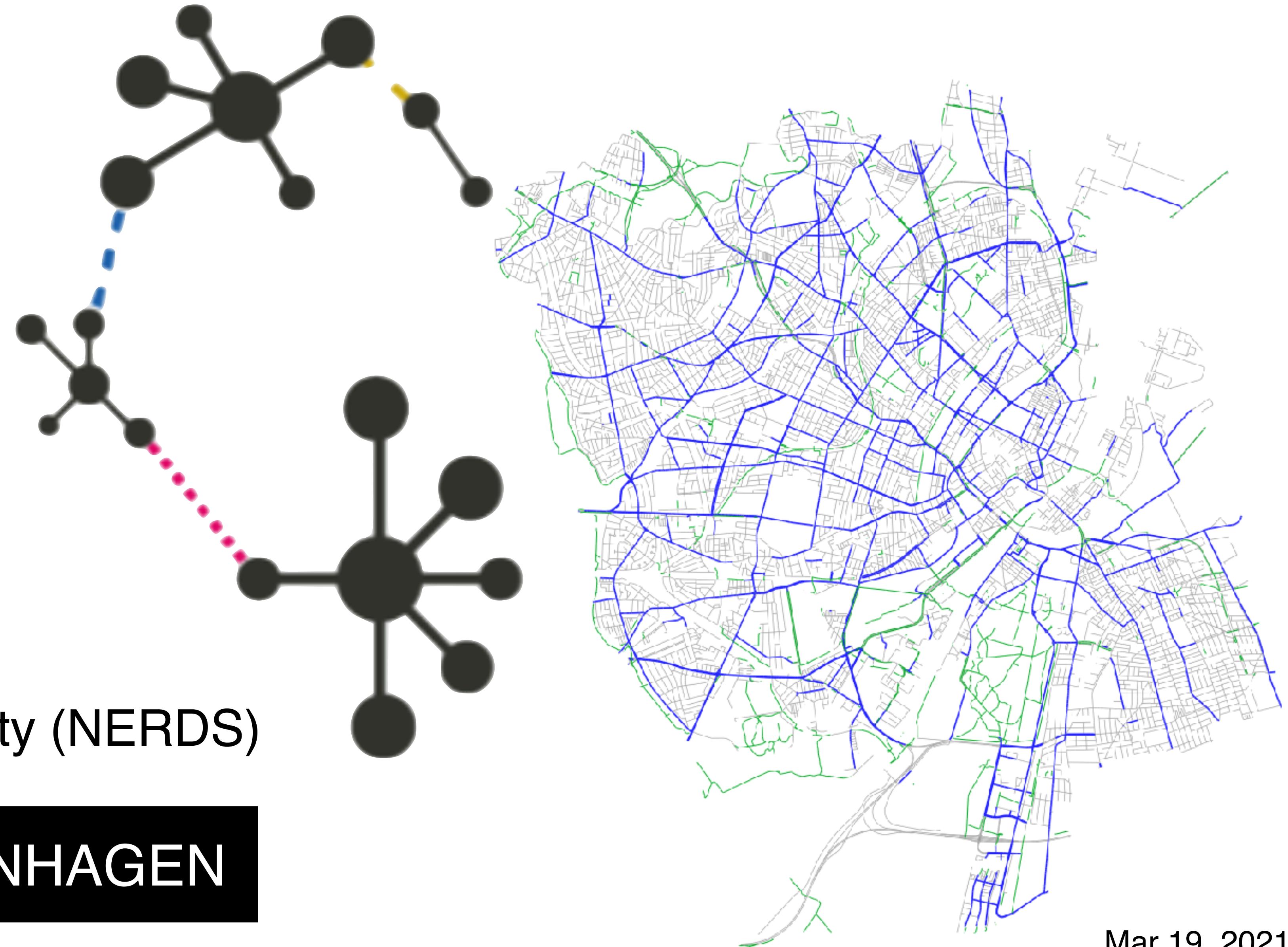


Data-driven strategies for optimal bicycle network growth

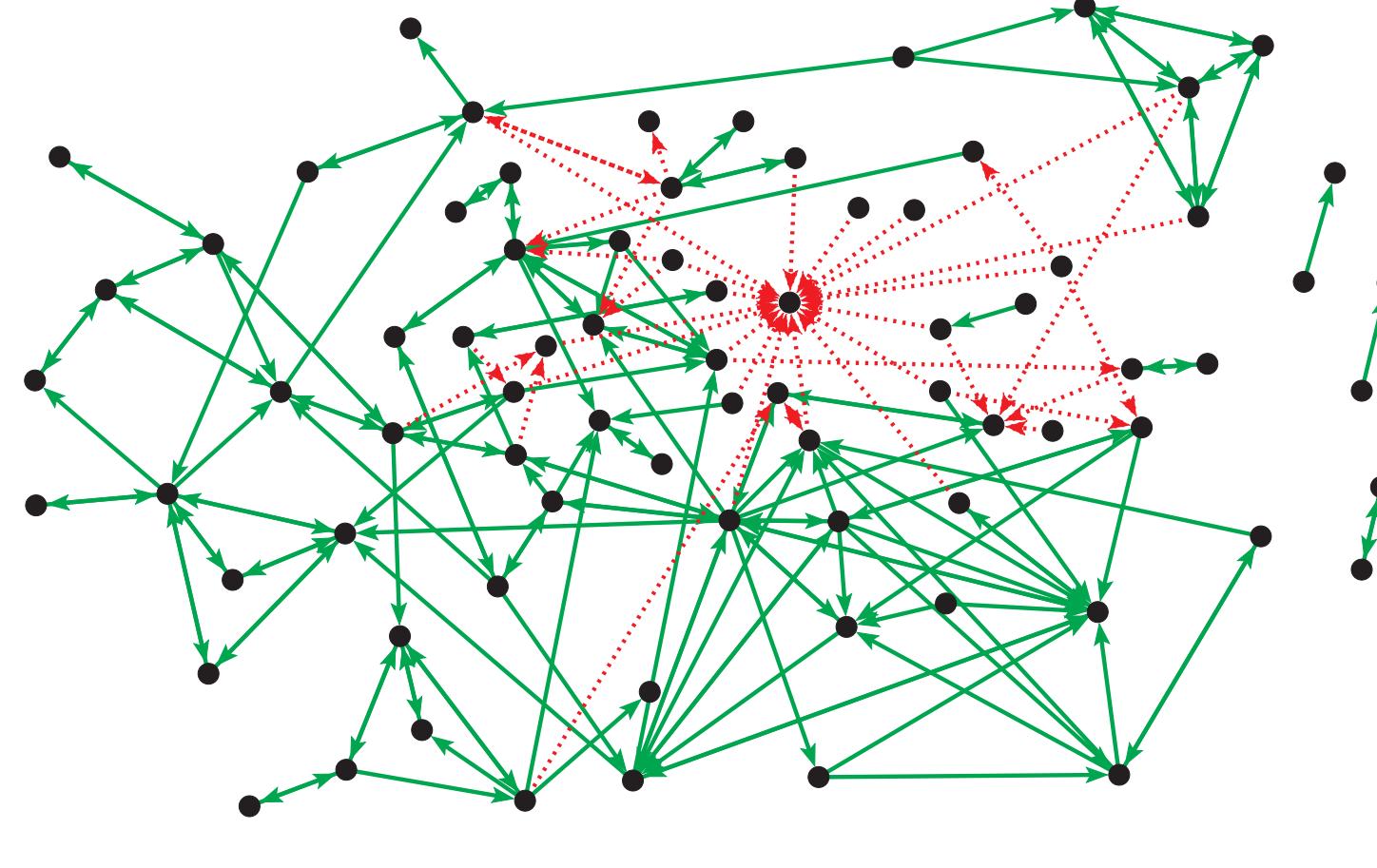
Michael Szell

NEtwoRks, Data, and Society (NERDS)



