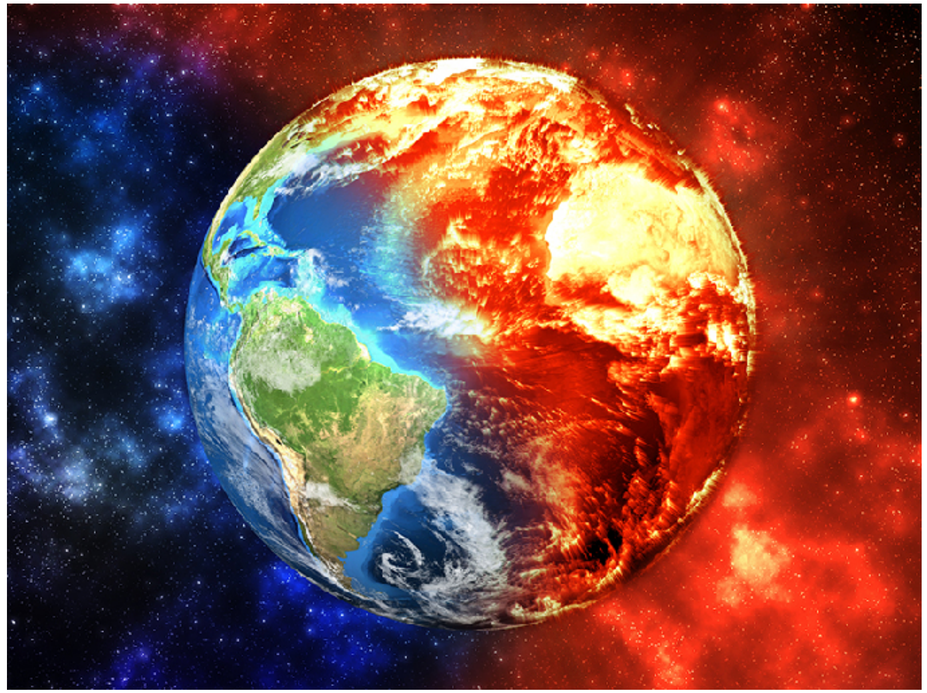
Carstensen et al., Geografisk Tidsskrift 115:2, 142-156 (2015)

Time is running out

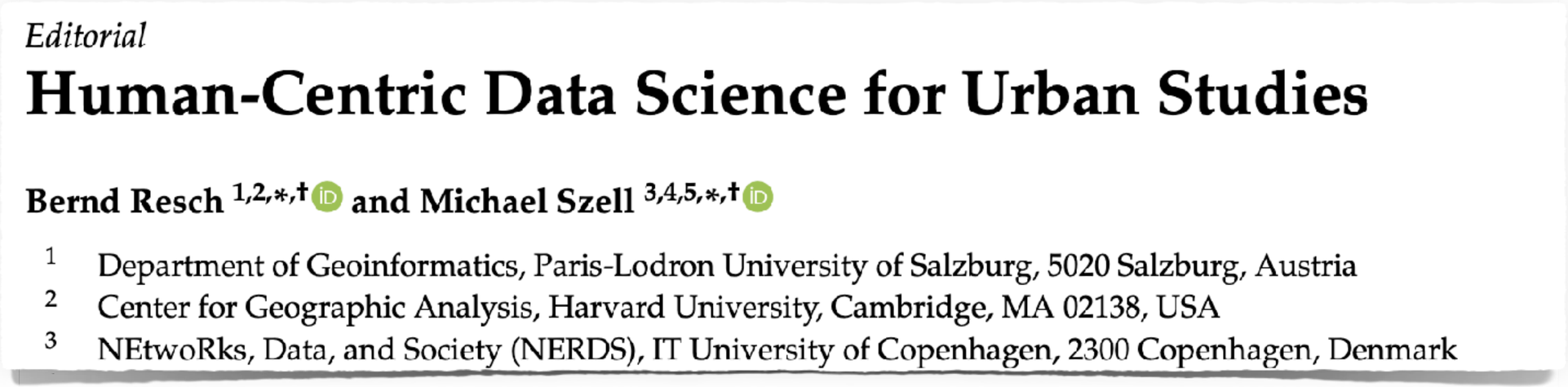
COVID popup lanes showed accelerated transition is possible



Failure to act fast has dire consequences..



My goal: Combine network+data science and data visualization to make cities better places



Editorial

Human-Centric Data Science for Urban Studies

Bernd Resch [1,2,*,†] **and Michael Szell** [3,4,5,*,†]

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2 Center for Geographic Analysis, Harvard University, Cambridge, MA 02138, USA
3 NEtwoRks, Data, and Society (NERDS), IT University of Copenhagen, 2300 Copenhagen, Denmark

Resch & Szell, ISPRS International Journal of Geo-Information 8, 584 (2019)

NERDS = NEtwoRks, Data, and Society

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