


Using OpenStreetMap to model bicycle traffic in an agent-based transport simulation

Dominik Ziemke and Simon Metzler
State of the Map | Milano | 29 July 2018

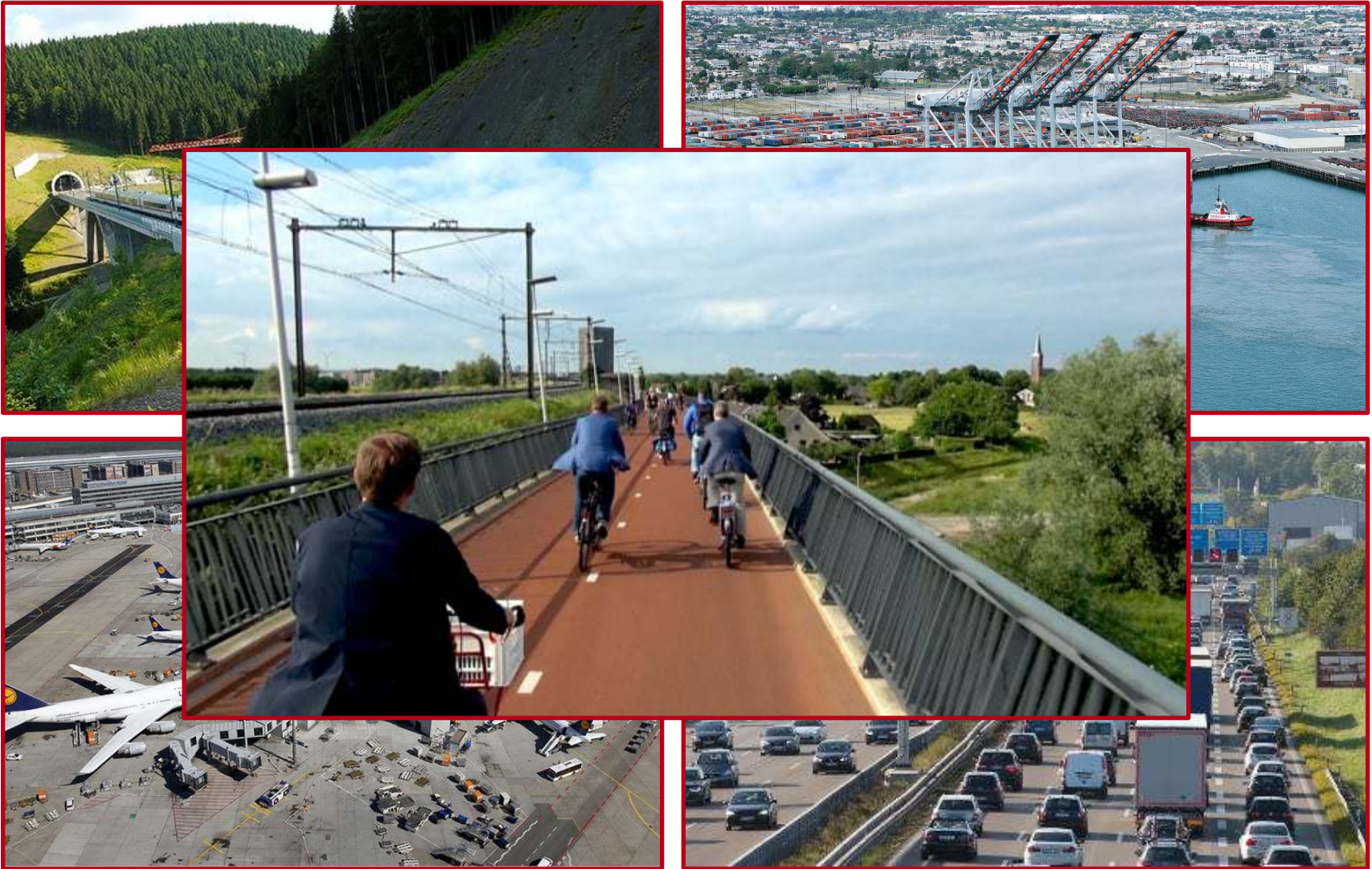
Cycling

- Inexpensive
 - Fast
 - Healthy
 - Quiet
 - Energy-efficient
 - Less land-consuming
 - Enjoyable
- 
- Societal, environmental, economic, and public health problems of motorized vehicle traffic
- Cities promote cycling for everyday use
 - Increasingly included into plans for travel behavior change

Need for appropriate infrastructures



Need for appropriate infrastructures

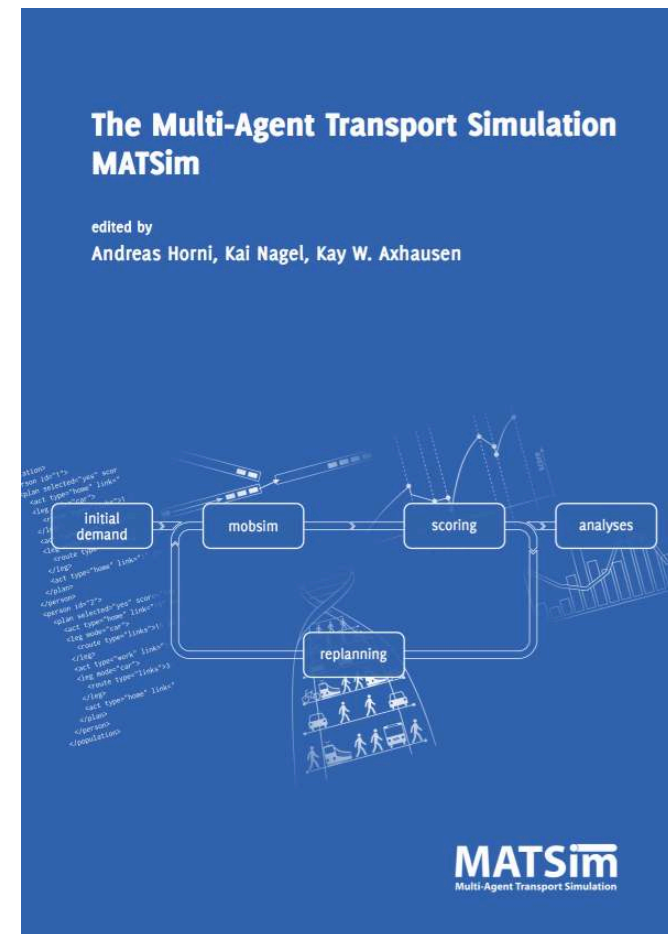


Transport (Planning) Models

- Important tool for effective planning of transport systems
- A means to evaluate proposed policies in a structured and systematic fashion
- State-of-the-practice for motorized individual transport and public transport