Interdisciplinarity is key for solving complex issues

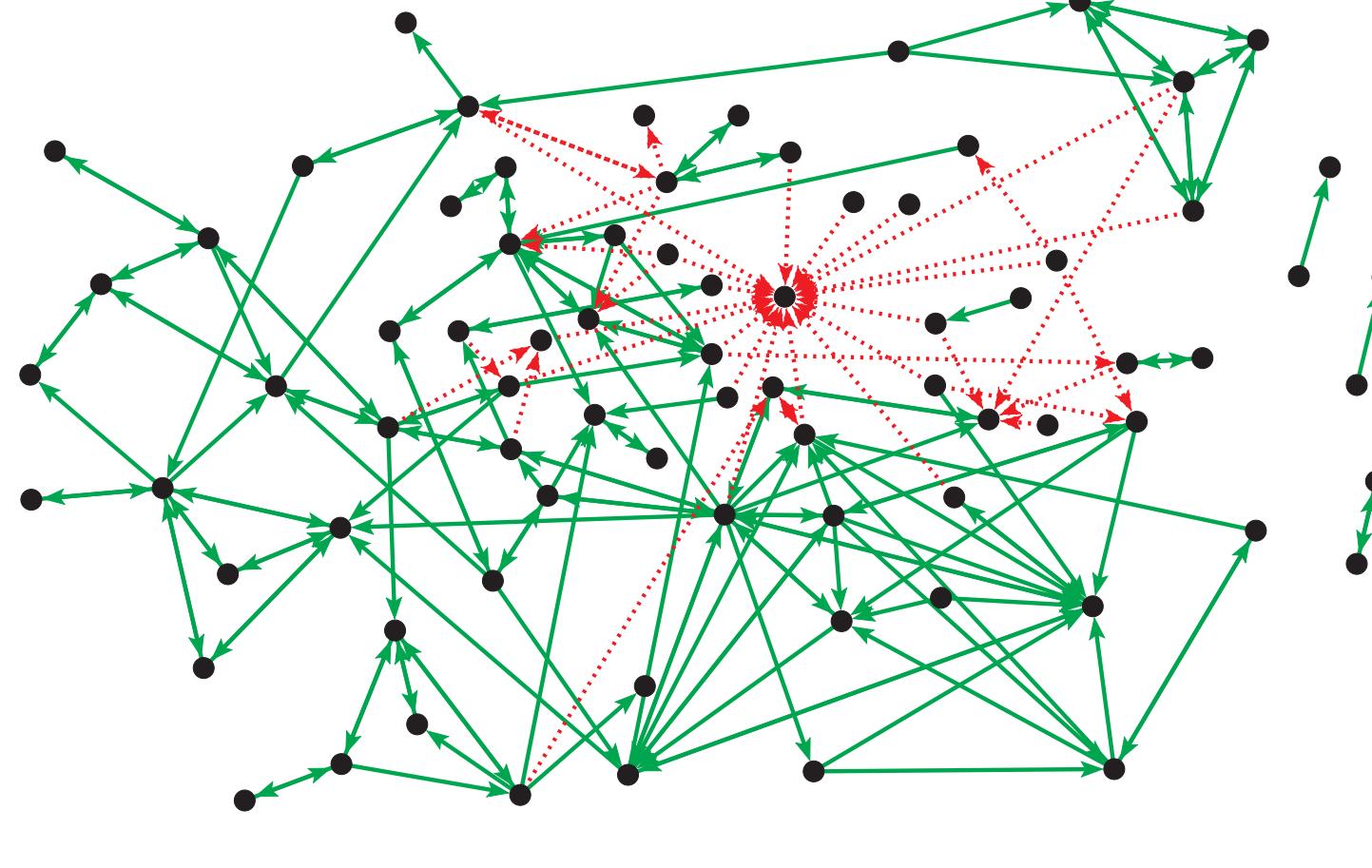
Network Science



Interdisciplinarity is key for solving complex issues



Network Science



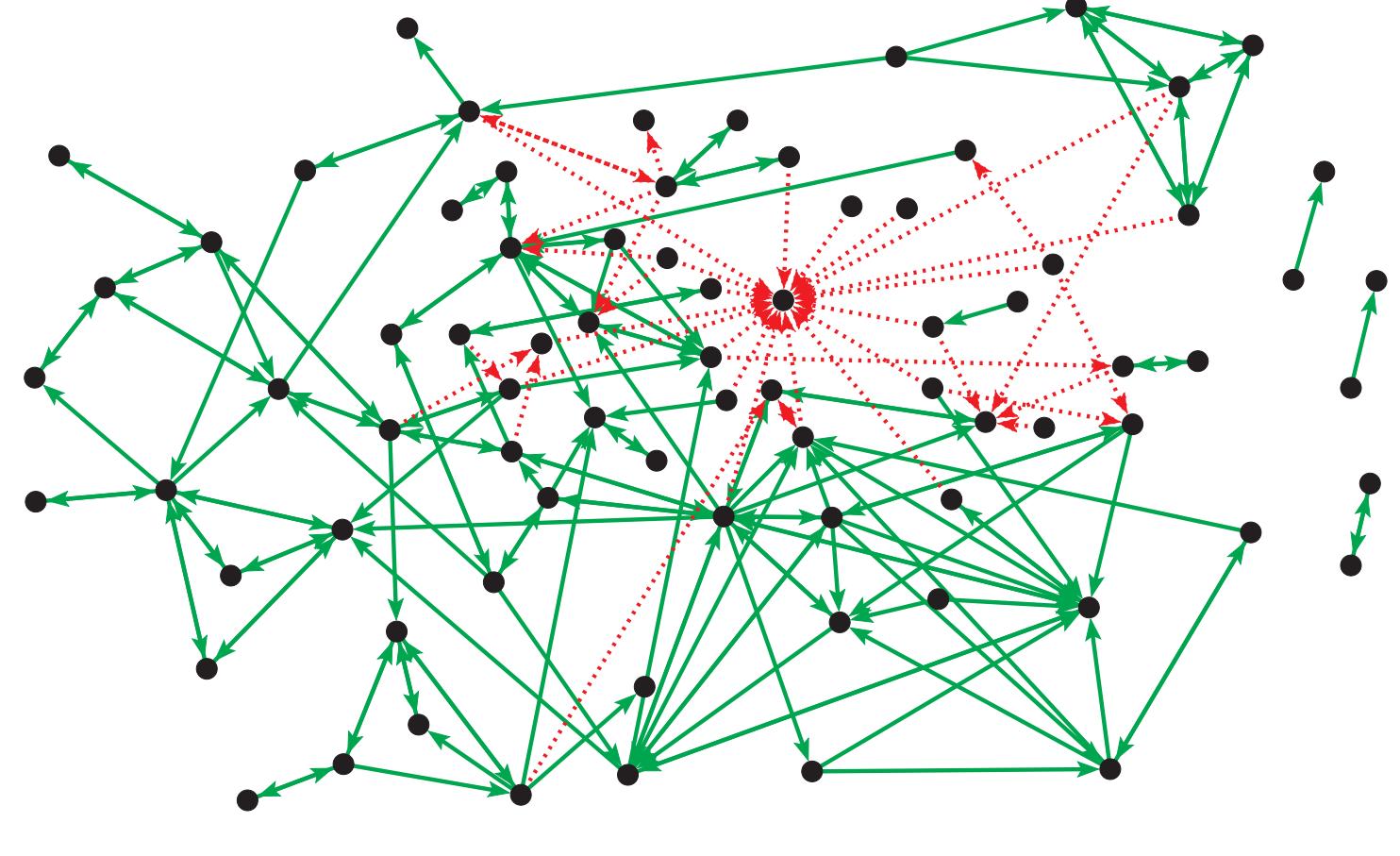
Tech Approach



Interdisciplinarity is key for solving complex issues



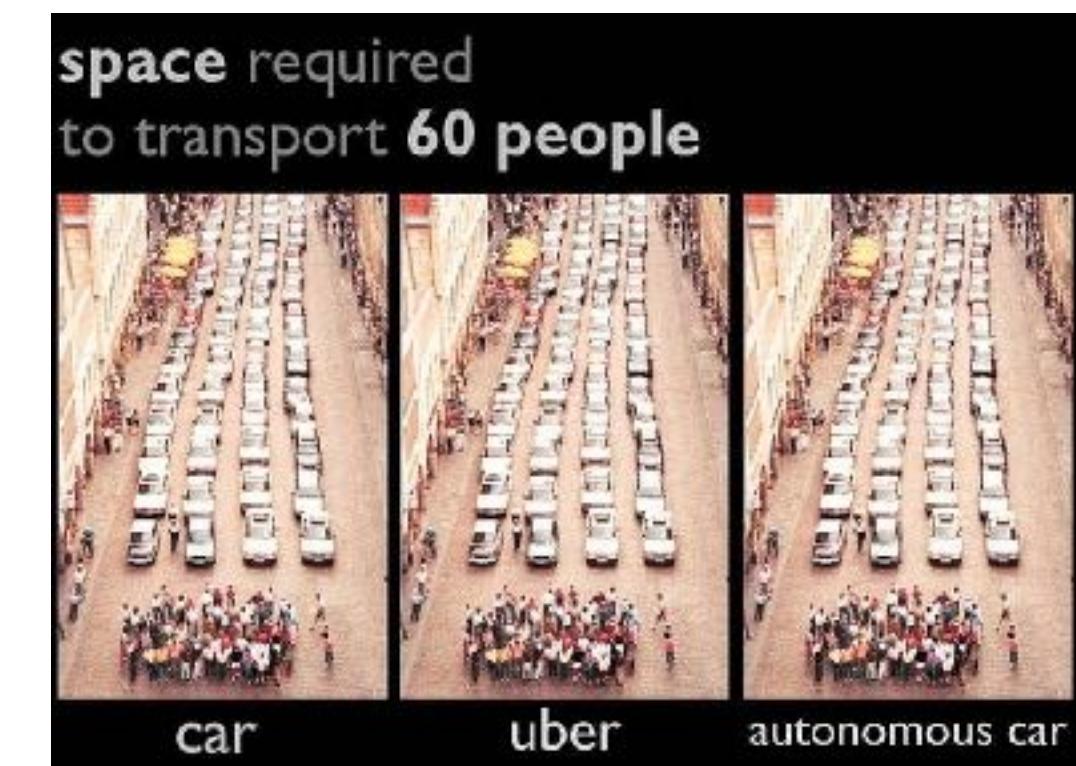
Network Science



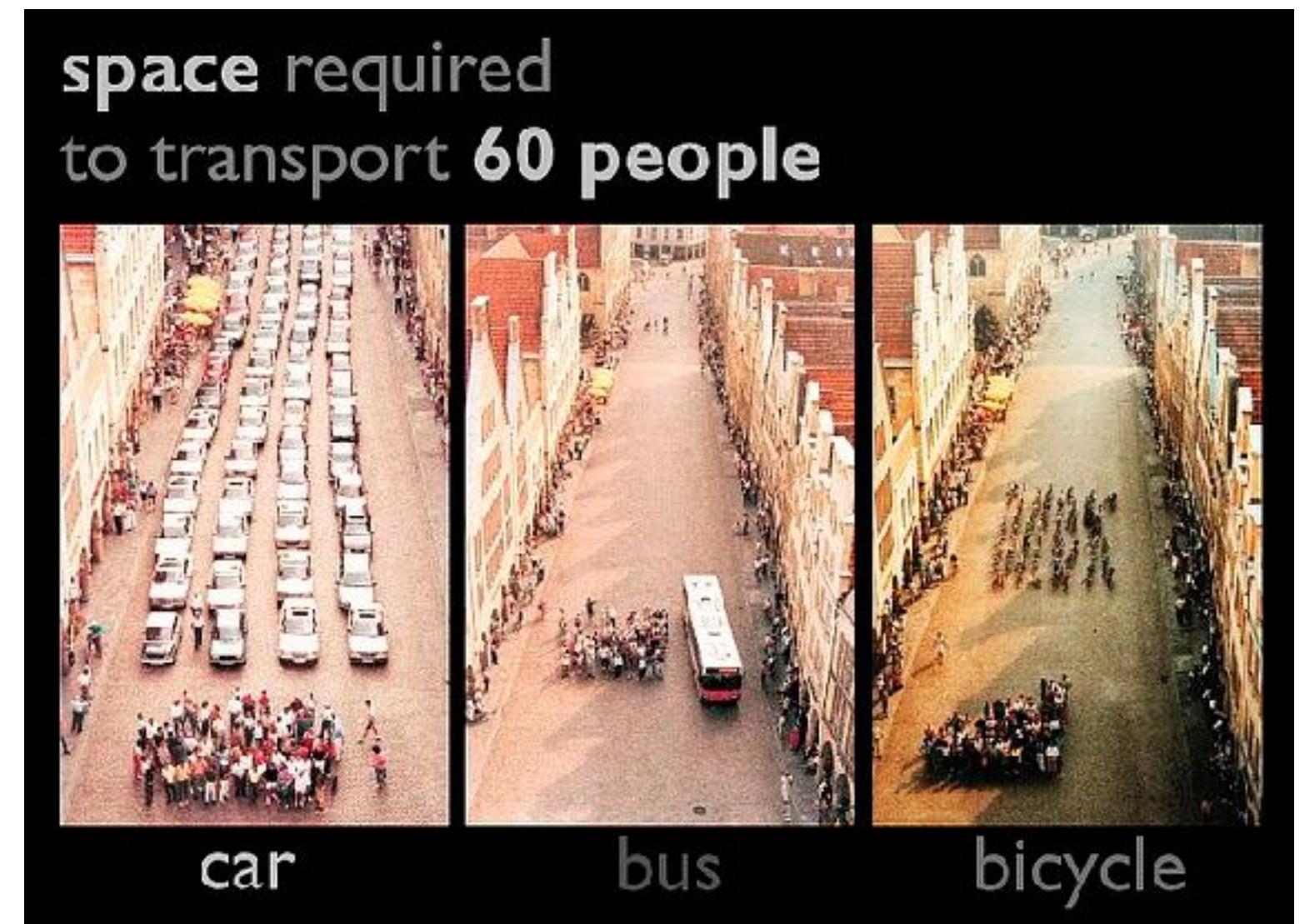
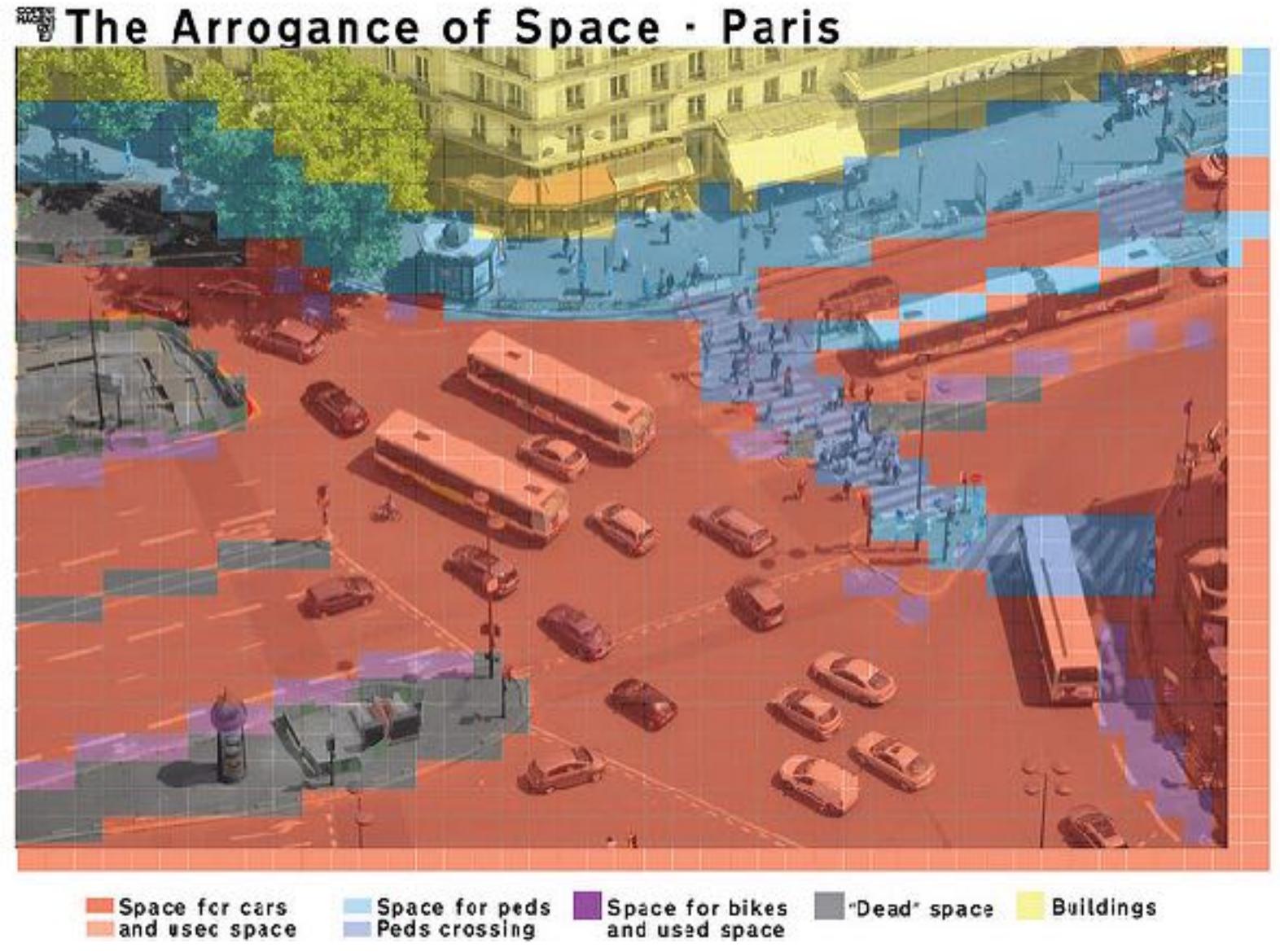
Tech Approach



Human Approach

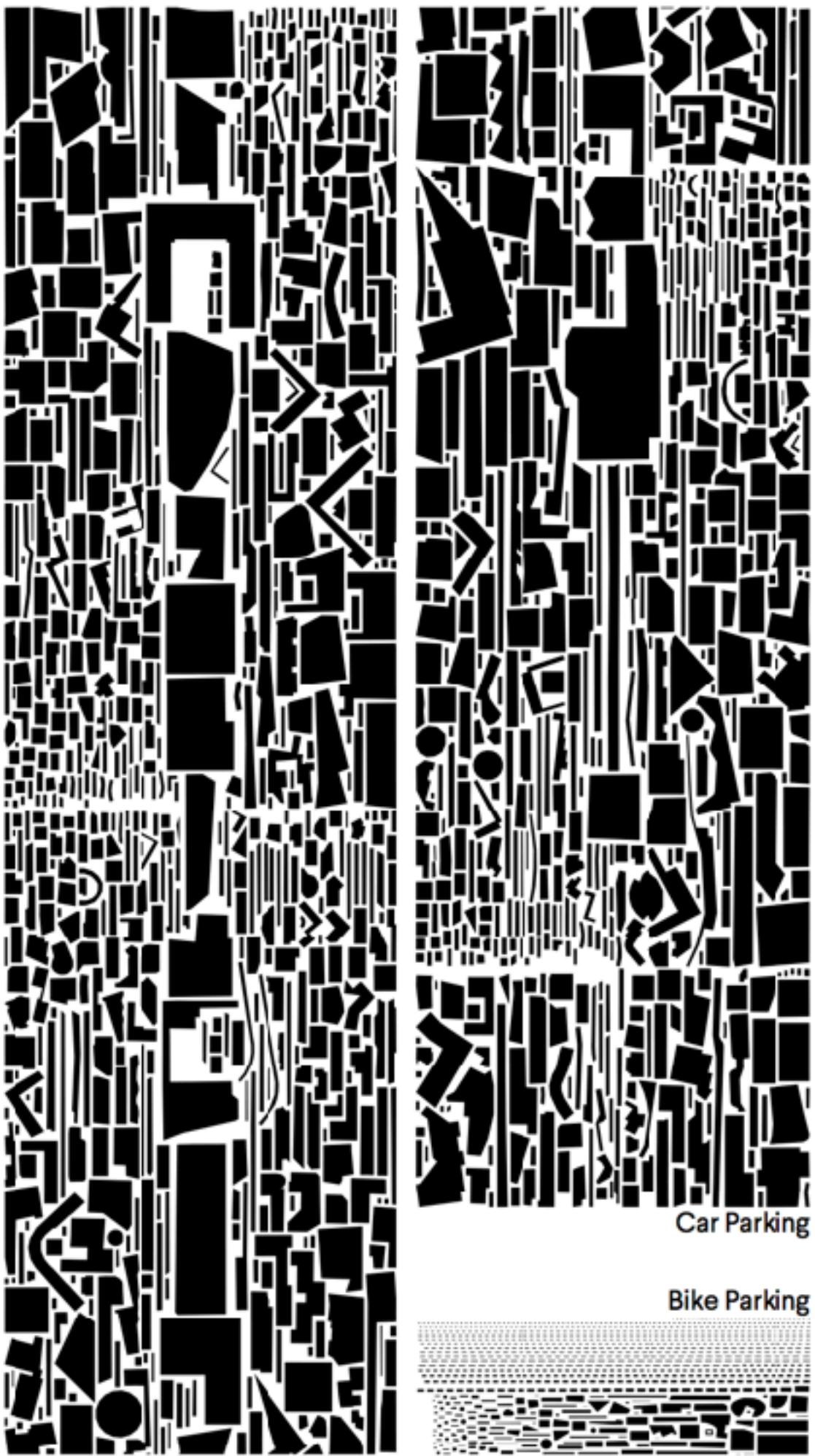


Previous project: What the Street!?



Copenhagen

What the Street!
<http://whatthestreet.moovellab.com>



<http://www.copenhagenize.com/2014/09/the-arrogance-of-space-paris-calgary.html>

Gossling, Schroder, Spath and Freytag, Transport Reviews 36, 659-679 (2016)



Szell, Urban Planning 3, 1-20 (2018)

Connecting bicycle networks

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>

Data-driven strategies for optimal bicycle network growth

Luis Guillermo Natera Orozco¹, Federico Battiston¹,
Gerardo Iñiguez^{1,2,3} and Michael Szell^{4,5,6}

¹Department of Network and Data Science, Central European University, 1100 Vienna, Austria

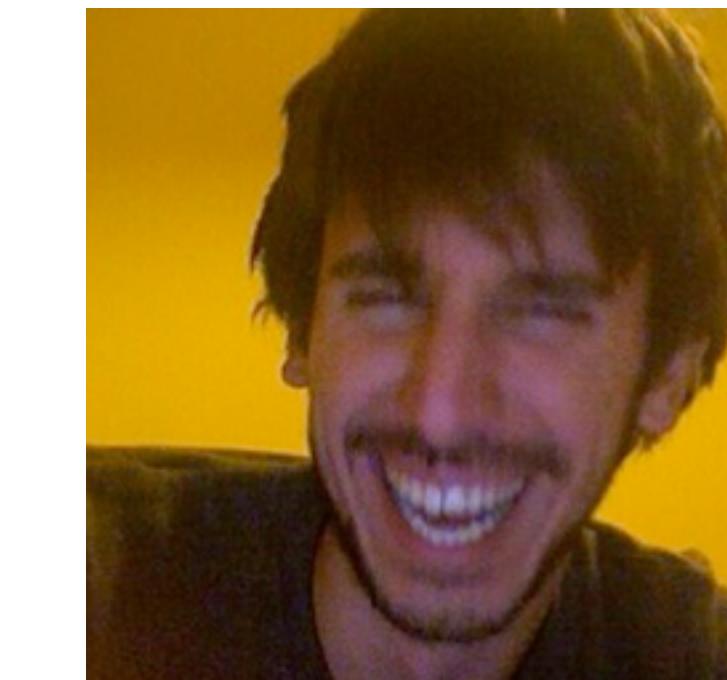
²Department of Computer Science, Aalto University School of Science, 00076 Aalto, Finland

³Centro de Ciencias de la Complejidad, Universidad Nacional Autónoma de México, 04510 CDMX, Mexico

⁴NEtworks, Data, and Society (NERDS), IT University of Copenhagen, 2300 Copenhagen, Denmark

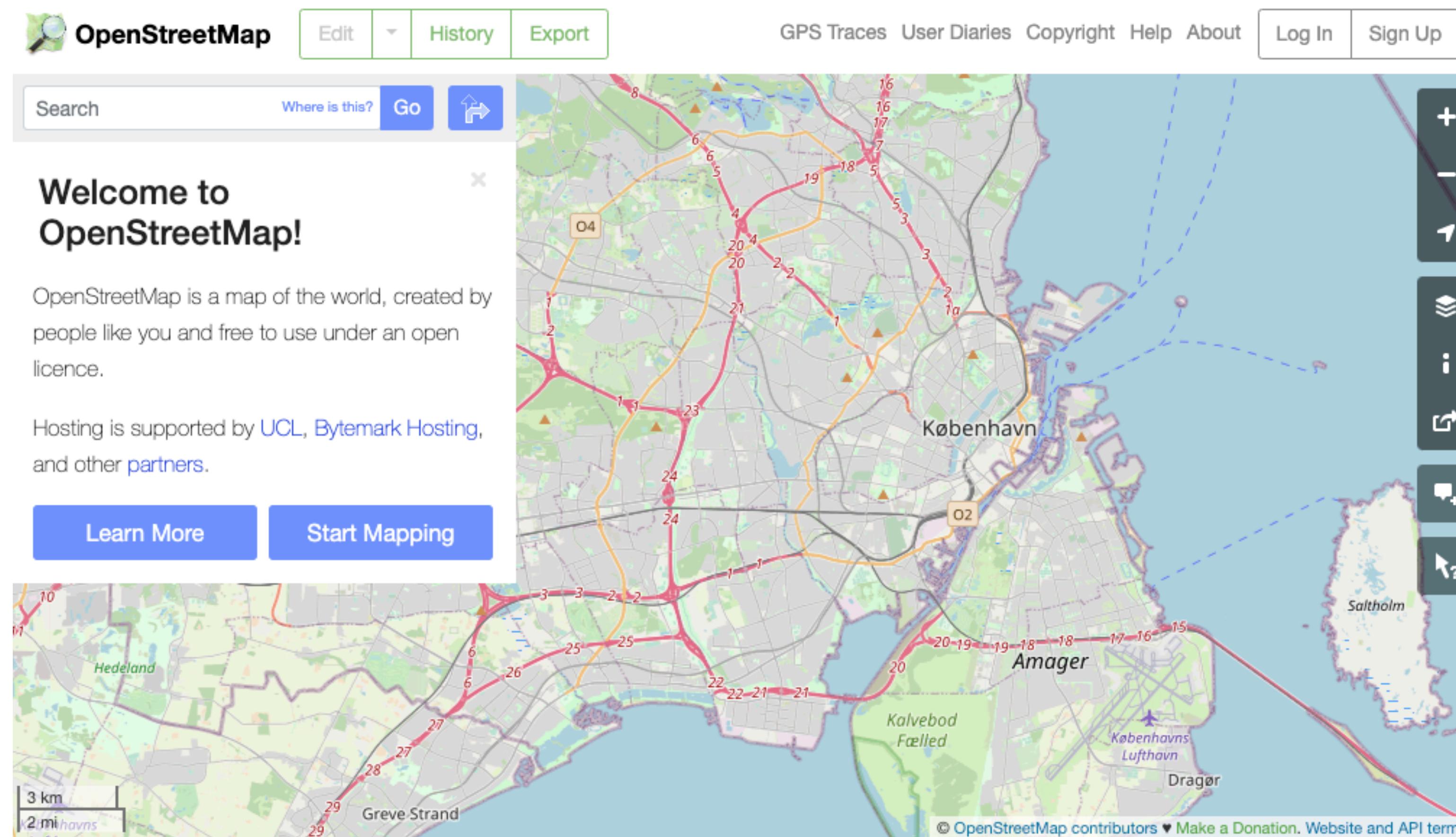
⁵ISI Foundation, 10126 Turin, Italy

⁶Complexity Science Hub Vienna, 1080 Vienna, Austria



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

We downloaded data from OpenStreetMap (OSM)

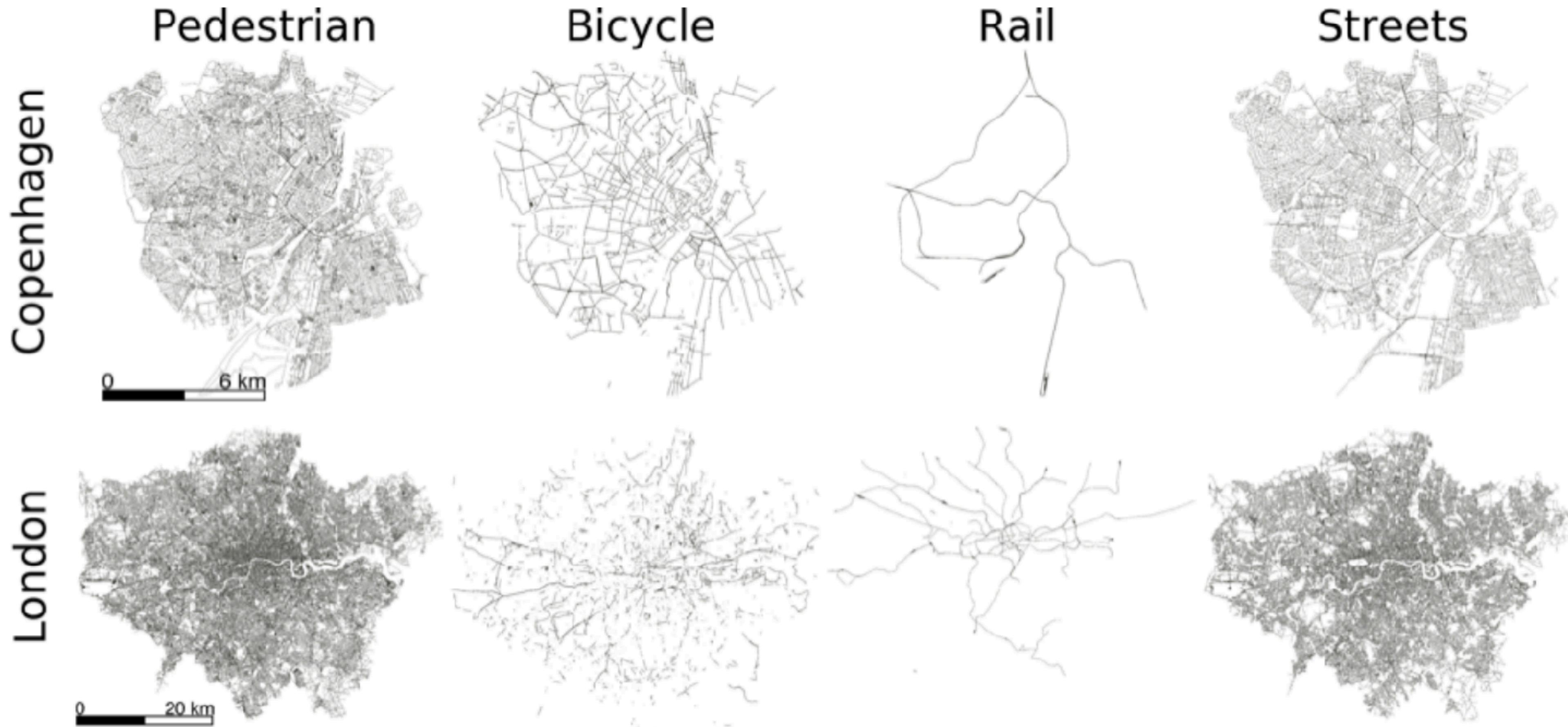


OSM data are quite reliable in western countries

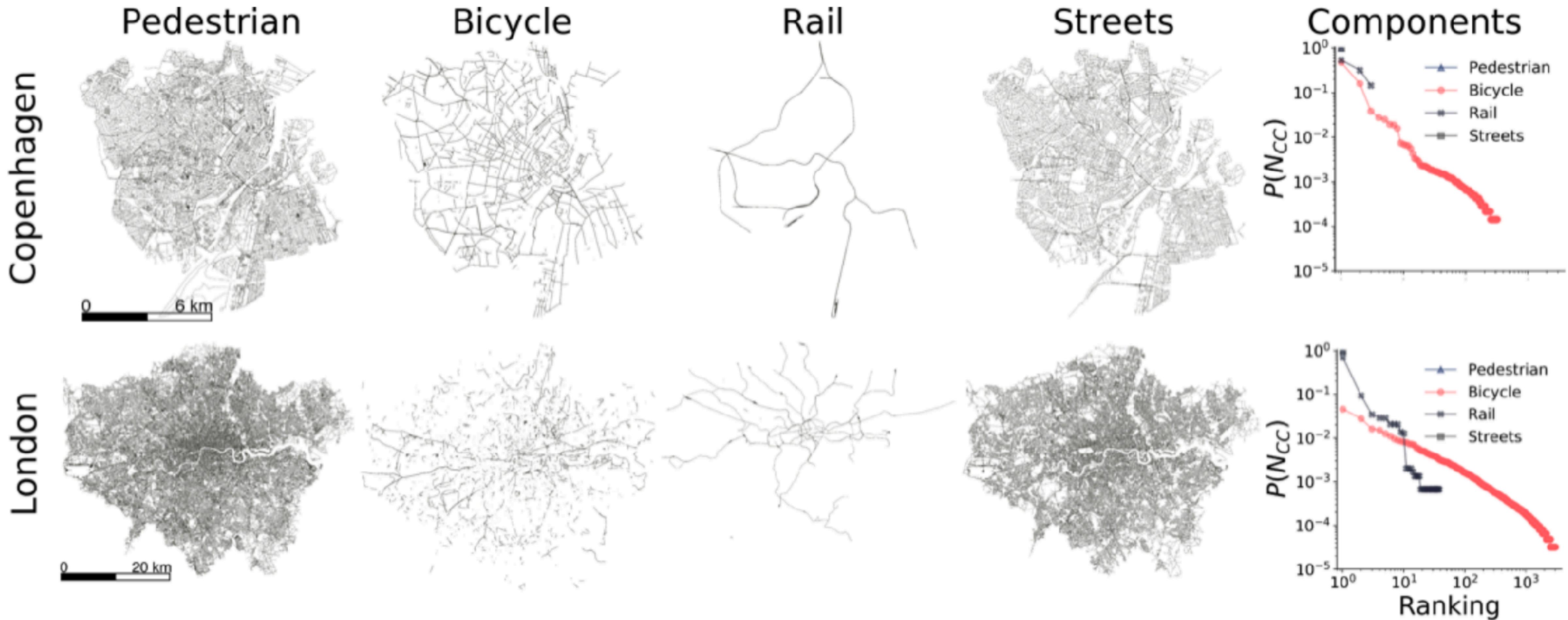
Haklay et al, Cart J 47 (2010)

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

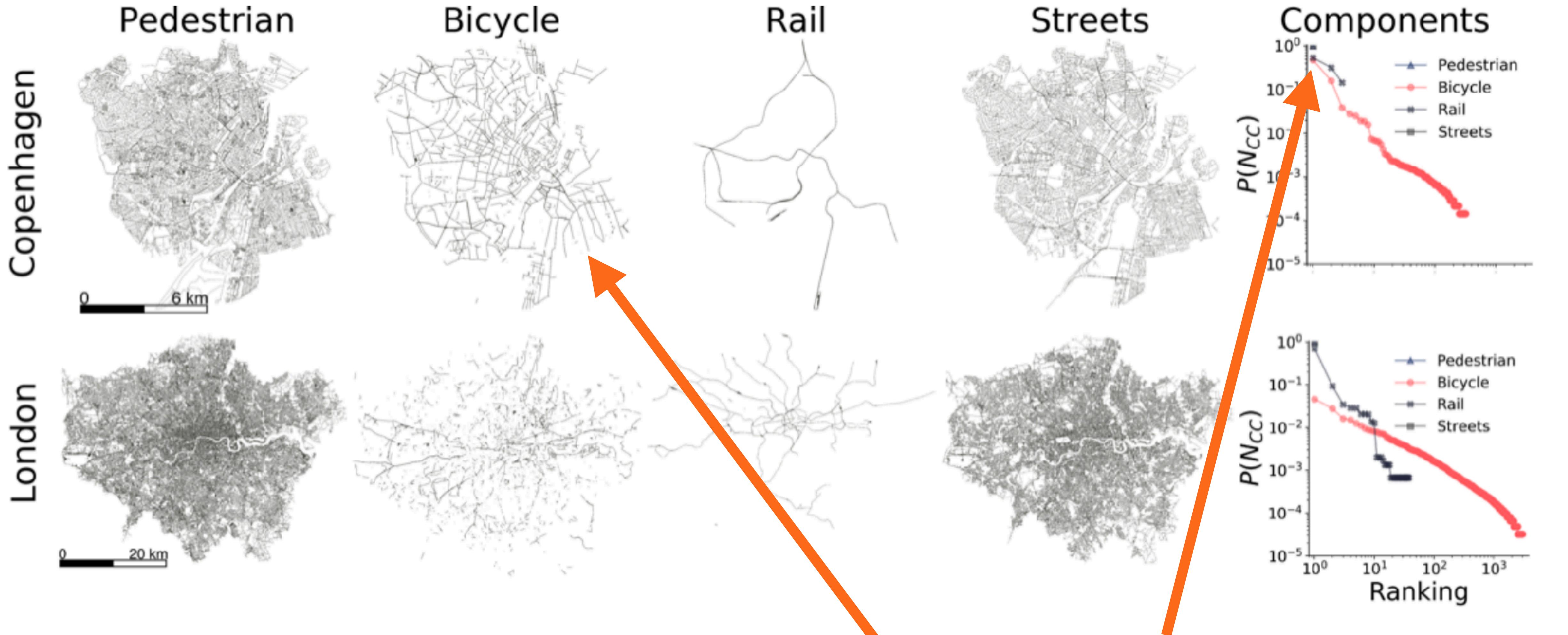
Cities have different transport network layers



Bicycle networks are highly fragmented

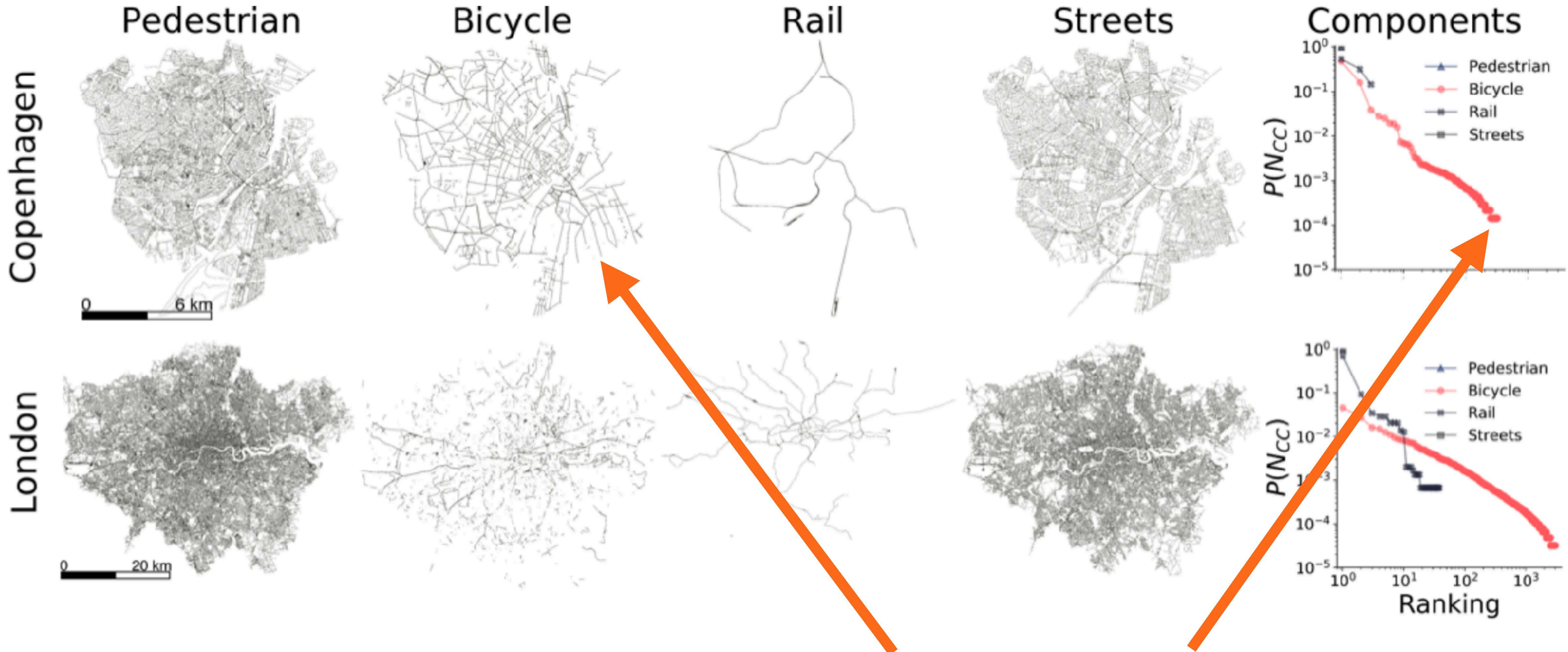


Bicycle networks are highly fragmented



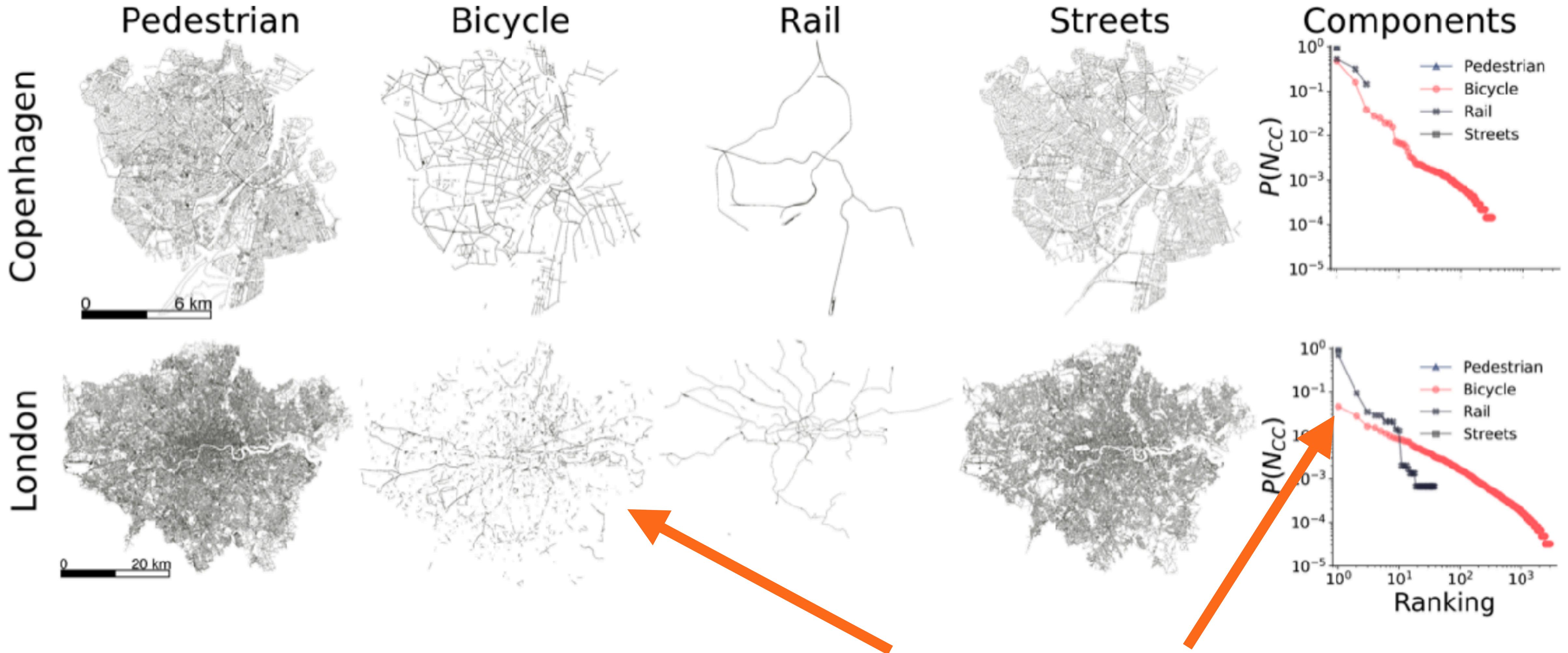
1) In Copenhagen, the largest connected bicycle component covers 50% of nodes

Bicycle networks are highly fragmented



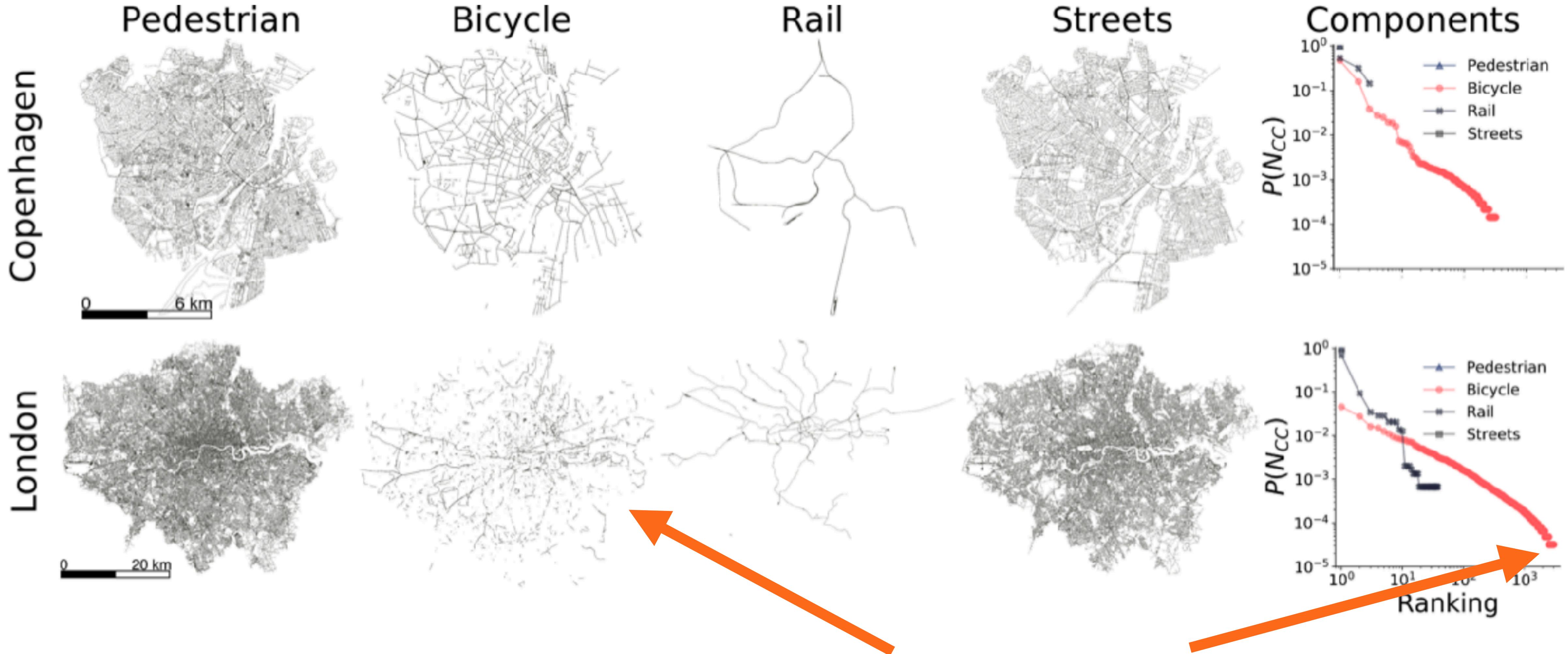
2) In Copenhagen, the bicycle network has 300 disconnected components

Bicycle networks are highly fragmented



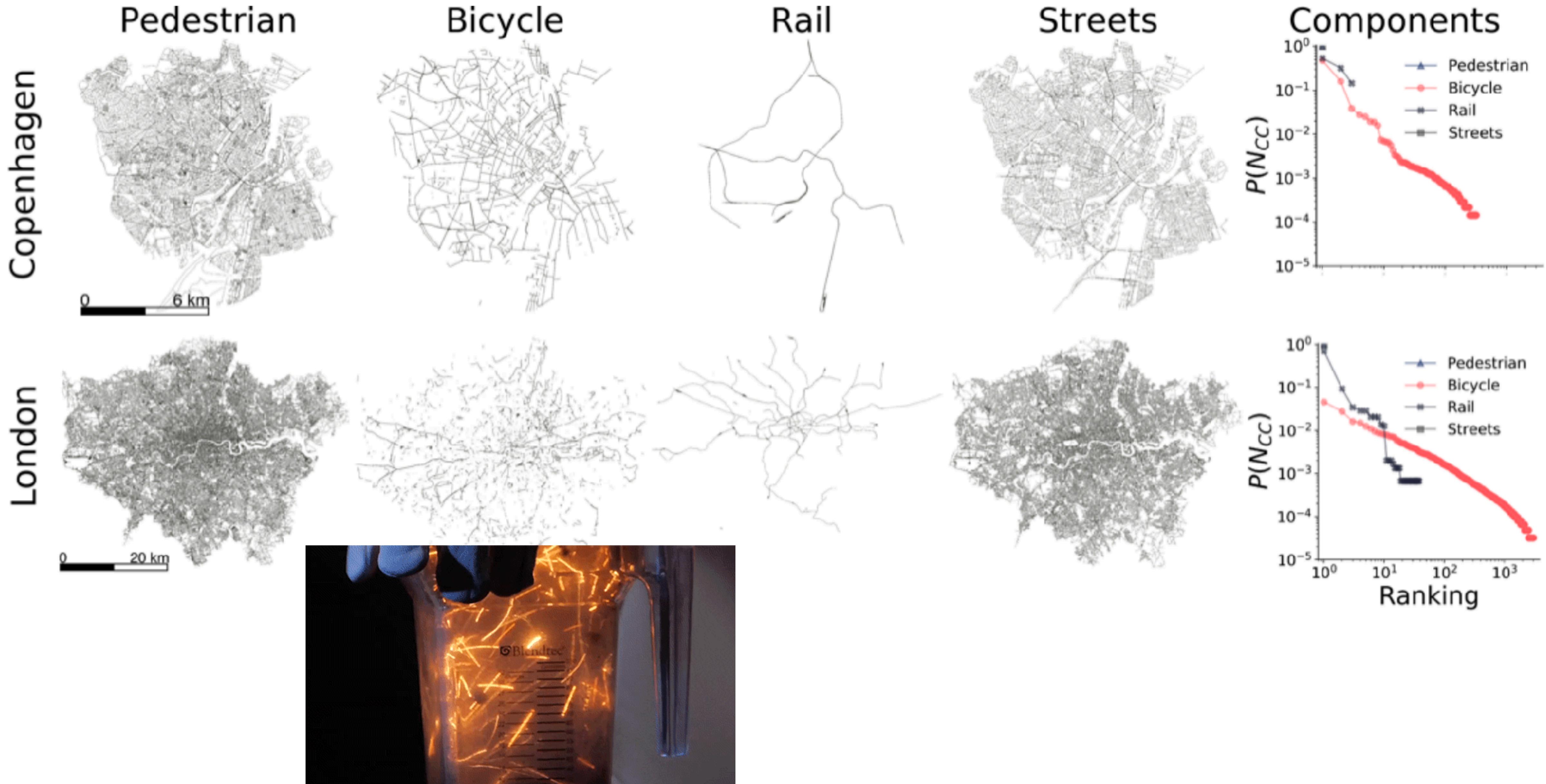
1) In London, the largest connected bicycle component covers 5% of nodes

Bicycle networks are highly fragmented



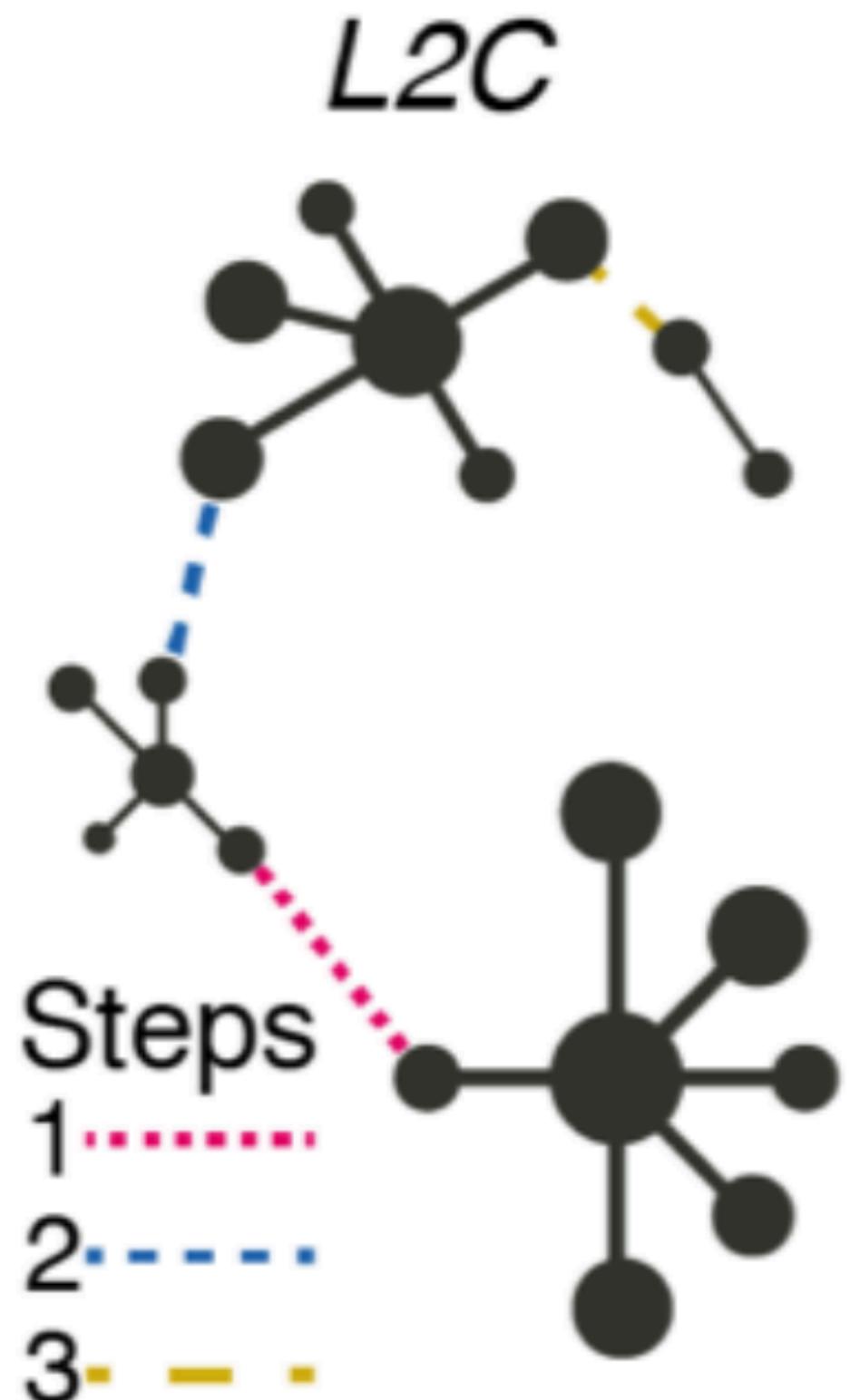
2) In London, the bicycle network has 3000 disconnected components

Bicycle networks are highly fragmented



How should we connect the components?