MATSim: Multi-Agent Transport Simulation Framework

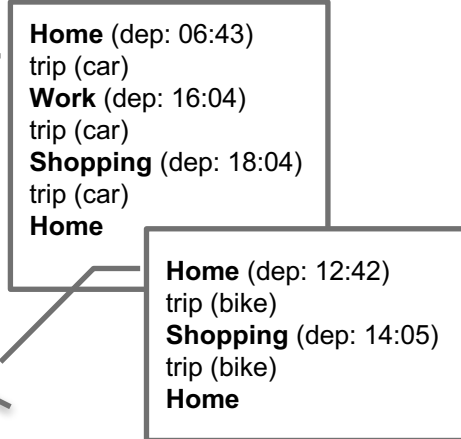
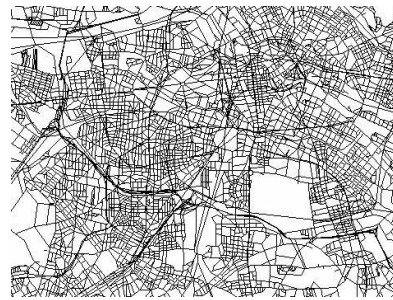
- Travelers (decision makers) represented individually (“agents”)
- Daily activity-travel patterns are modeled (“plans”)
- Implemented in Java
- Modular and **extendable**
- **Open source**
- Designed for large-scale scenarios
- Various analysis options
- www.matsim.org