Largest to
closest



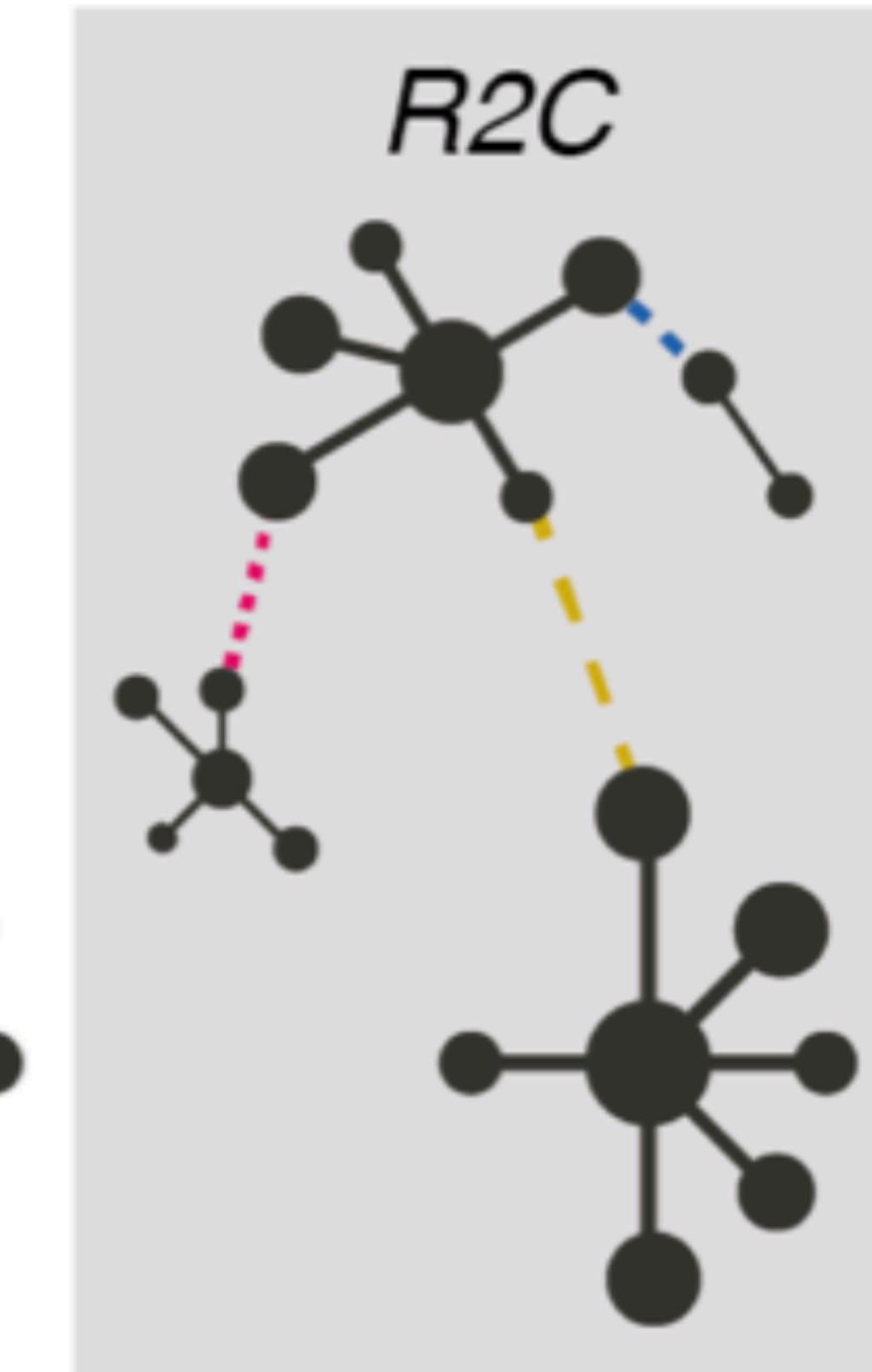
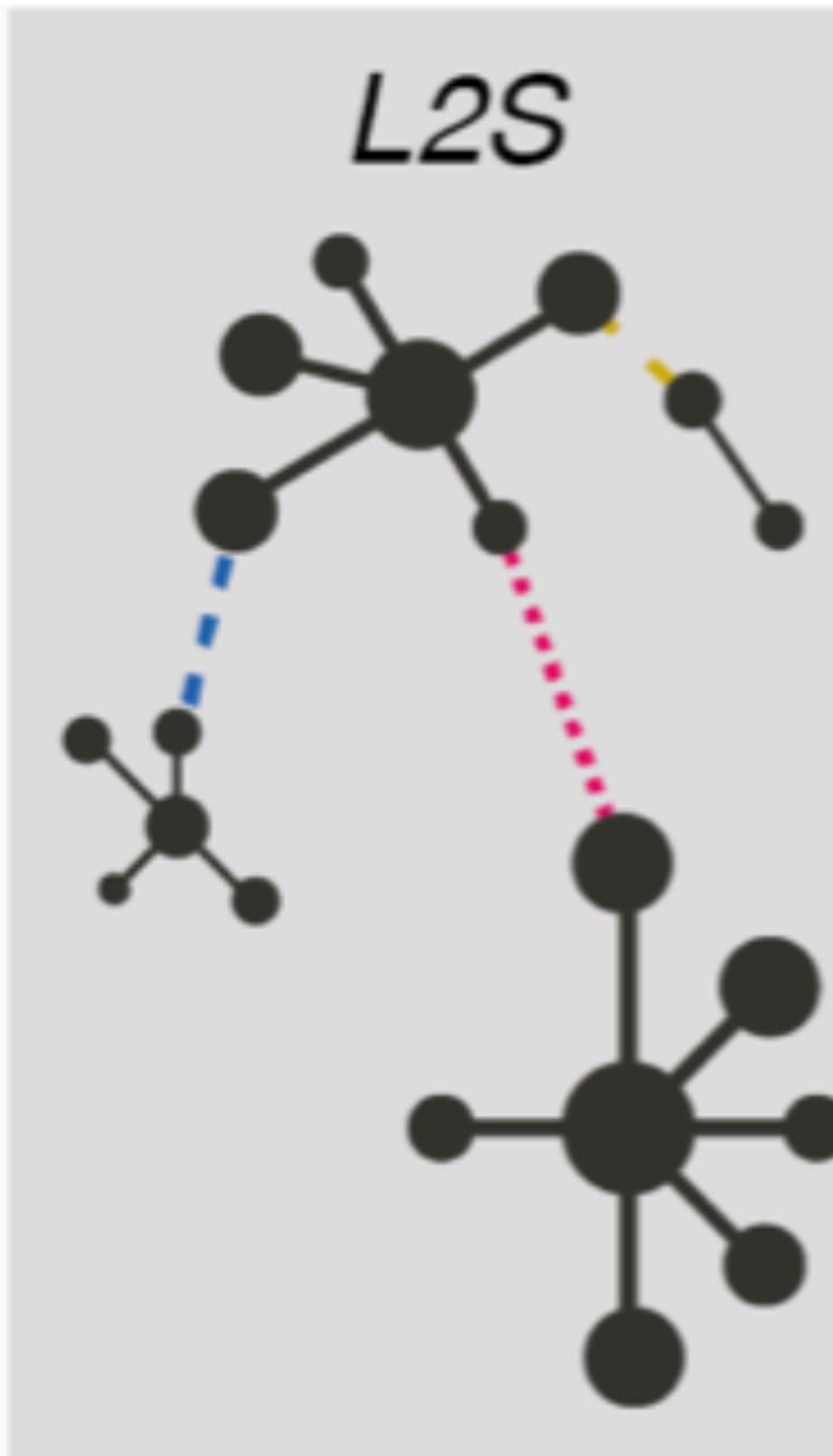
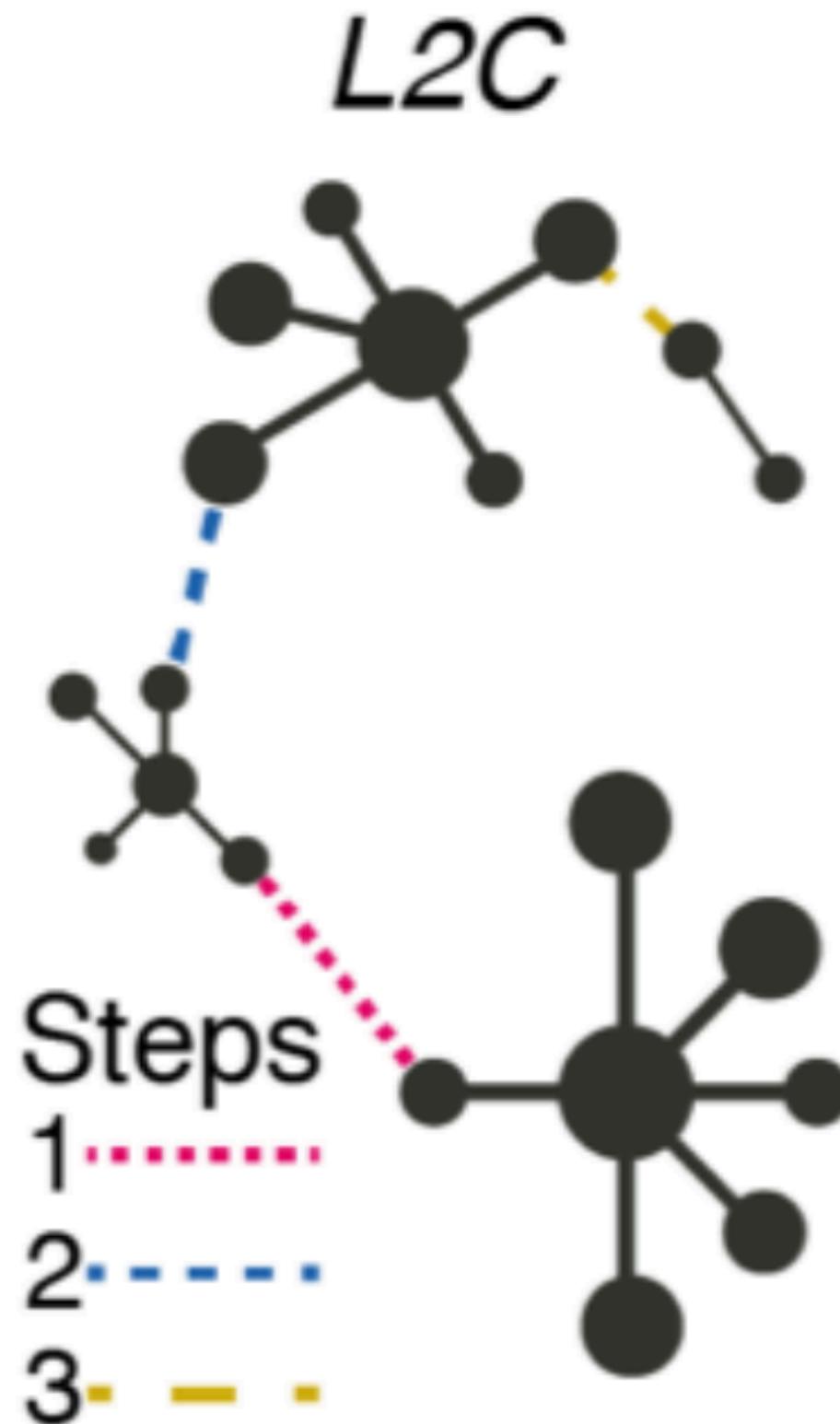
How should we connect the components?

Largest to
closest

Largest to
second largest

Closest
components

Random to
closest



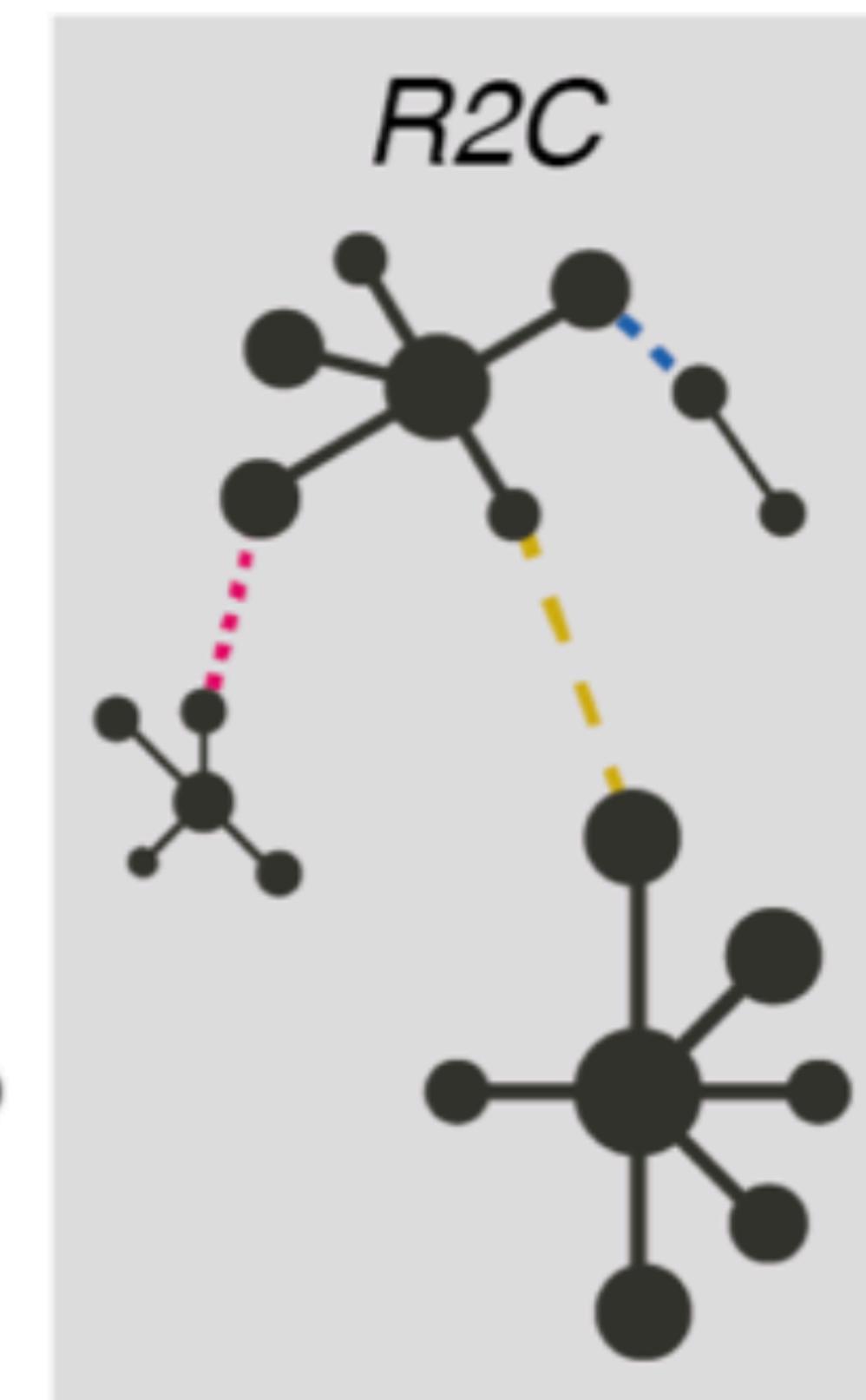
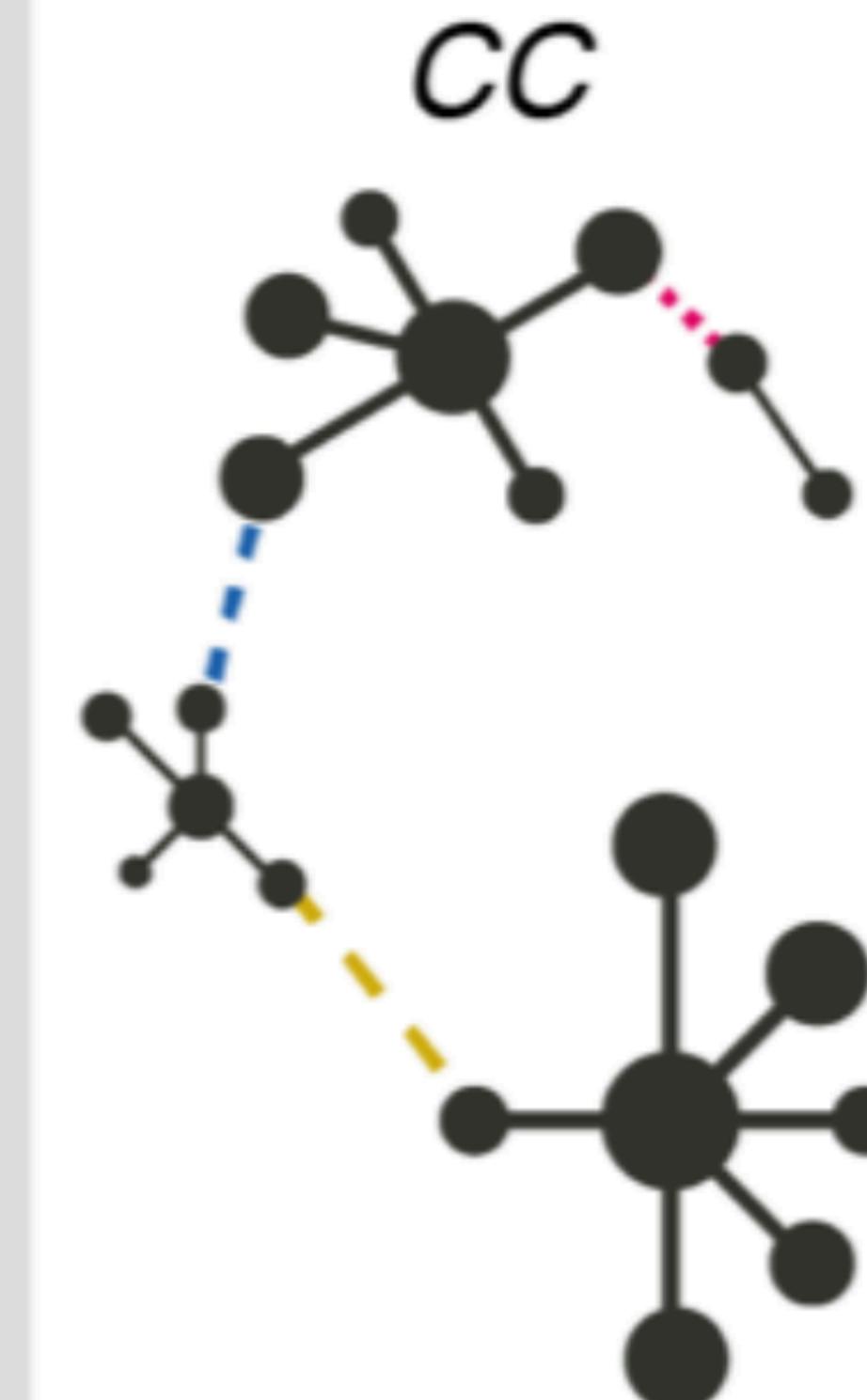
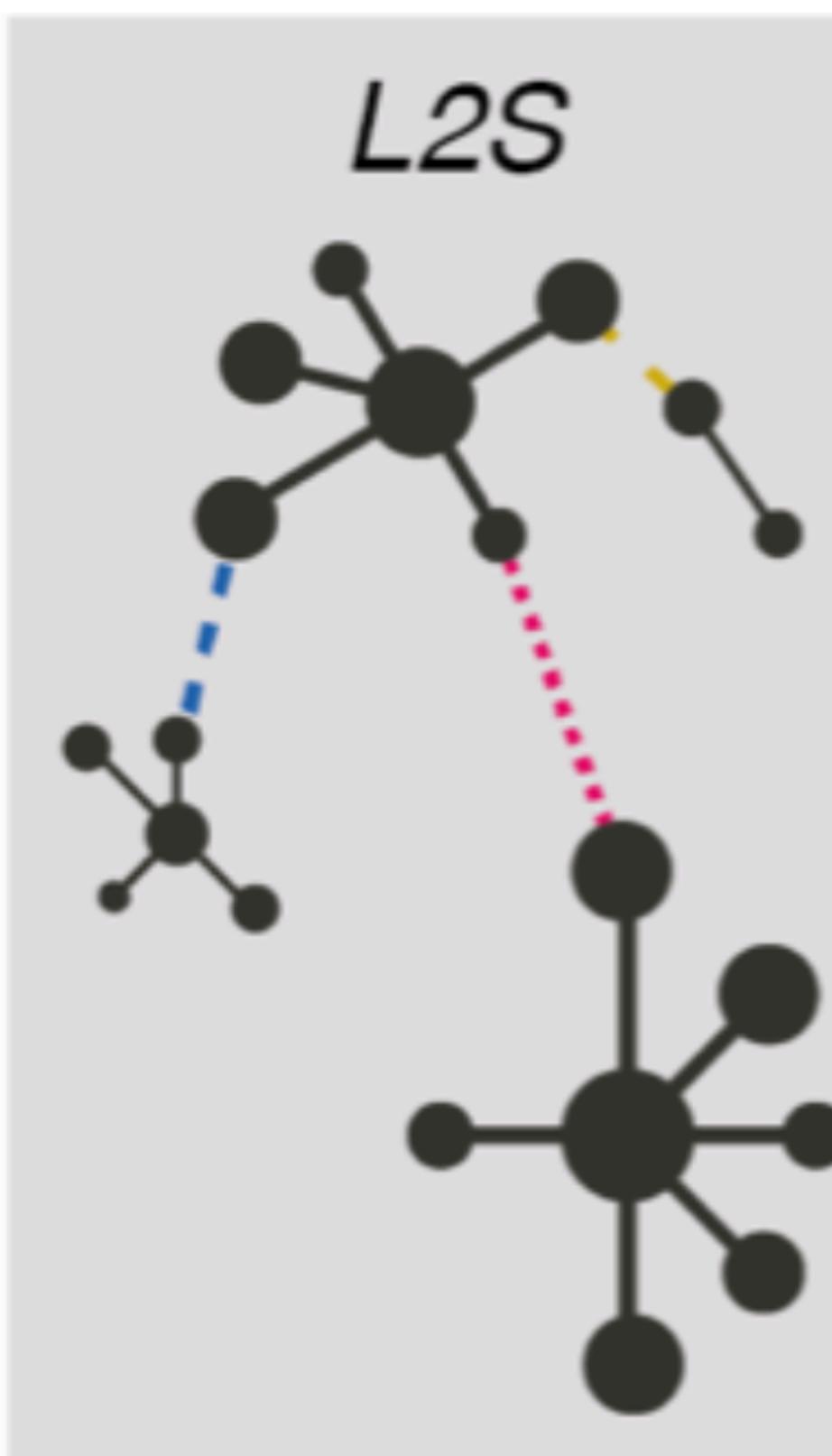
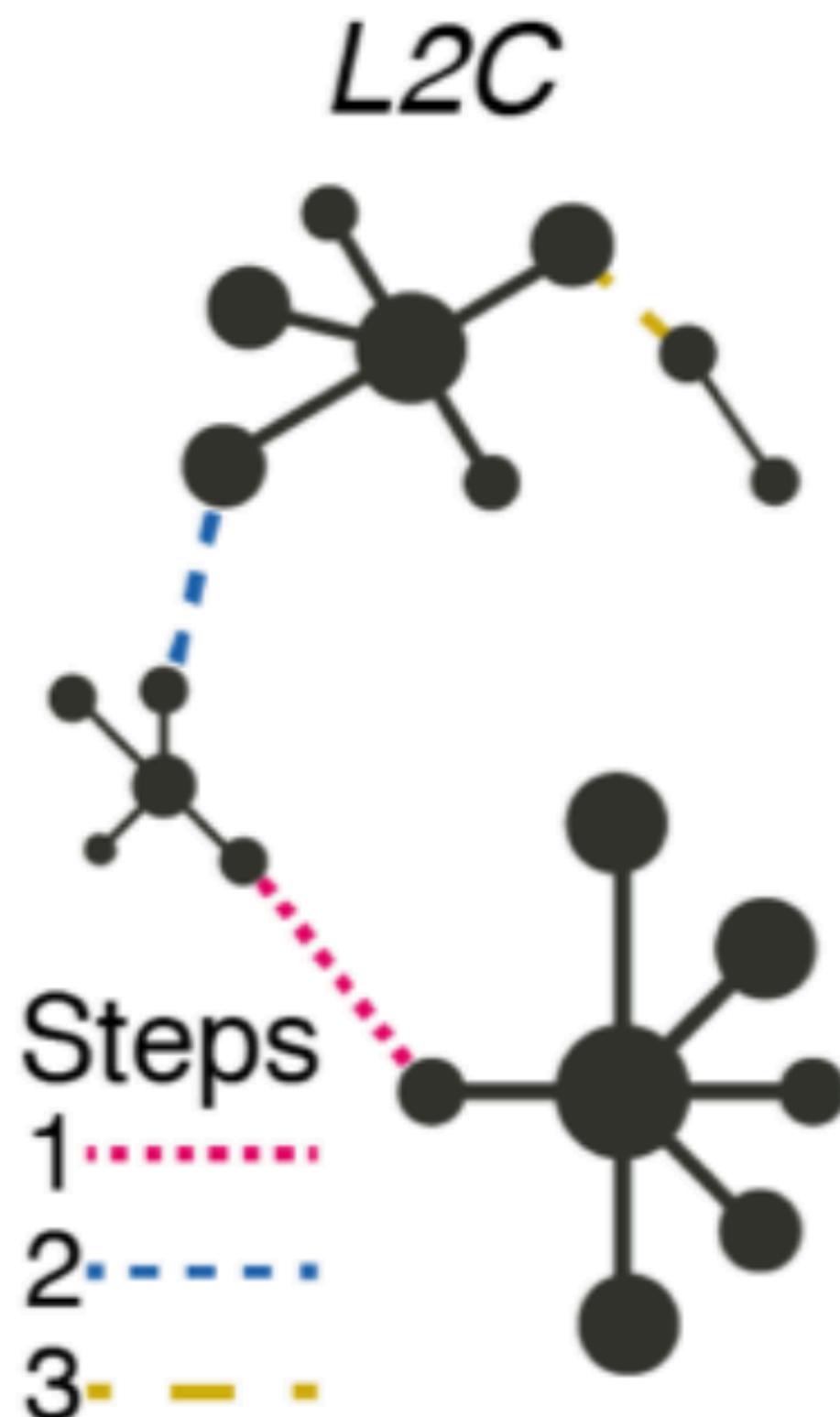
How should we connect the components?

Largest to
closest

Largest to
second largest

Closest
components

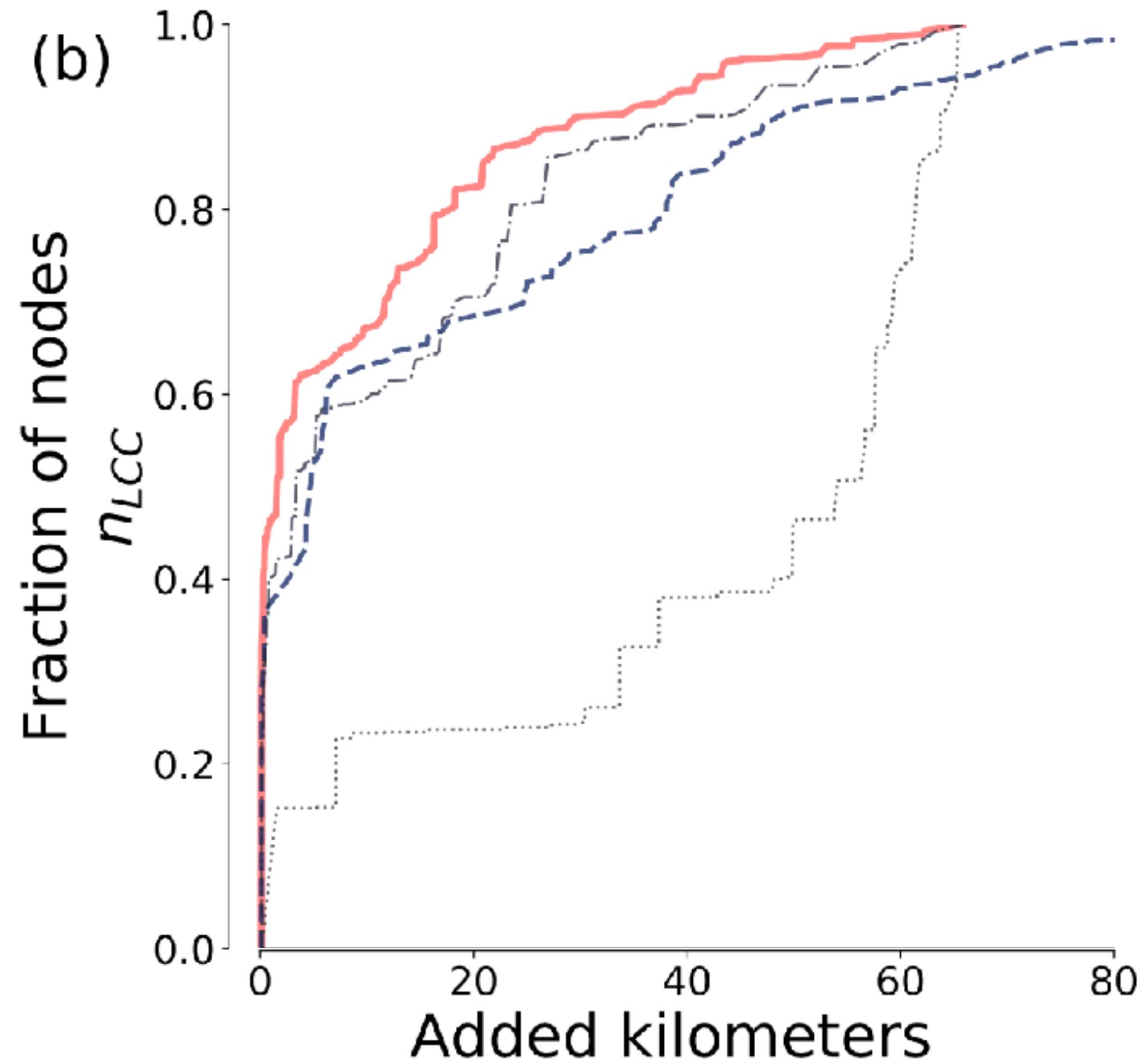
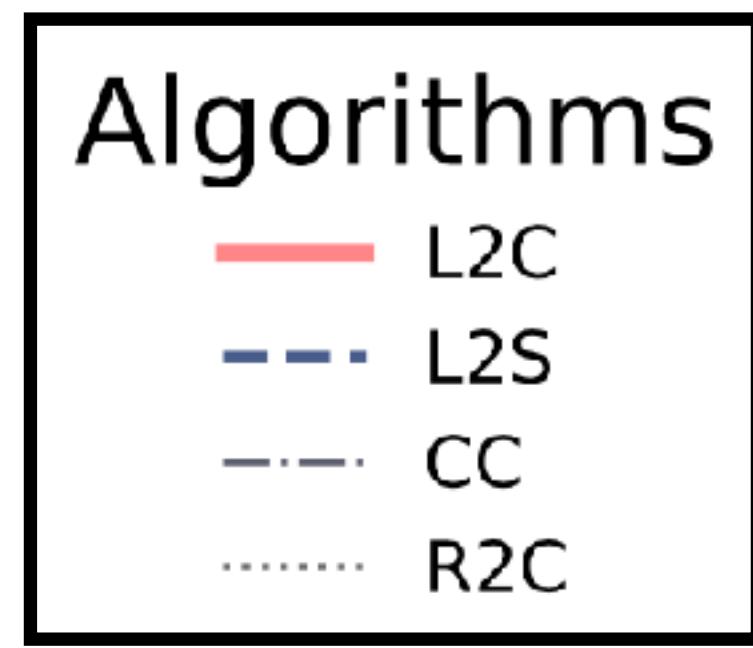
Random to
closest



Greedy
investment
(Kruskal)

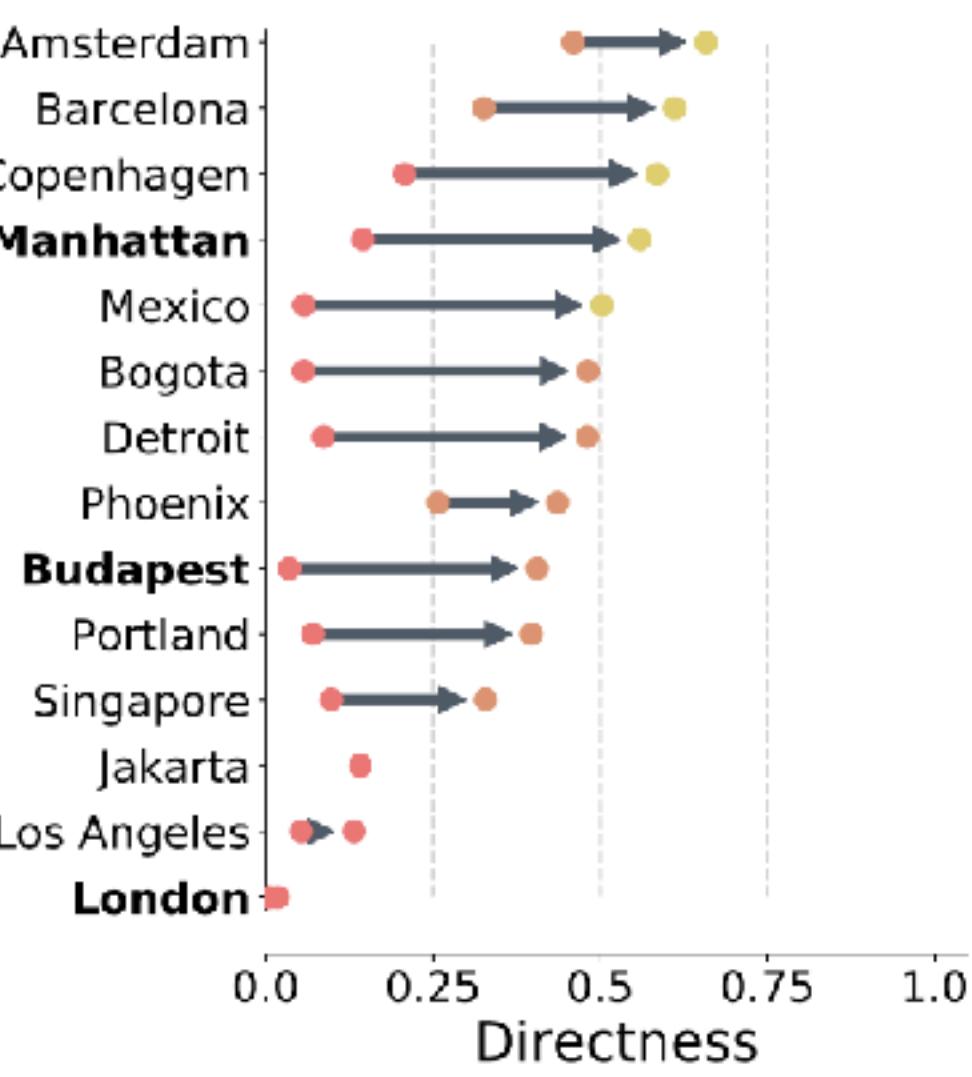
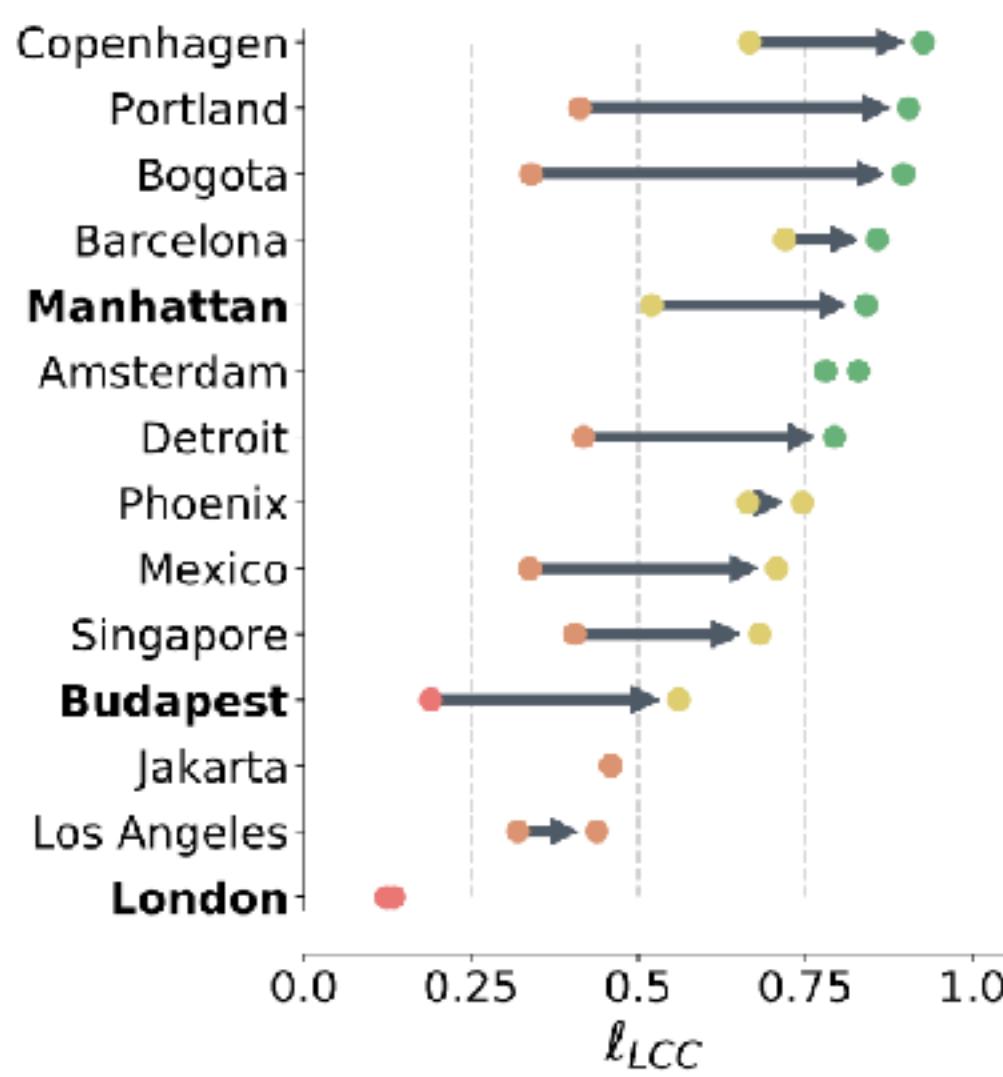
Baseline