MATSim: Basics

Traffic Simulation

- Agents travel on network

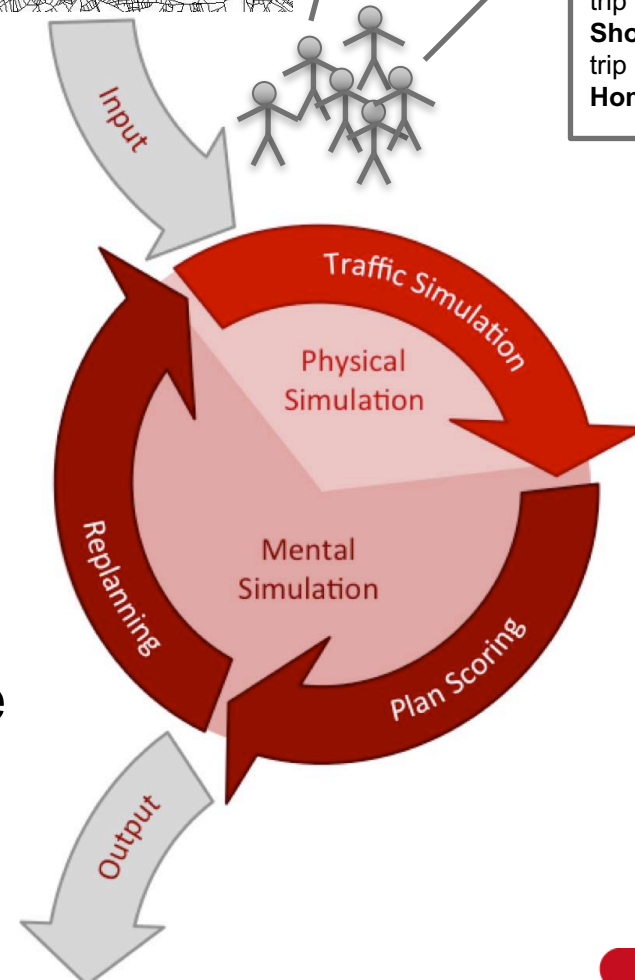


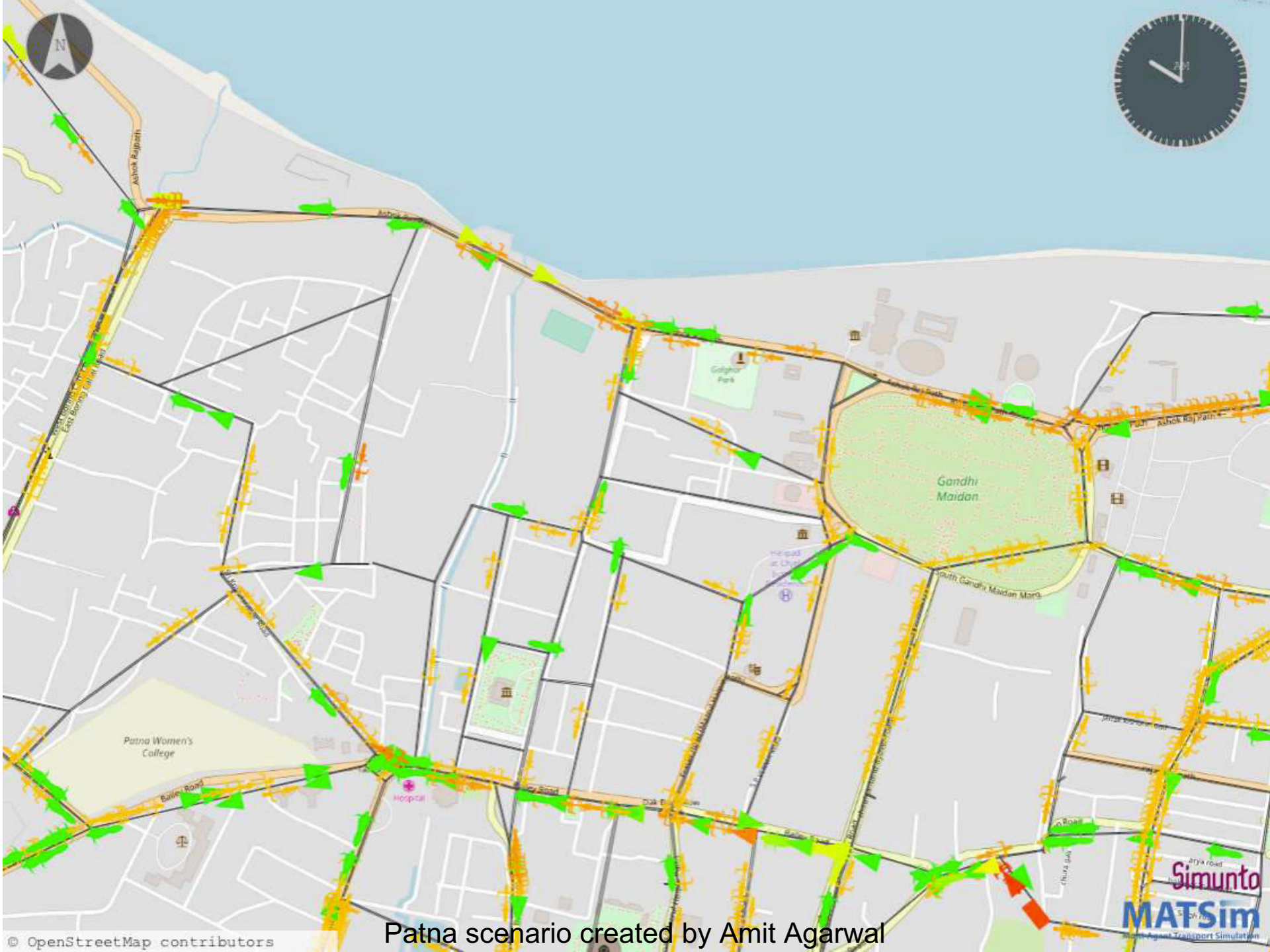
Plan Scoring

- Agents score their executed activities and trips

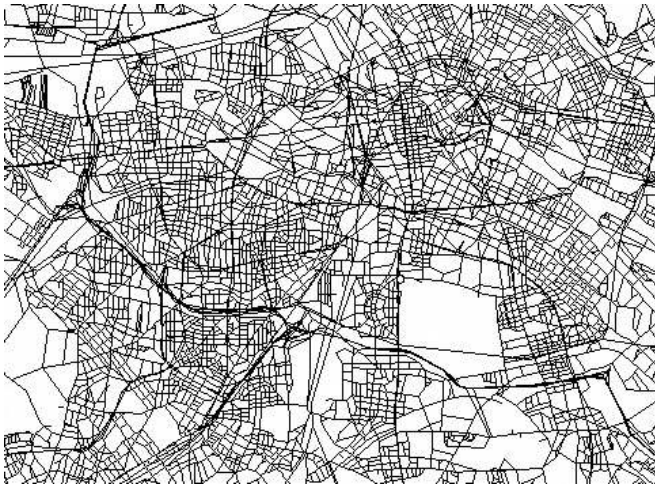
Replanning

- Agents modify their plans along various possible choice dimensions
- Agents select a plan based on a multinomial logit model