Largest to closest component gives best results



Invest little or much? Depends on the city

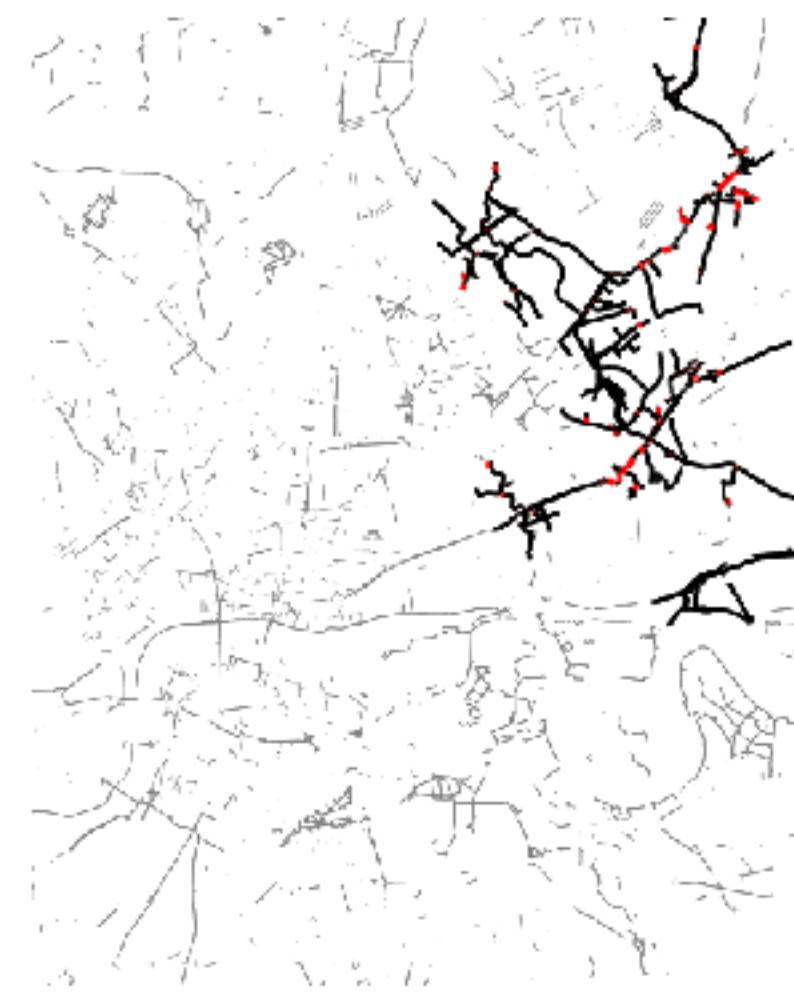
(a) 5 km investment



Manhattan



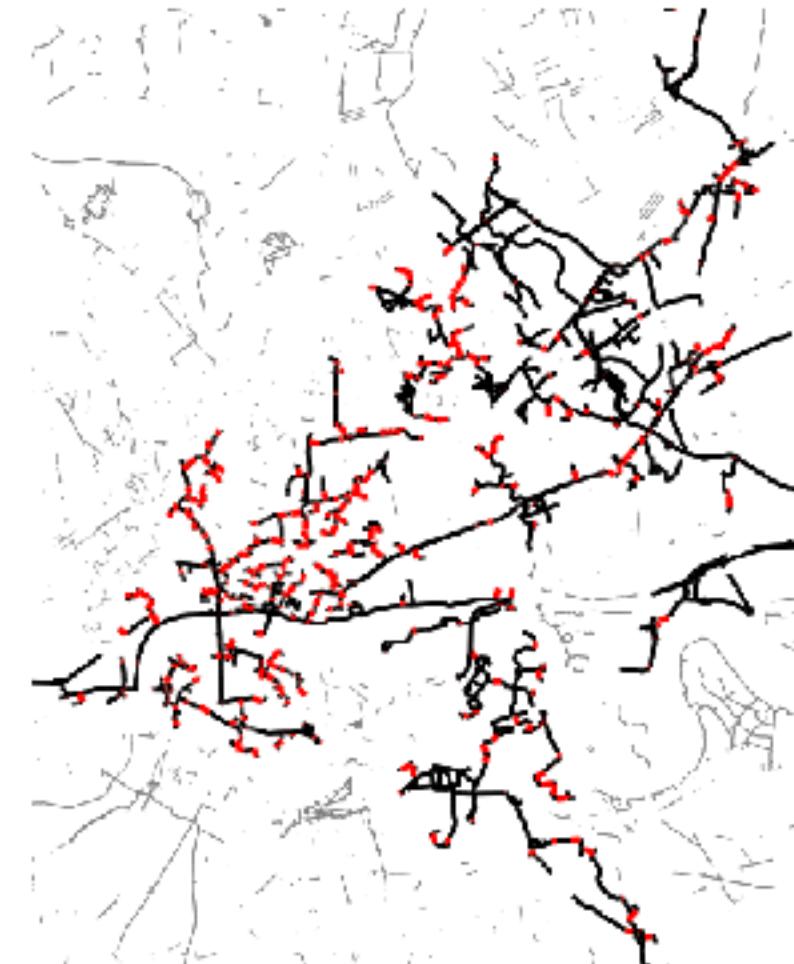
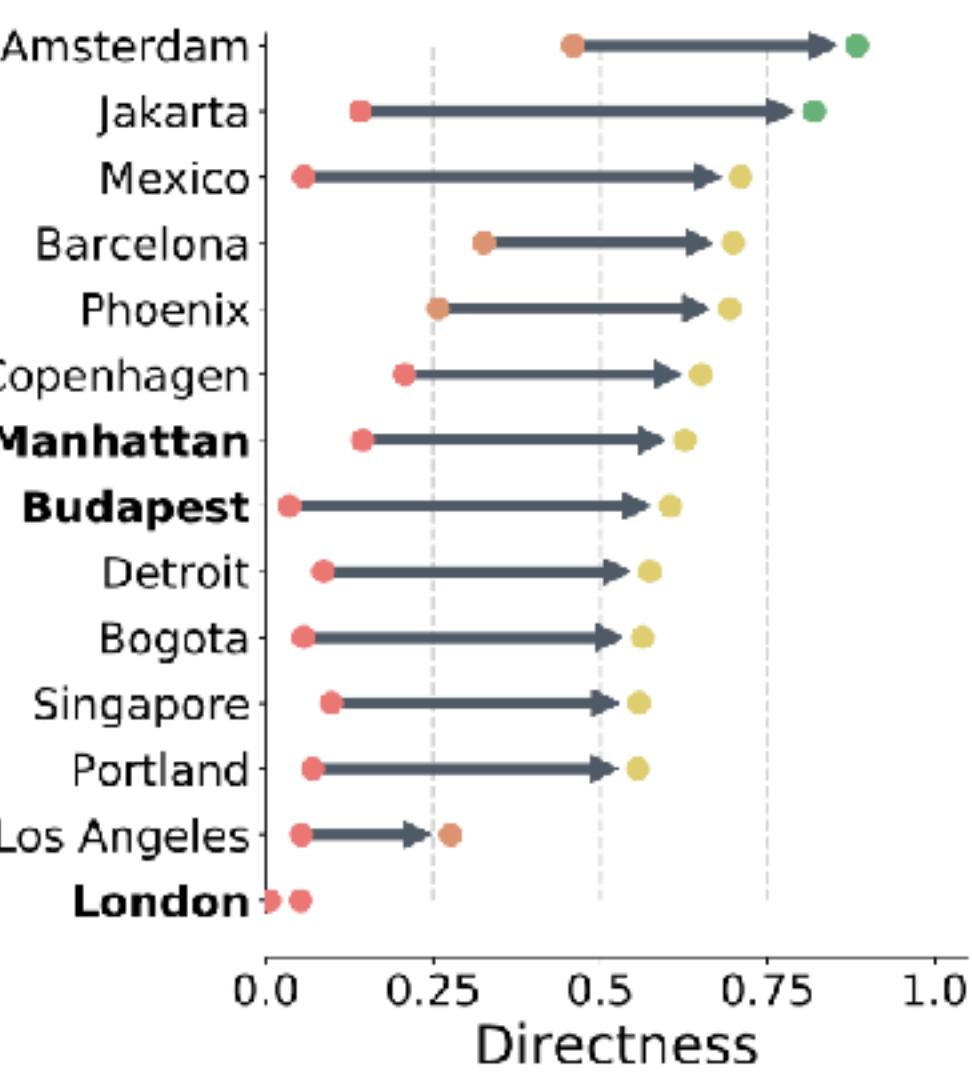
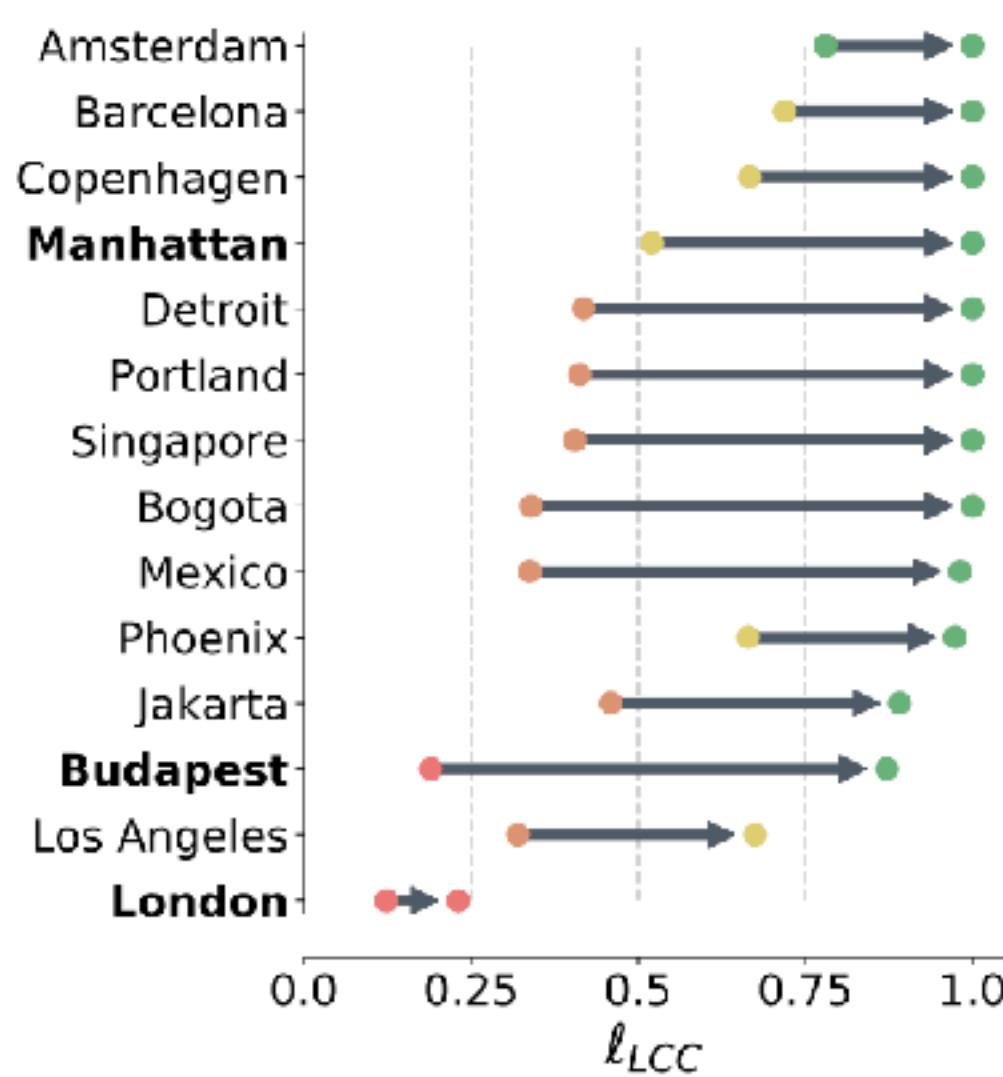
London



Budapest

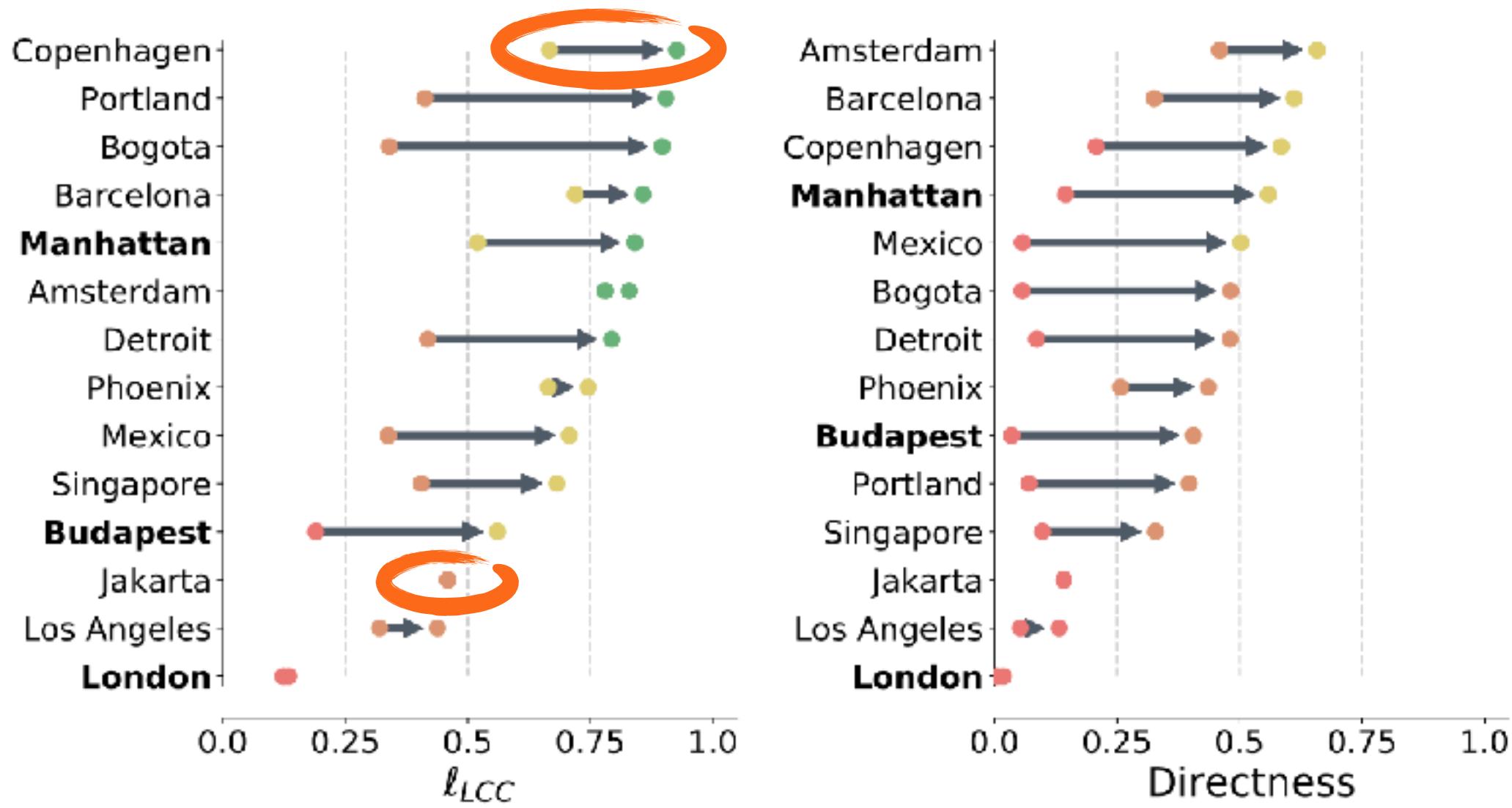


(b) 35 km investment



Invest little or much? Depends on the city

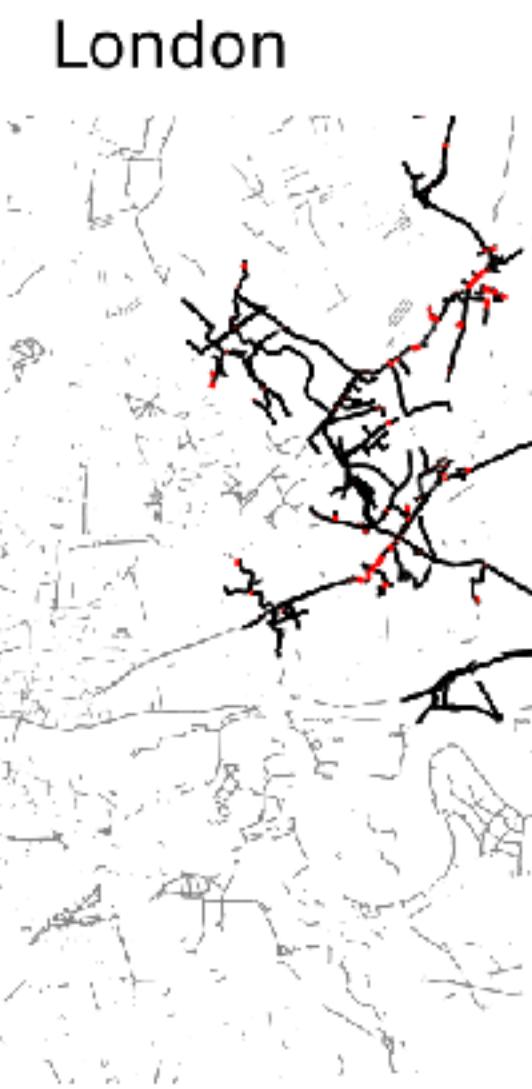
(a) 5 km investment



Manhattan



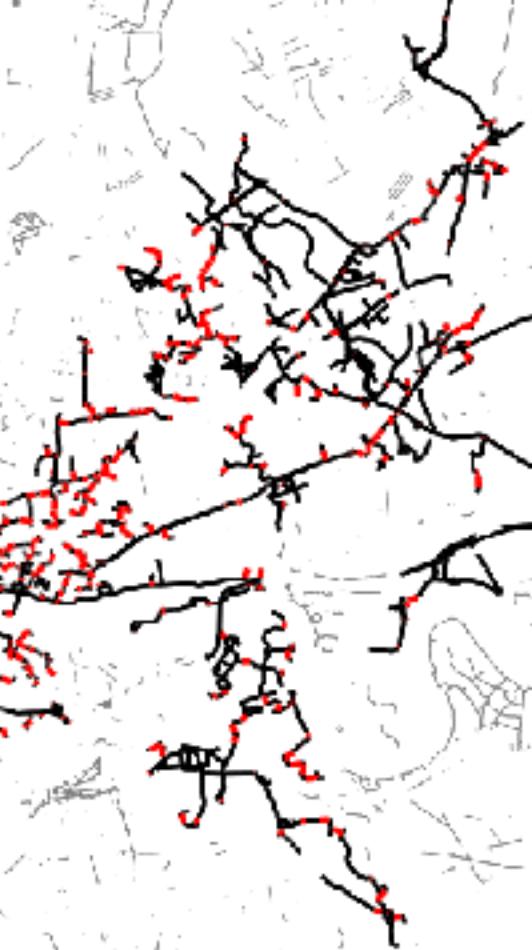
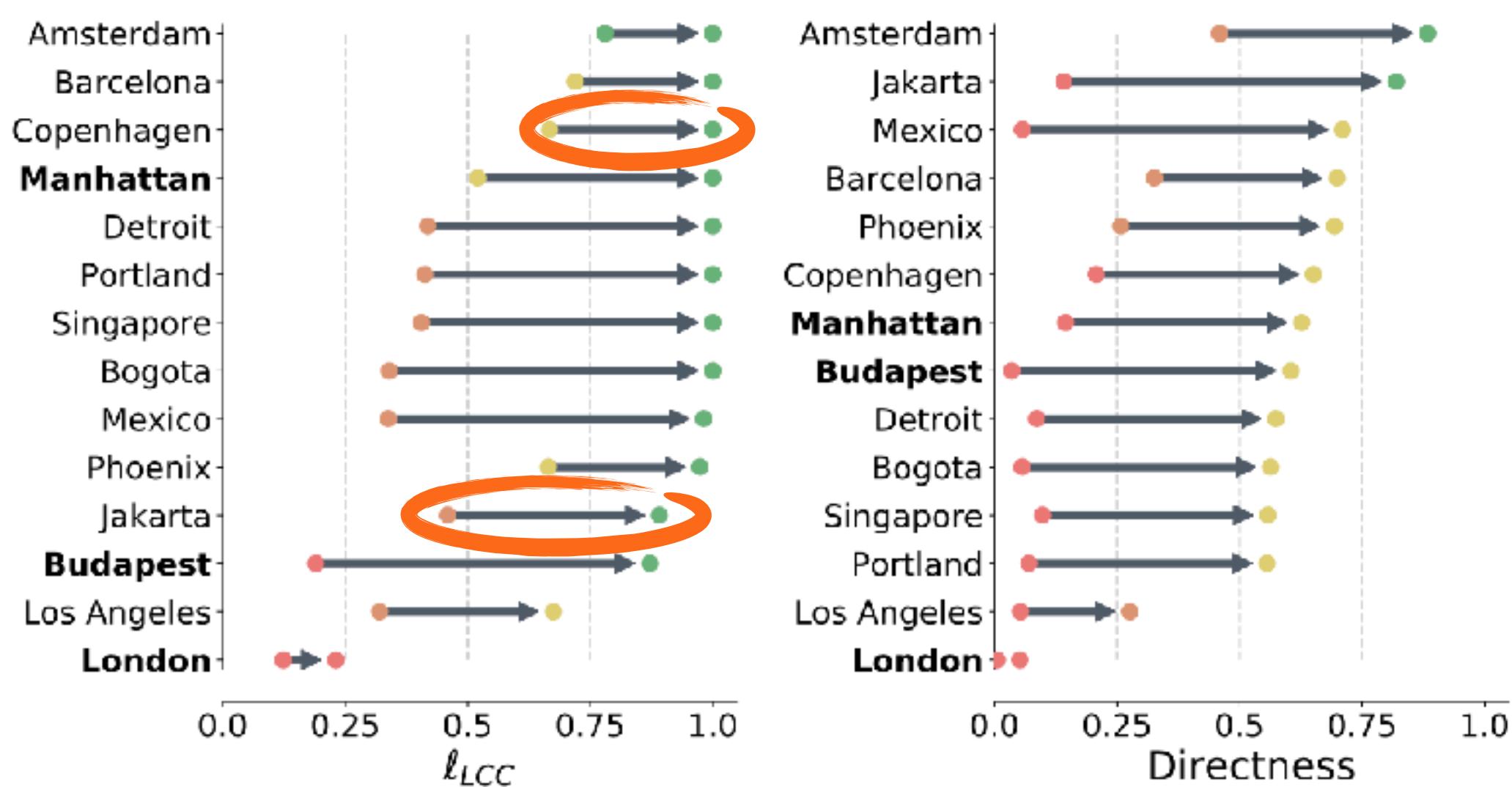
London



Budapest



(b) 35 km investment



Main insights from our study

1) Fragmentation

All cities have fragmented bicycle networks, even Copenhagen

2) Effective connectivity improvements

In developed cities like Copenhagen, small but focused investments connect the bicycle network effectively

3) Effective directness improvements

In developed cities like Copenhagen, small but focused investments increase directness in the bicycle network effectively

Where are the gaps?

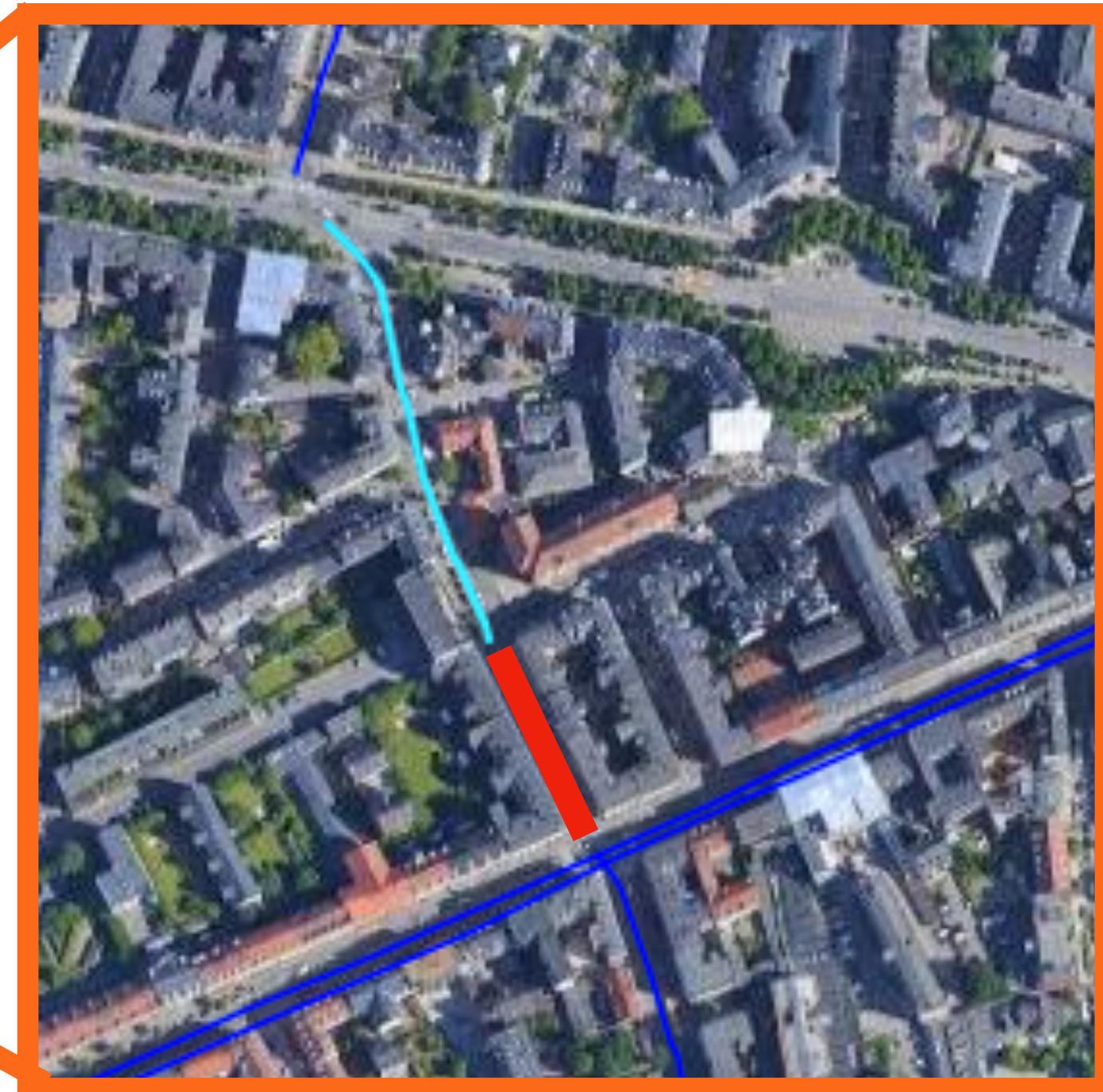
How to find gaps *within* a connected component?

Repairing bicycle networks



Anastassia Vybornova

We systematically identify and categorize all gaps

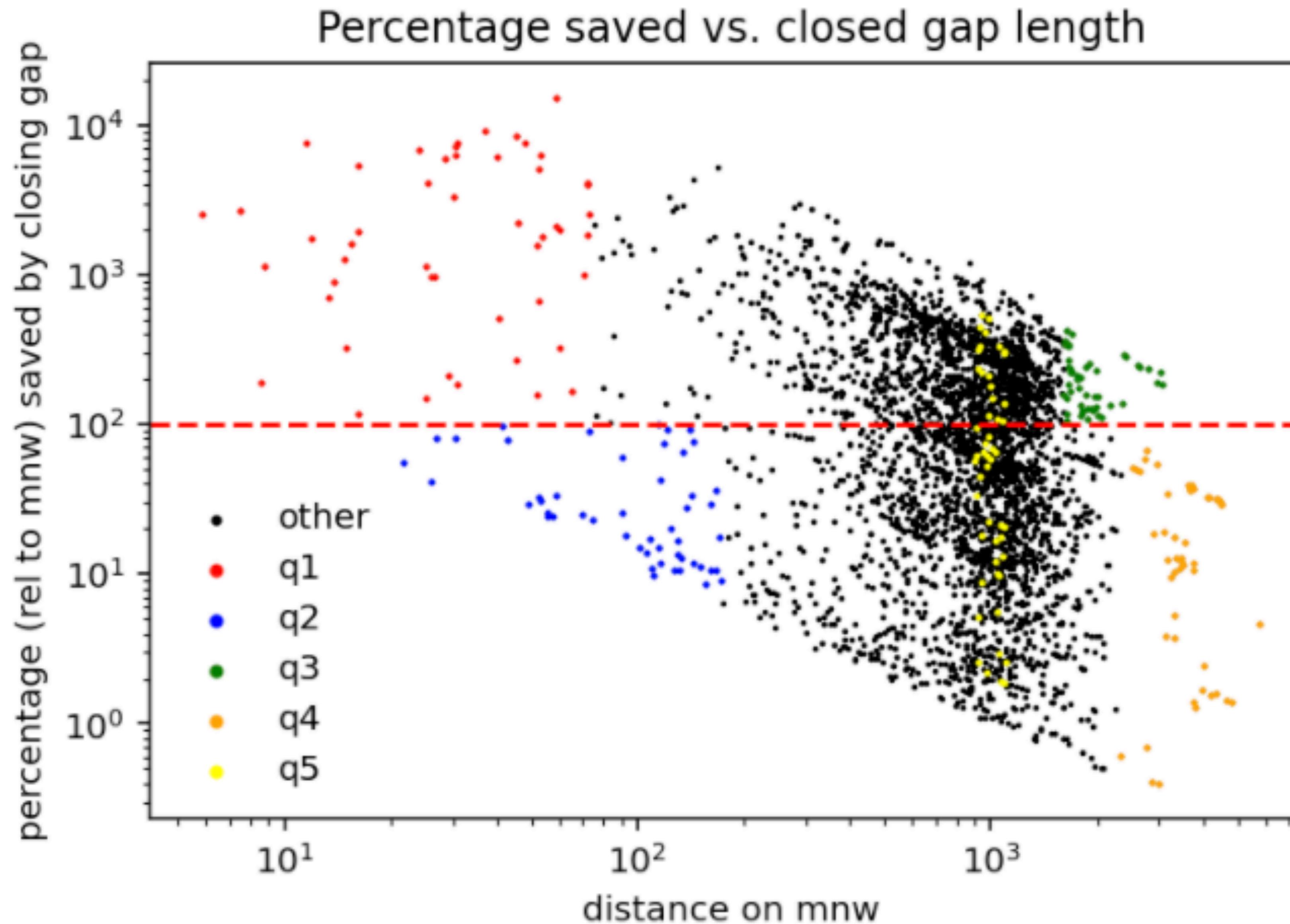


Example Kingosgade:

Disconnected component

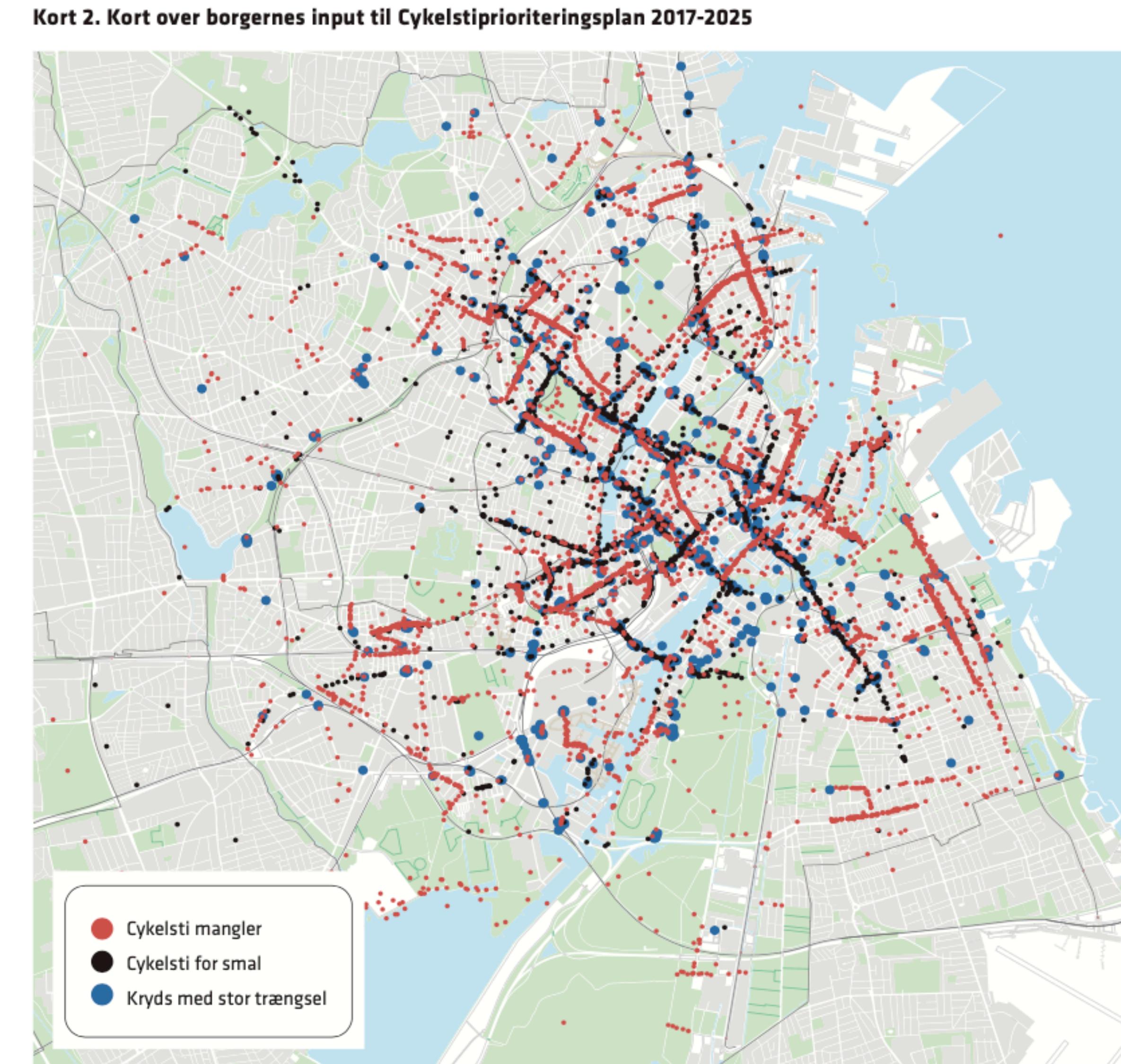
Possible reason: Width

We systematically identify and categorize all gaps



The "Universe of gaps"

We will compare with Copenhagen's plans



This is not the end of the story

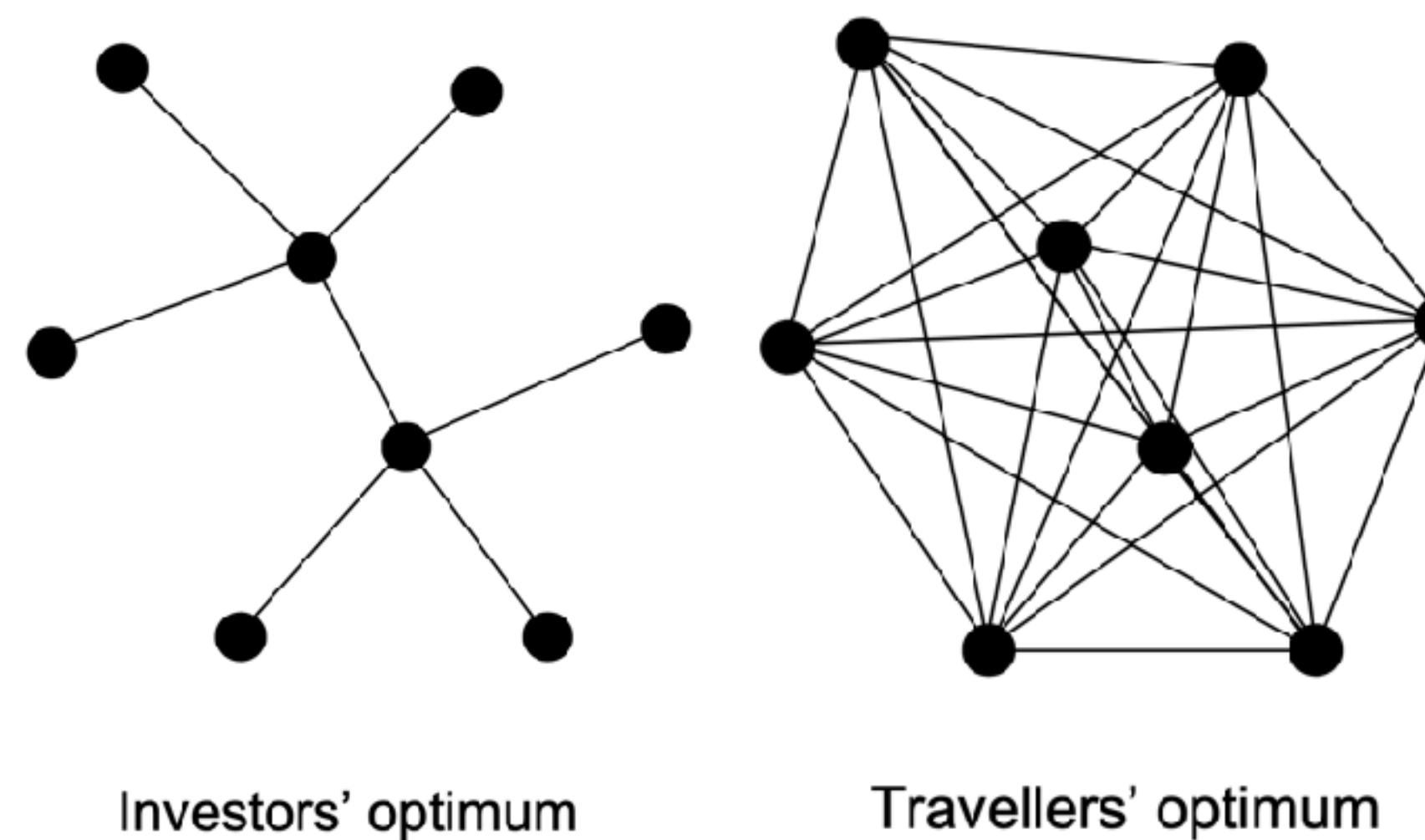
So far we focused ONLY on 1) connectedness, 2) directness

This is not the end of the story

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

Our current research extends to:

Efficiency



Investors' optimum

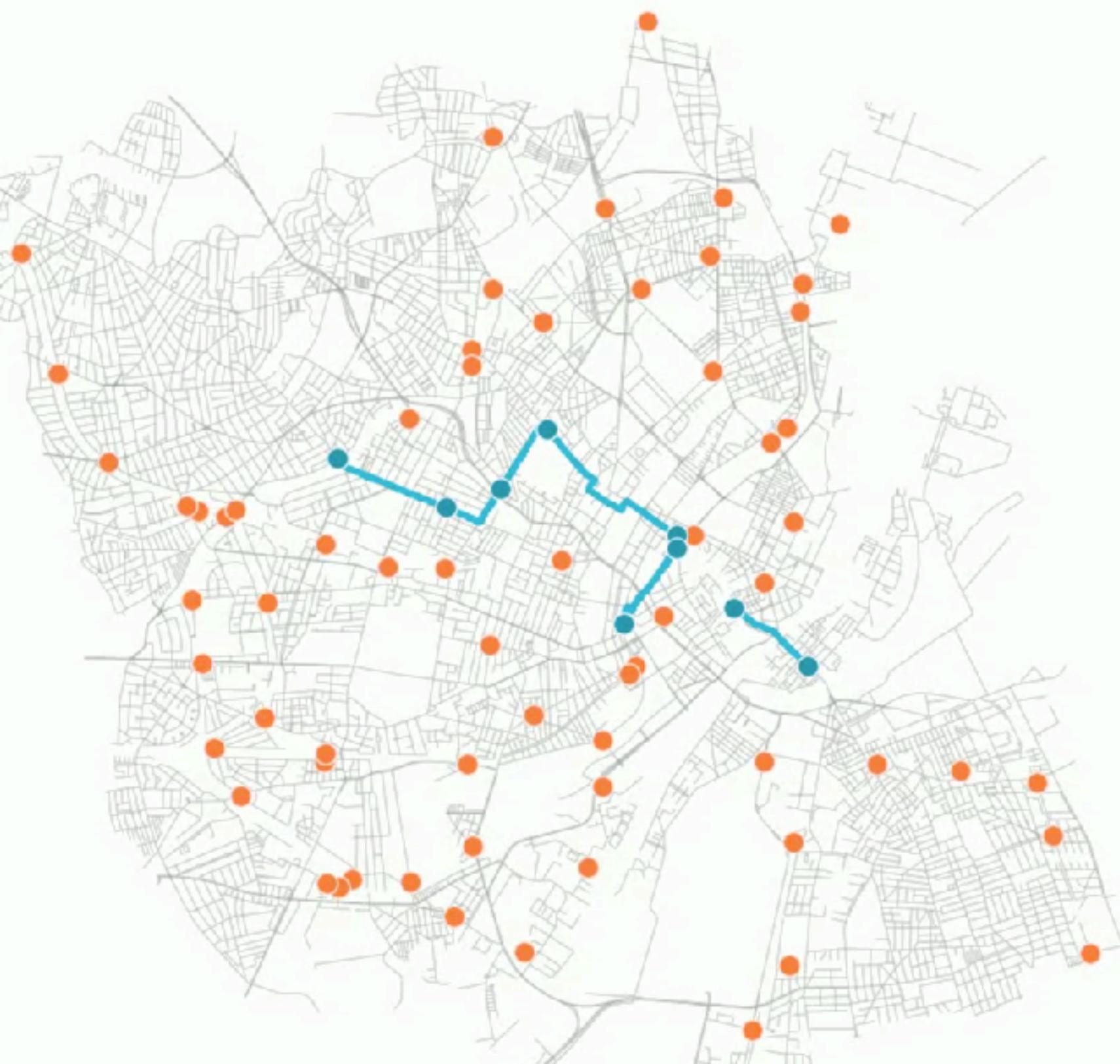
Travellers' optimum

This is not the end of the story

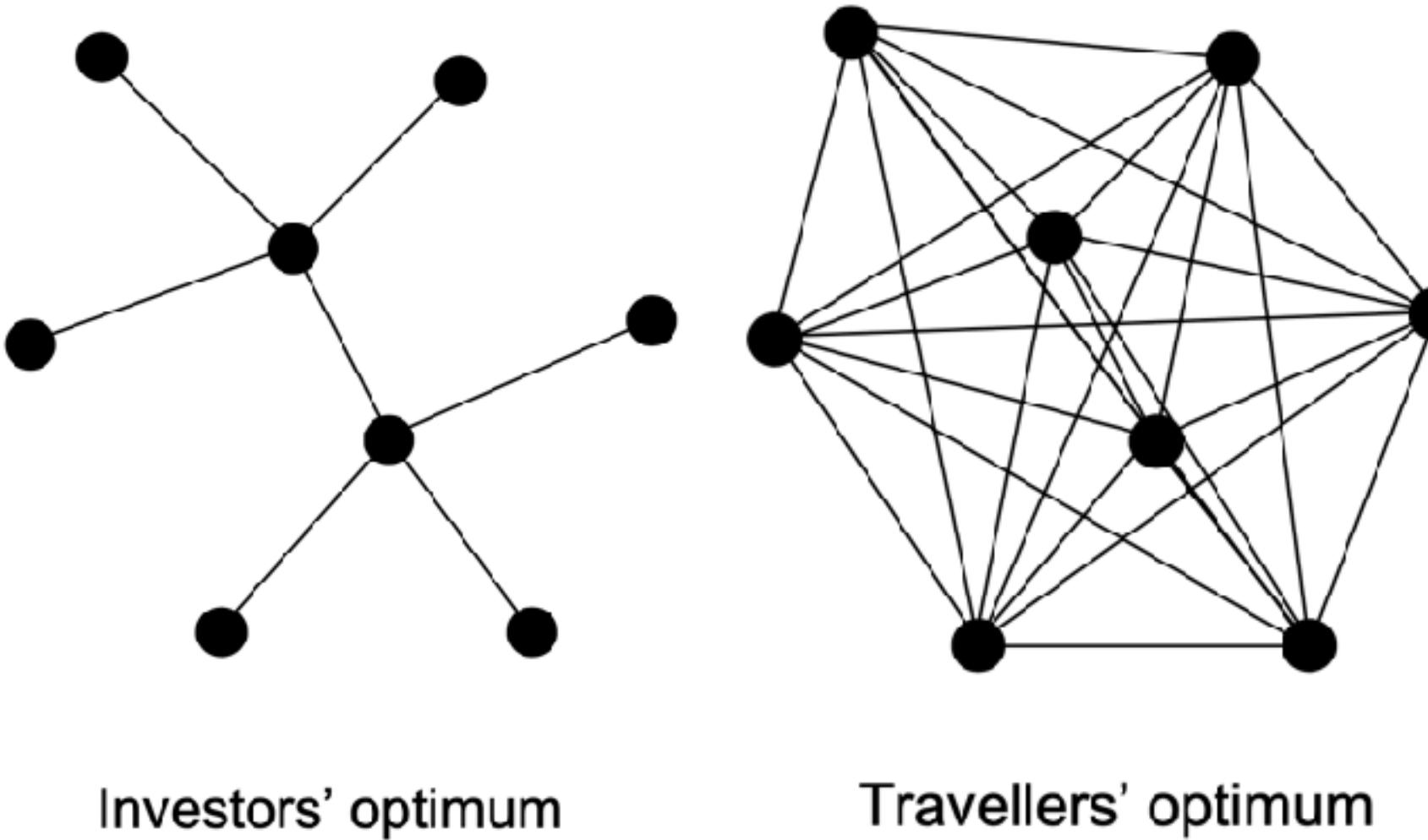
So far we focused ONLY on 1) connectedness, 2) directness

Our current research extends to:

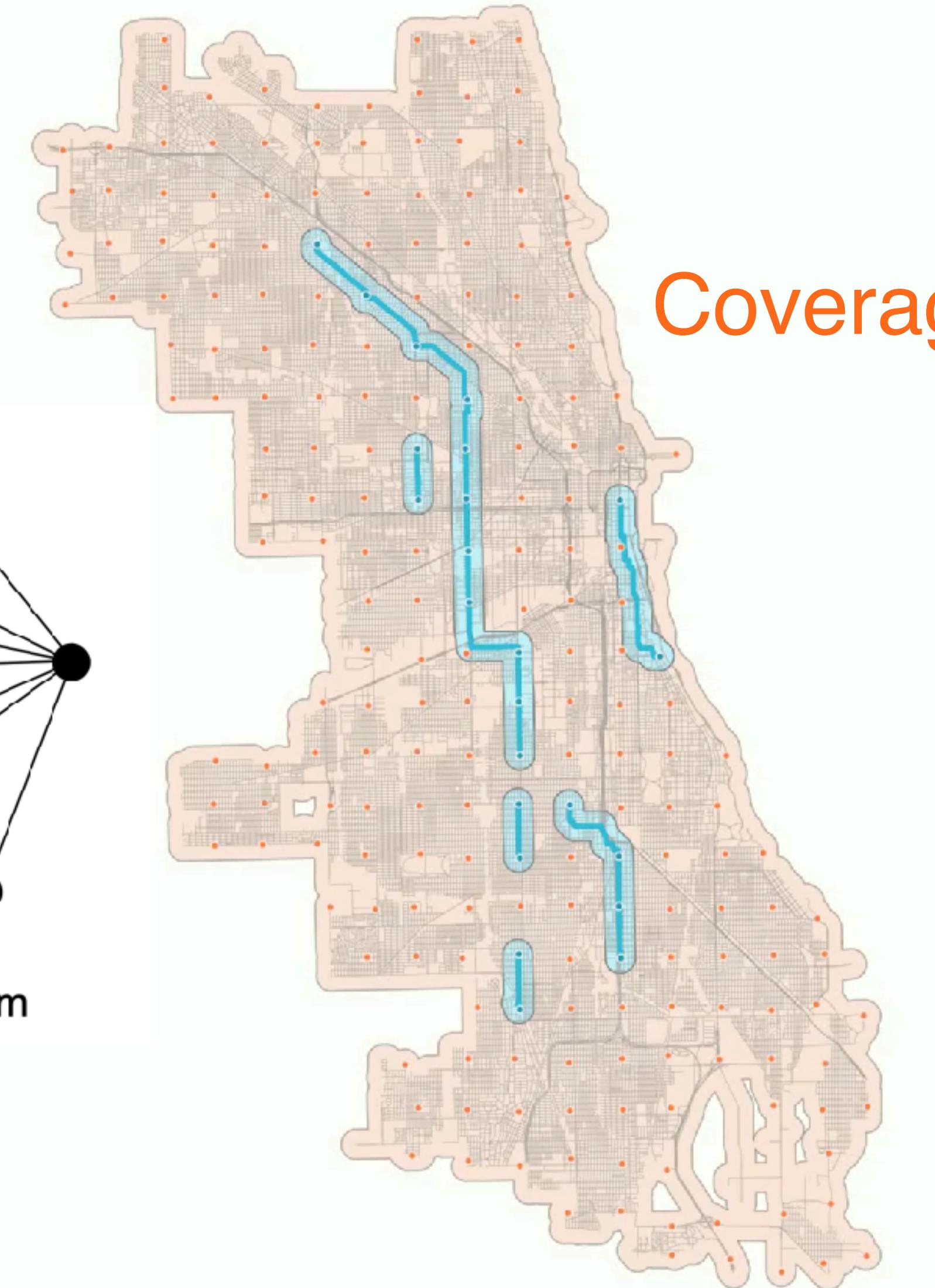
Growth



Efficiency



Coverage



van Nes, Univ of Delft (2002)

This is not the end of the story

Also fundamental:

Safety
Hierarchy
Desire lines



This is not the end of the story

Also fundamental:

Safety
Hierarchy
Desire lines



Trees!