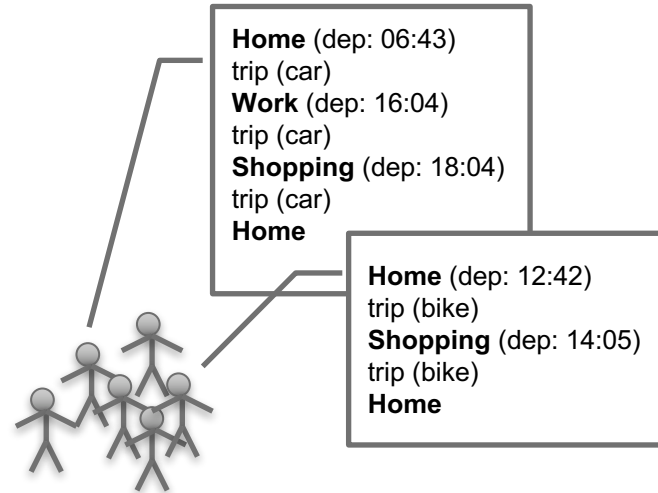




MATSim Input Data



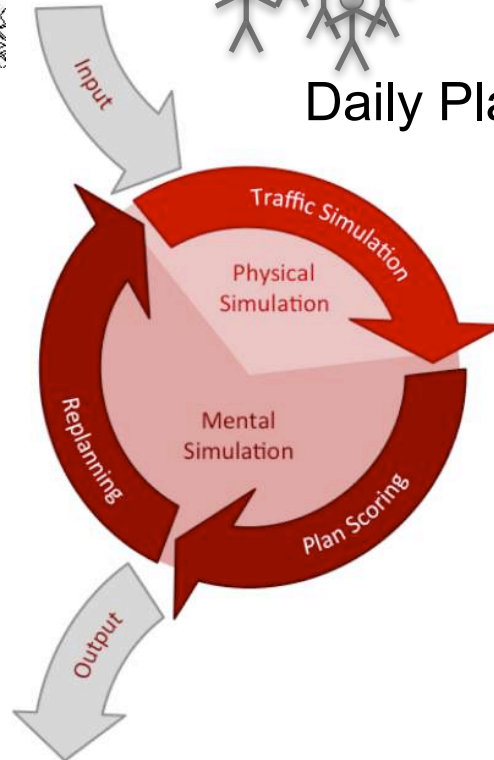
Network



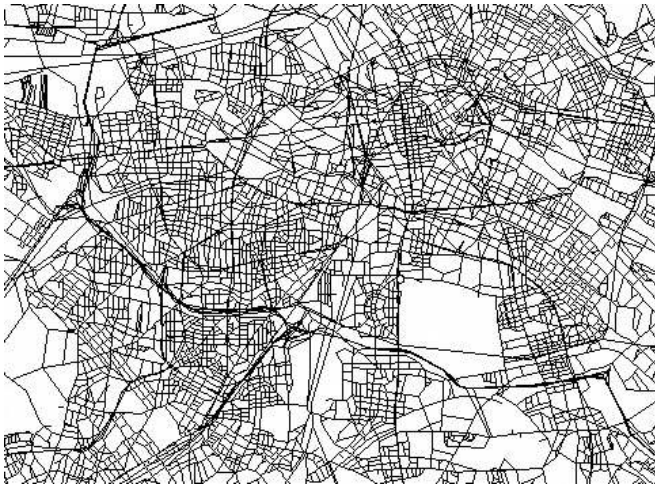
Daily Plans

Transport Supply

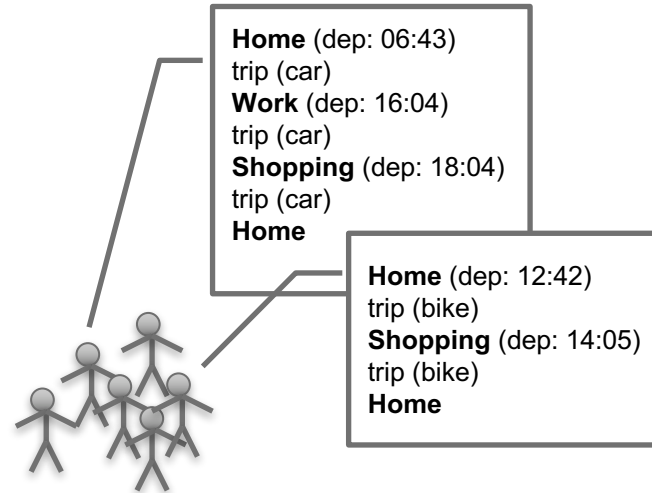
Transport Demand



MATSim Input Data



Network

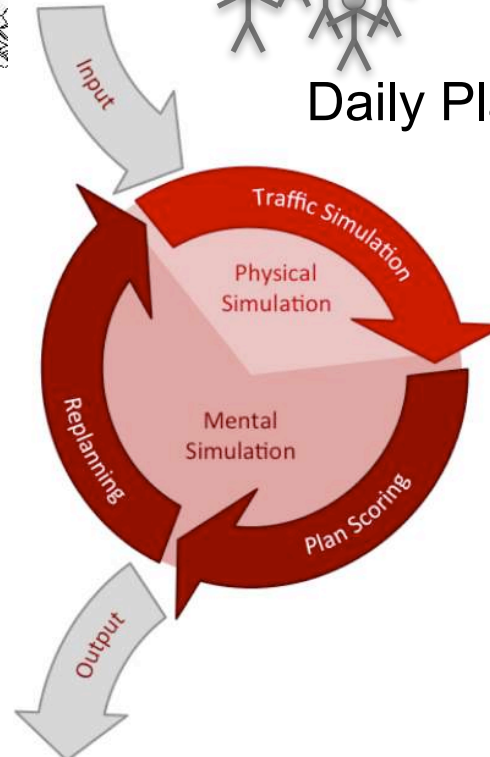


Daily Plans



Transport Supply

Transport Demand



Network creation for MATSim

- Parse way und node objects in study region
- Optional: Remove ways below certain highway type
- Create MATSim node if node at end of way or at intersection
- Create MATSim links connecting nodes on that way
 - Compute length
 - Process maxspeed
 - Consider oneway → MATSim network = directed graph
 - Estimate flow capacity (based on highway type, lanes etc.)
- Clean up: Remove unconnected nodes and links etc.

Network creation: Extension for lanes and signals

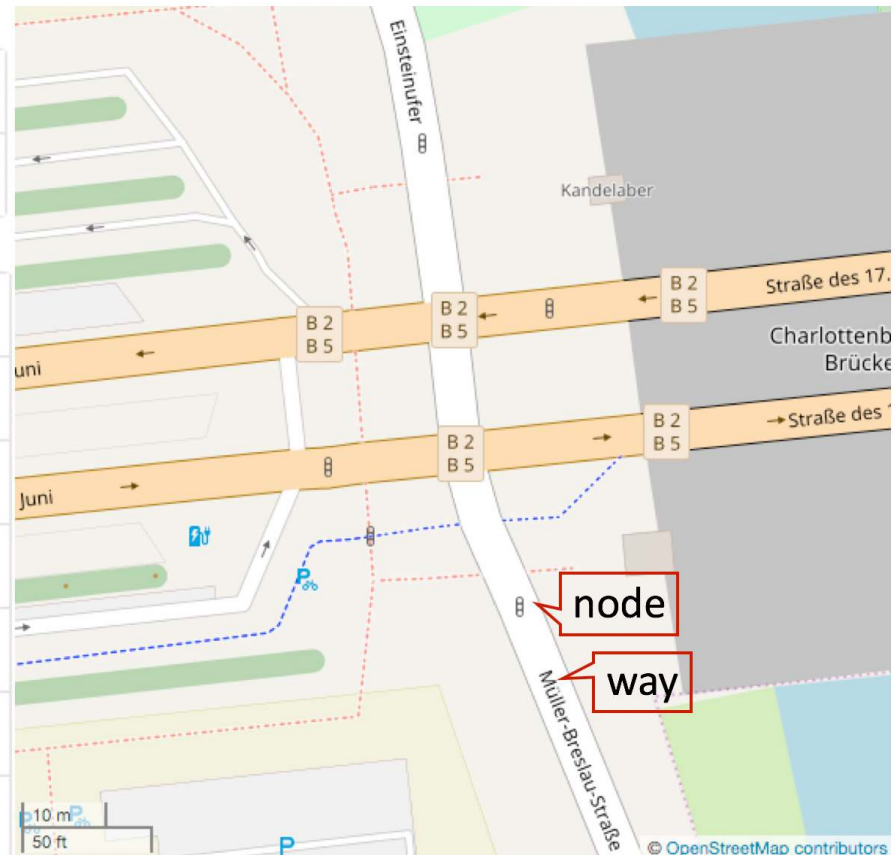
- Poster here at SotM 2018 by Theresa Thunig

node – traffic signal:

highway	traffic_signals
traffic_signals:direction	backward

way – bidirectional:

highway	tertiary
lanes	4
lanes:backward	2
lanes:forward	2
name	Müller-Breslau-Straße
postal_code	10623
turn:lanes:backward	left;through right