<https://www.youtube.com/watch?v=HjzzV2Akyds>

de Groot, CROW Media 28, 2016
copenhagenize, 2018

Our focus: Topology. Later: Consider more data.

Contents lists available at [ScienceDirect](#)

Transportation Research Part C

journal homepage: www.elsevier.com/locate/trc

 ELSEVIER

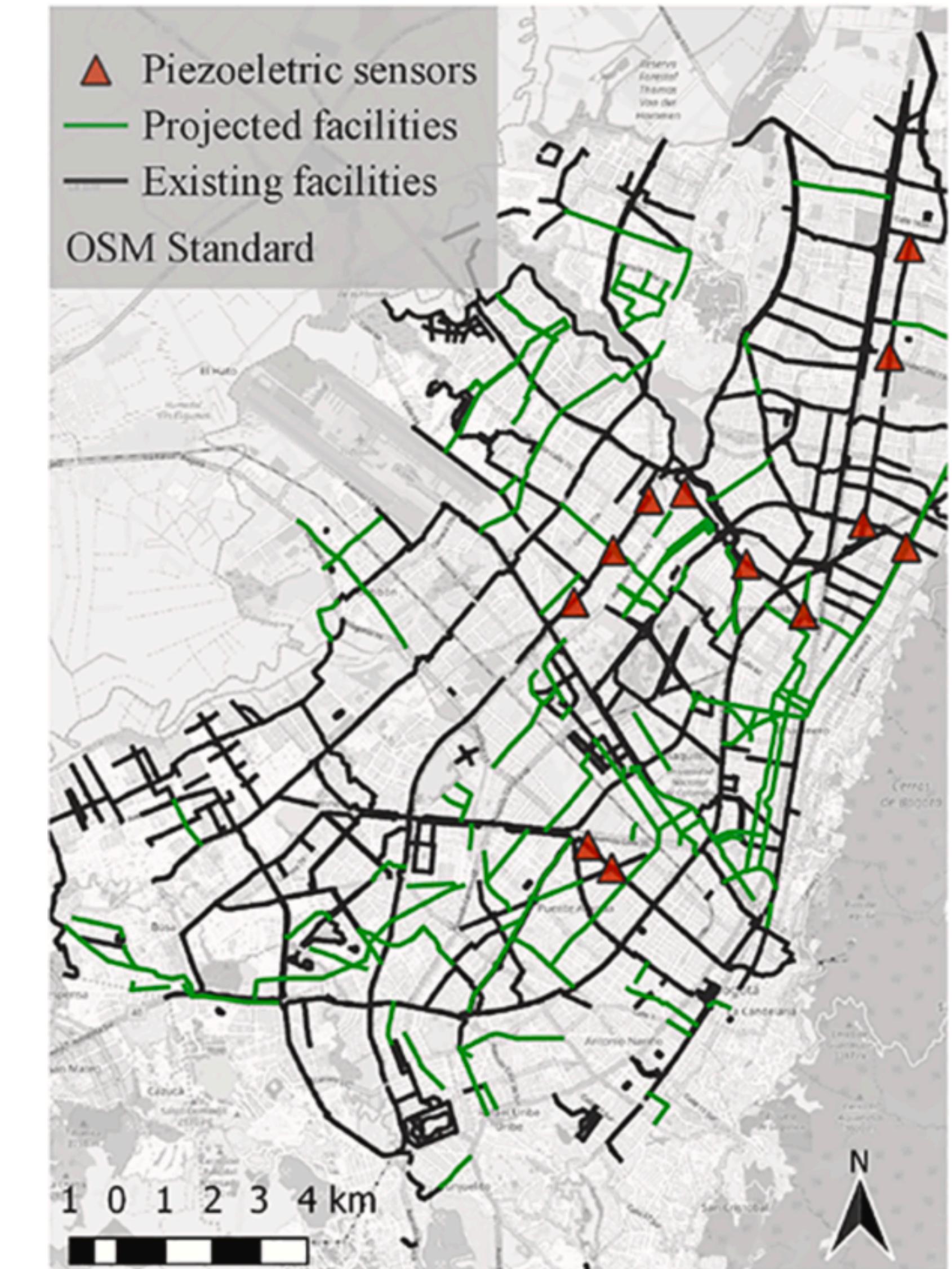


A data science framework for planning the growth of bicycle infrastructures[☆]

Luis E. Olmos^{a,*¹}, Maria Sol Tadeo^{b,¹}, Dimitris Vlahogiannis^b, Fahad Alhasoun^c, Xavier Espinet Alegre^d, Catalina Ochoa^d, Felipe Targa^d, Marta C. González^{a,b,e}



- OD matrices
- Mobile phone GPS
- Census
- Mobility surveys
- Bicycle counters
- Planned bicycle networks



Human-centric Urban Data Science

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

I am establishing a Human-Centric Urban Data Science in Copenhagen

Editorial

Human-Centric Data Science for Urban Studies

Bernd Resch^{1,2,*†}  and Michael Szell^{3,4,5,*†} 

¹ Department of Geoinformatics, Paris-Lodron University of Salzburg, 5020 Salzburg, Austria

² Center for Geographic Analysis, Harvard University, Cambridge, MA 02138, USA

³ NEtwoRks, Data, and Society (NERDS), IT University of Copenhagen, 2300 Copenhagen, Denmark

⁴ ISI Foundation, 10126 Turin, Italy

⁵ Complexity Science Hub Vienna, 1080 Vienna, Austria

* Correspondence: bernd.resch@sbg.ac.at (B.R.); misz@itu.dk (M.S.)

† These authors contributed equally to this work.

Bicycle network research at NERDS, ITU Copenhagen

NERDS = NEtwoRks, Data, and Society

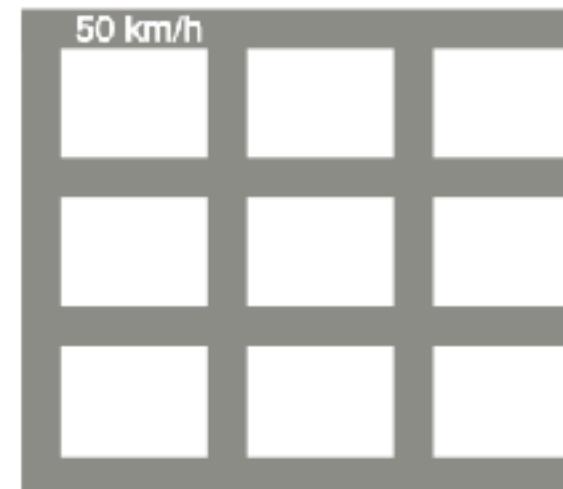
Founded Apr 2019

nerds.itu.dk

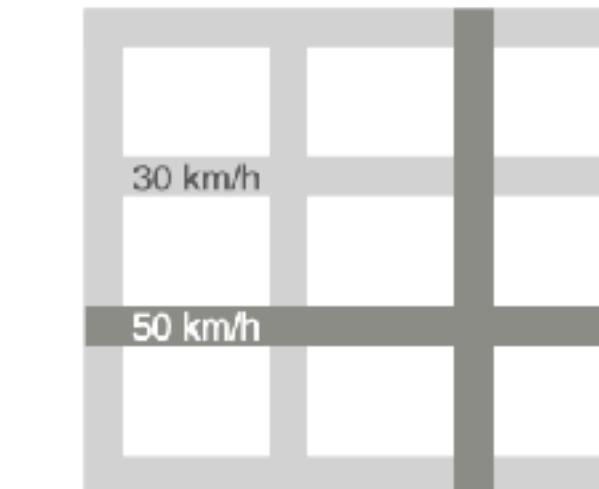
Urban Bicycle Network Approaches

Michael Szell @mszell

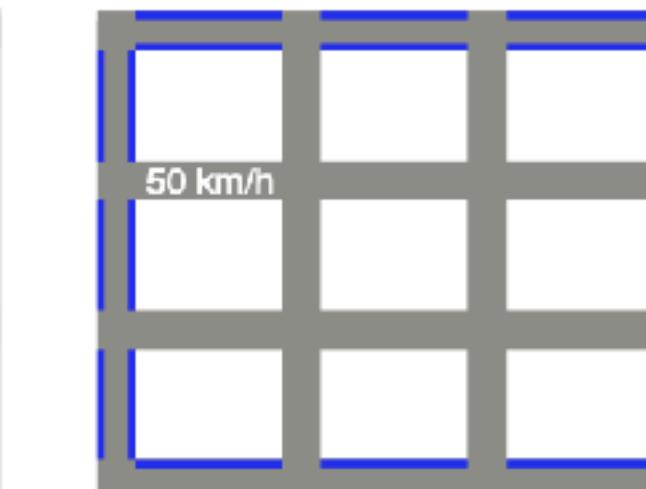
US Approach
No effective bicycle infrastructure, e.g. sharrows



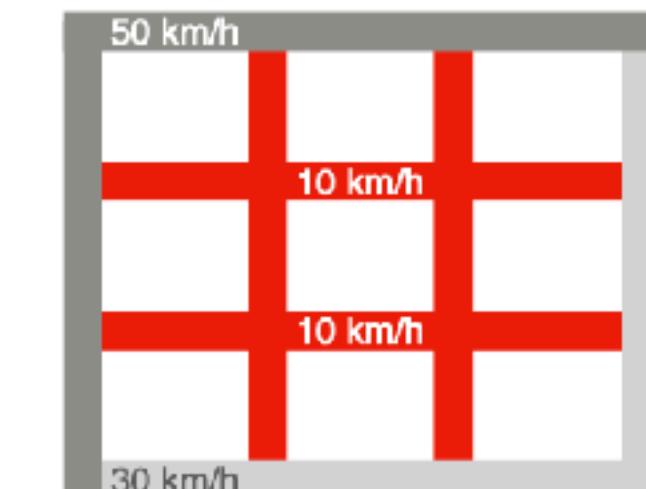
Brussels Approach
Medium speed limits on most streets



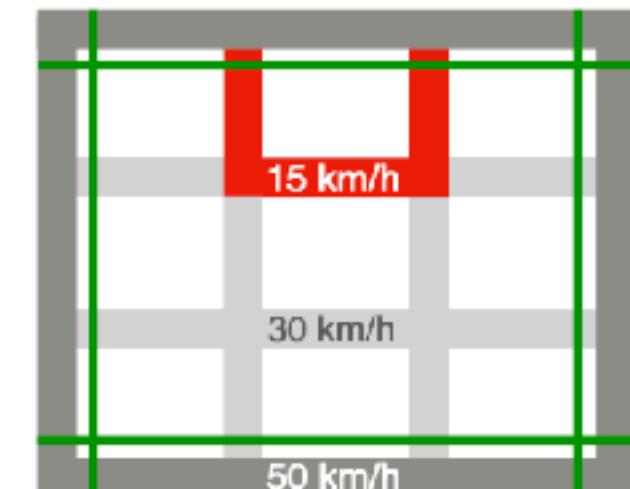
Copenhagen Approach
Network of protected on-street tracks



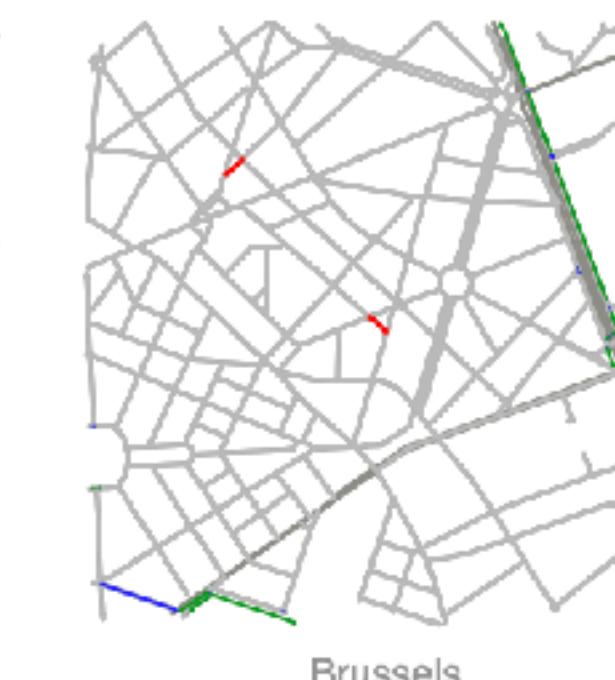
Barcelona Approach
Superblocks: Spatially clustered living streets



Dutch Approach
Network of off-street tracks, medium and low speed limit erf and fietsstraat



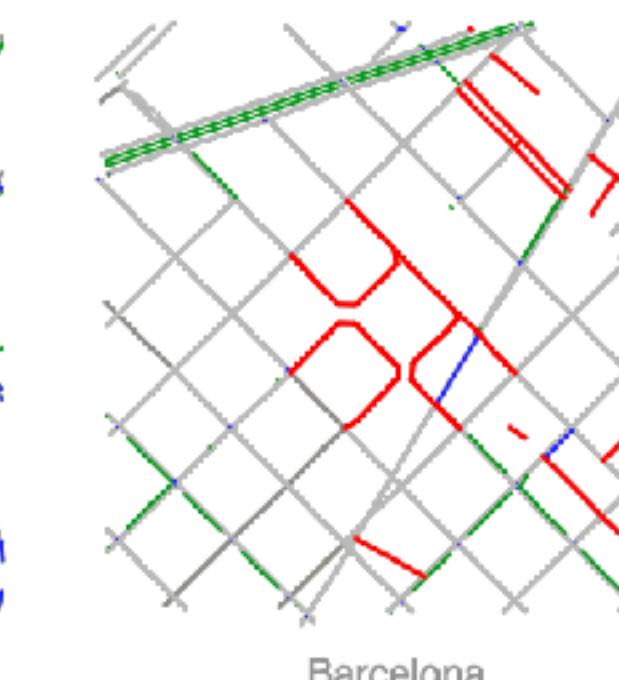
Houston



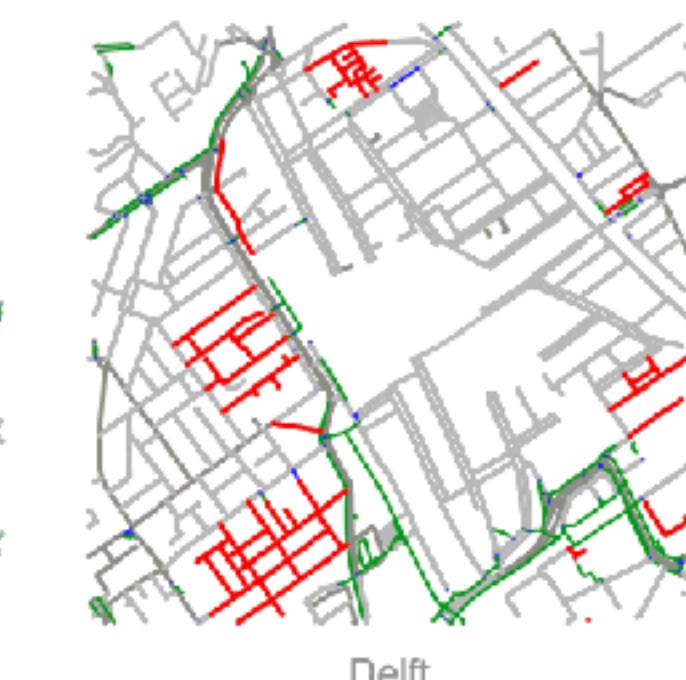
Brussels



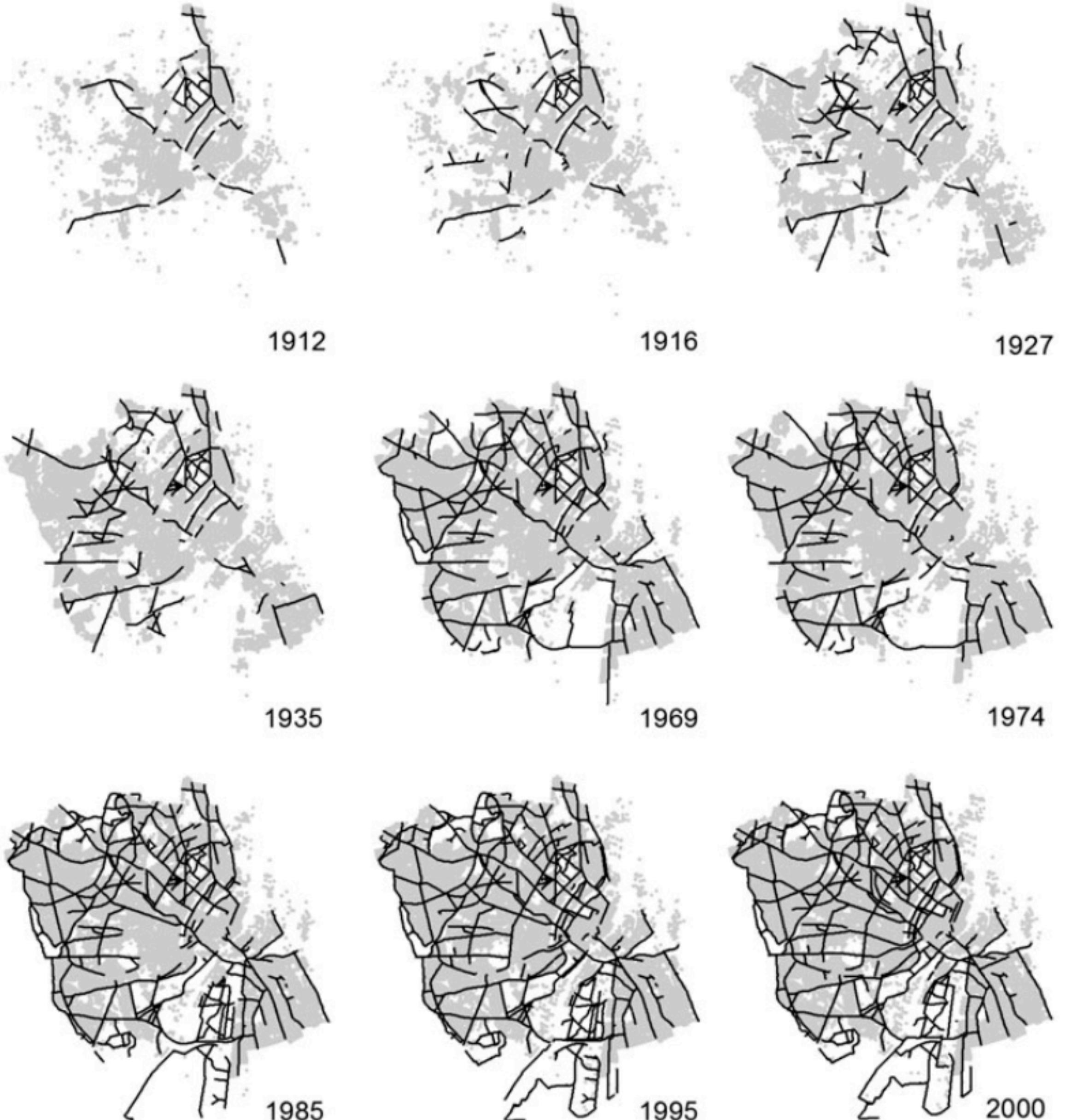
Copenhagen



Barcelona



Delft



Michael Szell
michael.szell.net

@mszll
misz@itu.dk

How is Copenhagen growing its bicycle network?

How to get access to official data sets?

Interest for Industrial PhD?