Network creation: Extension for bicycle traffic

- Focus of this talk

People are different



People are different



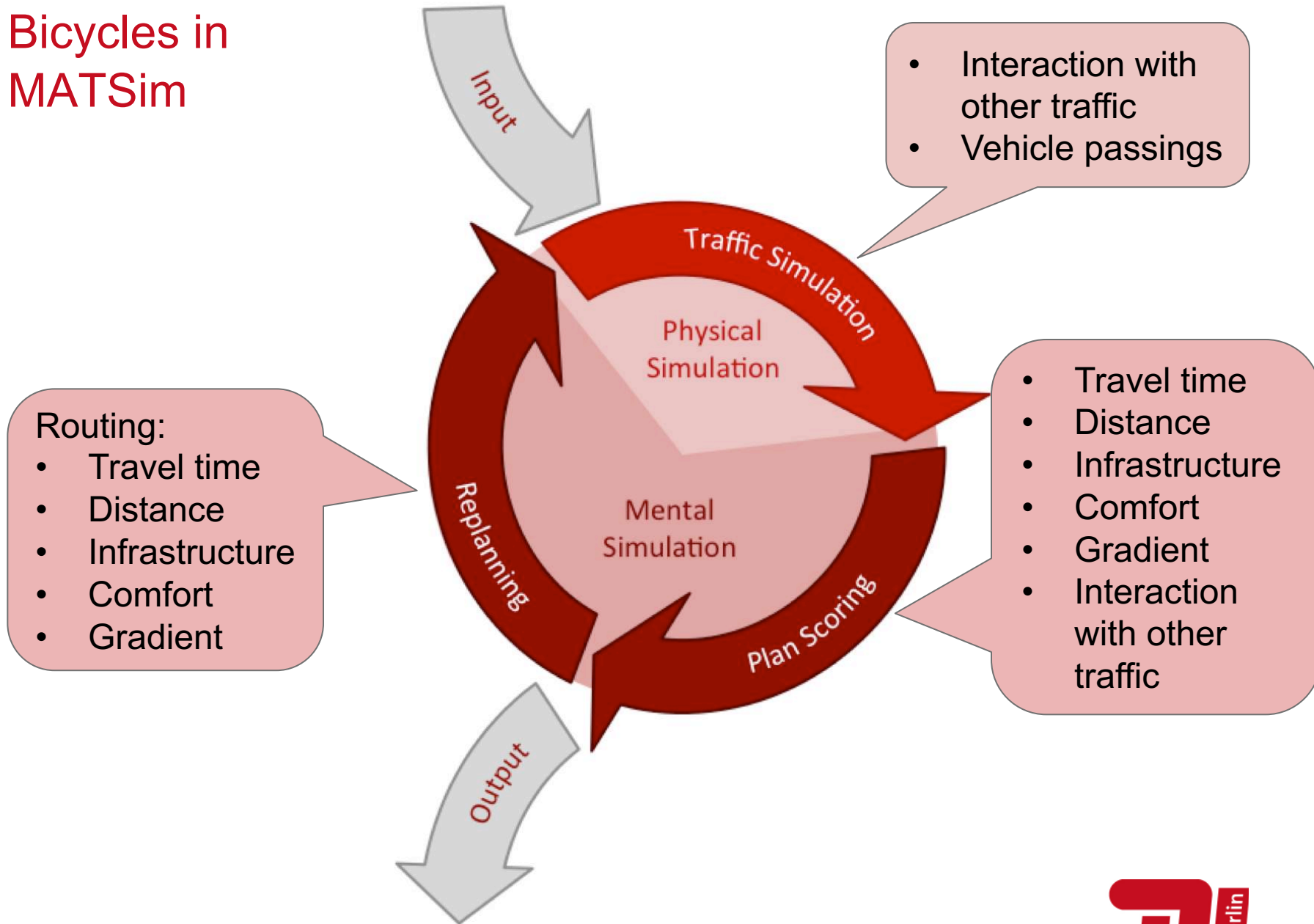
- ... but less so when traveling by car
- Minimize travel time



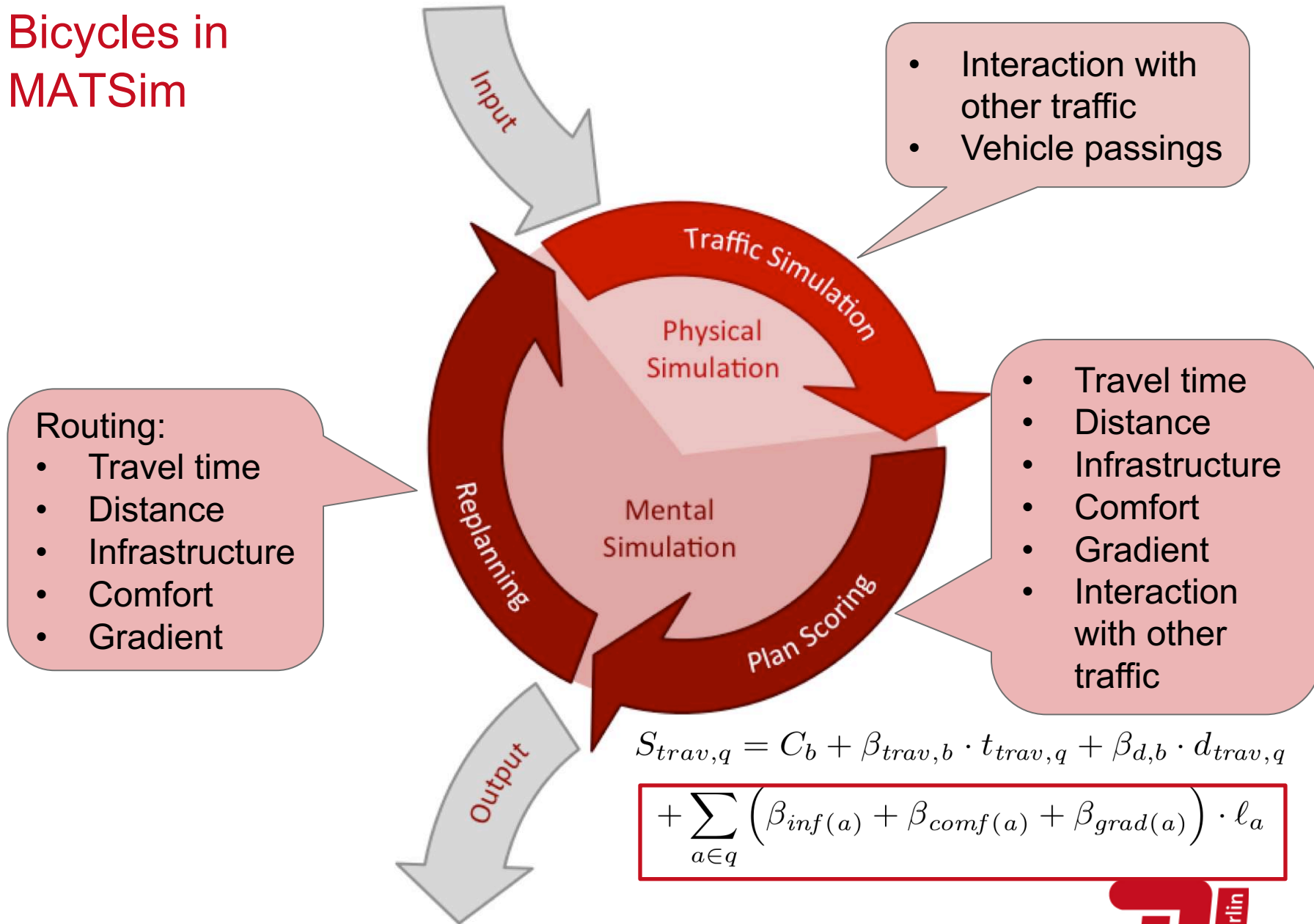
How do cyclists choose their routes?

- Travel time
- Route length
- Gradient
- Comfort
 - Smoothness / Surfaces
- Cycling infrastructure
 - Bicycle lanes
 - Bicycle tracks
- Intersections
- Volumes of motorized traffic
- Parking facilities along route
- ...

Bicycles in MATSim



Bicycles in MATSim



$$S_{trav,q} = C_b + \beta_{trav,b} \cdot t_{trav,q} + \beta_{d,b} \cdot d_{trav,q} + \sum_{a \in q} \left(\beta_{inf(a)} + \beta_{comf(a)} + \beta_{grad(a)} \right) \cdot l_a$$

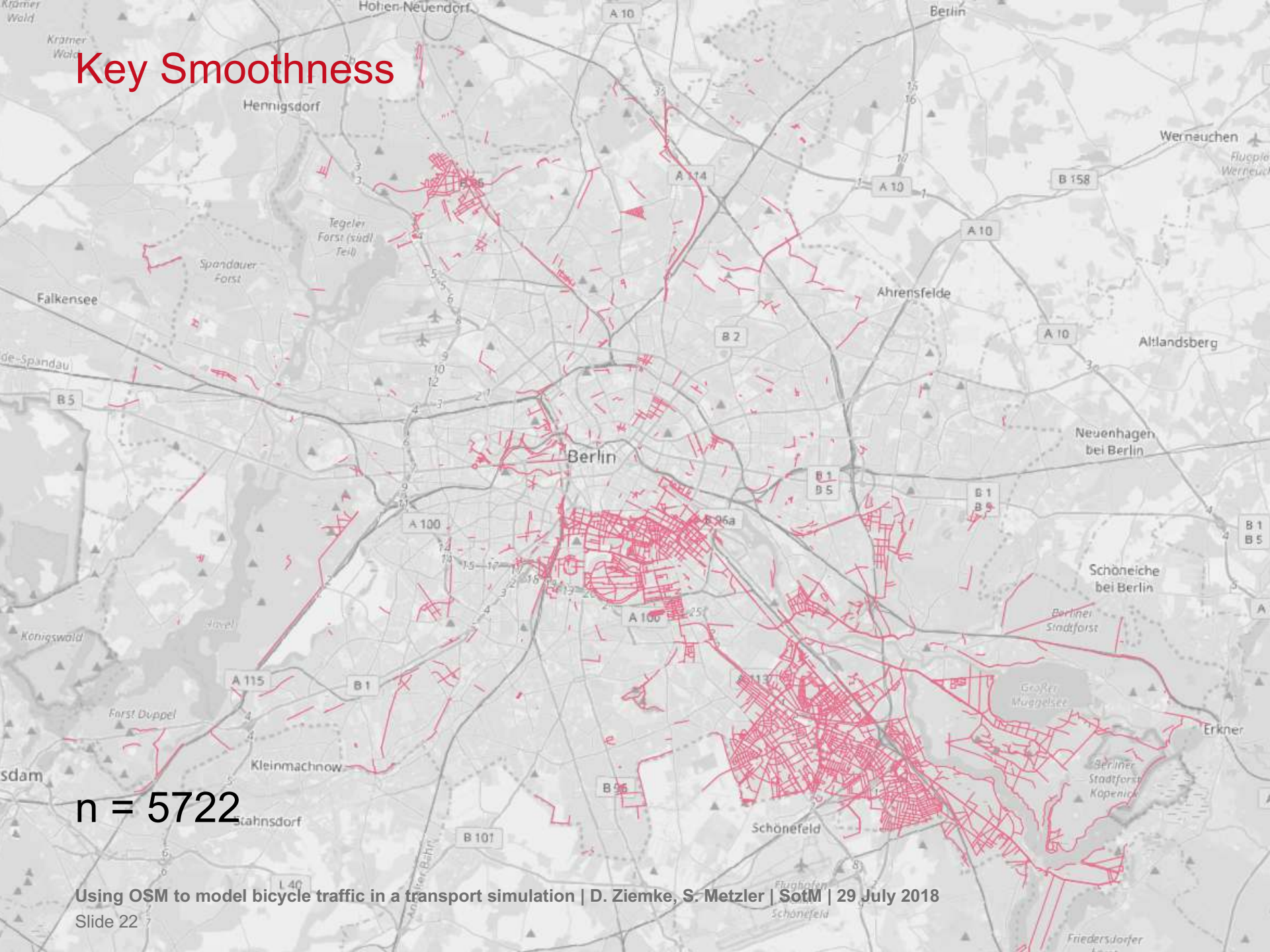
INFRASTRUCTURE

Cycling-relevant Data on OpenStreetMap

- Determine cycling Infrastructure
 - Main road with a bicycle lane
 - `highway=?` and `cycleway=lane`
 - Bicycle lane on the sidewalk
 - `highway=?` and `cycleway=track`
 - A bicycle track away from roads
 - `highway=cycleway`
- Further information
 - `cycleway:right/left/both`
 - Cyclists allowed to travel in opposite direction
 - ...

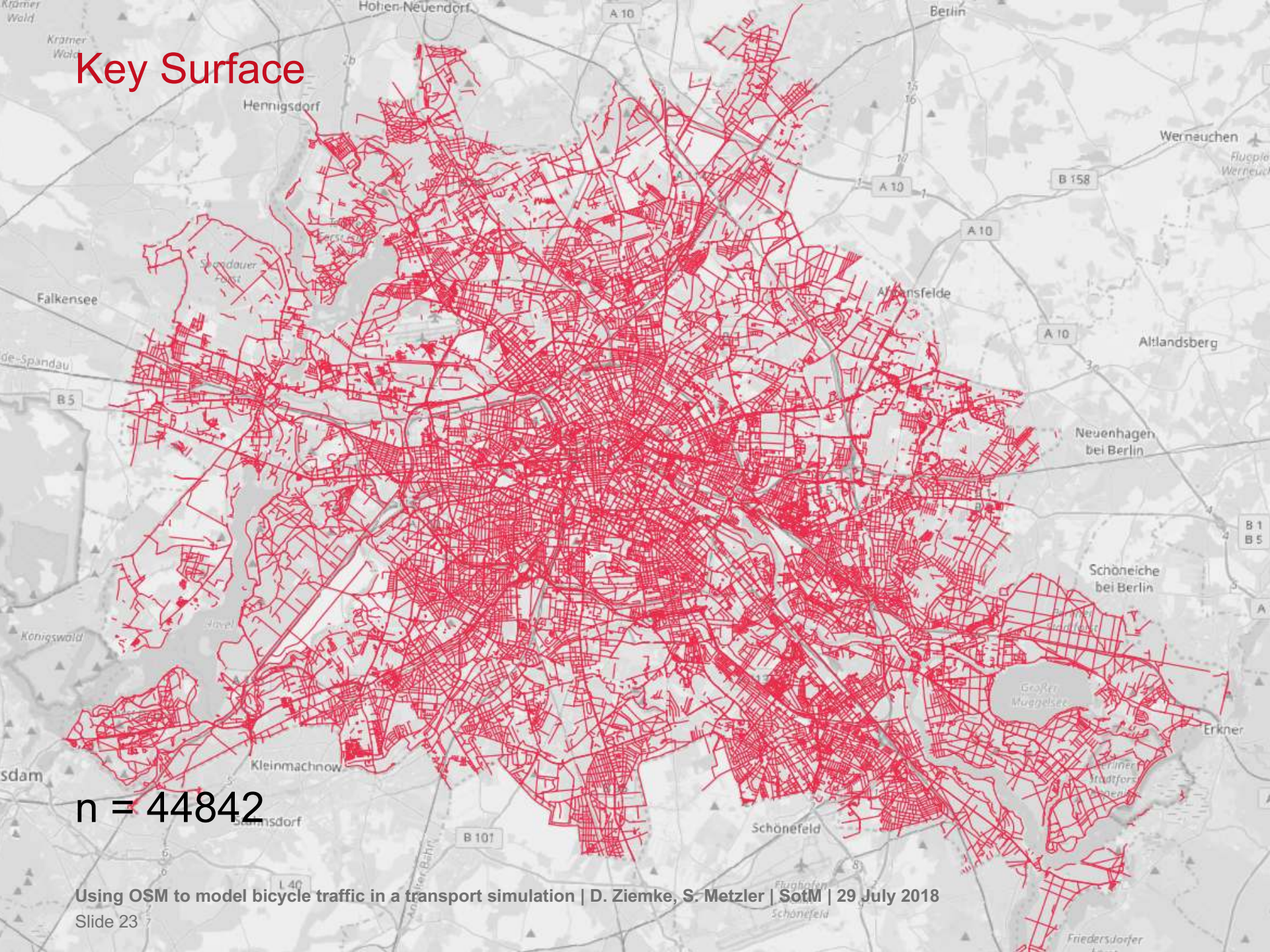
COMFORT

Key Smoothness



n = 5722

Key Surface



n = 44842

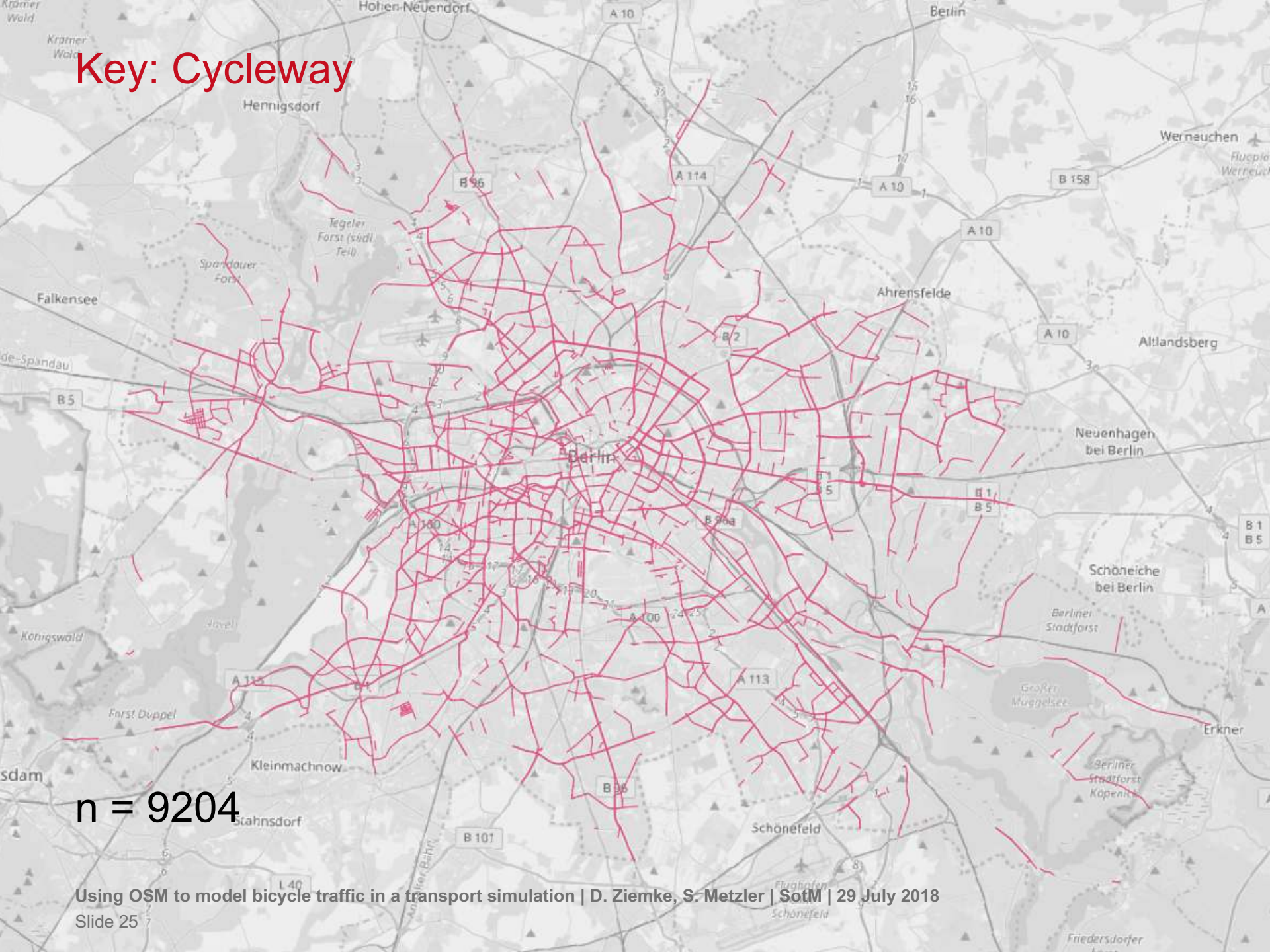
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Slide 23

Street surface \neq cycleway surface

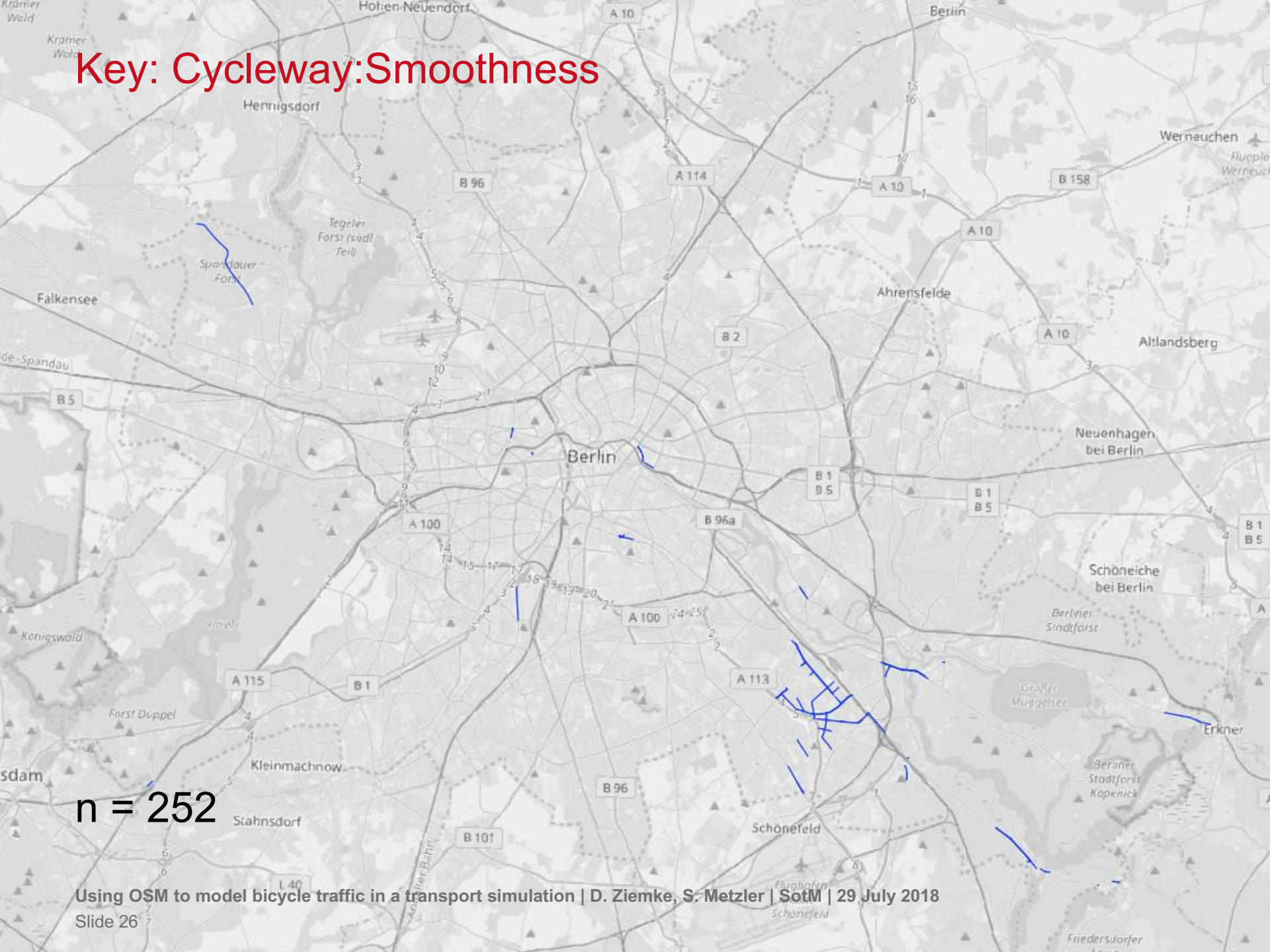


Key: Cycleway



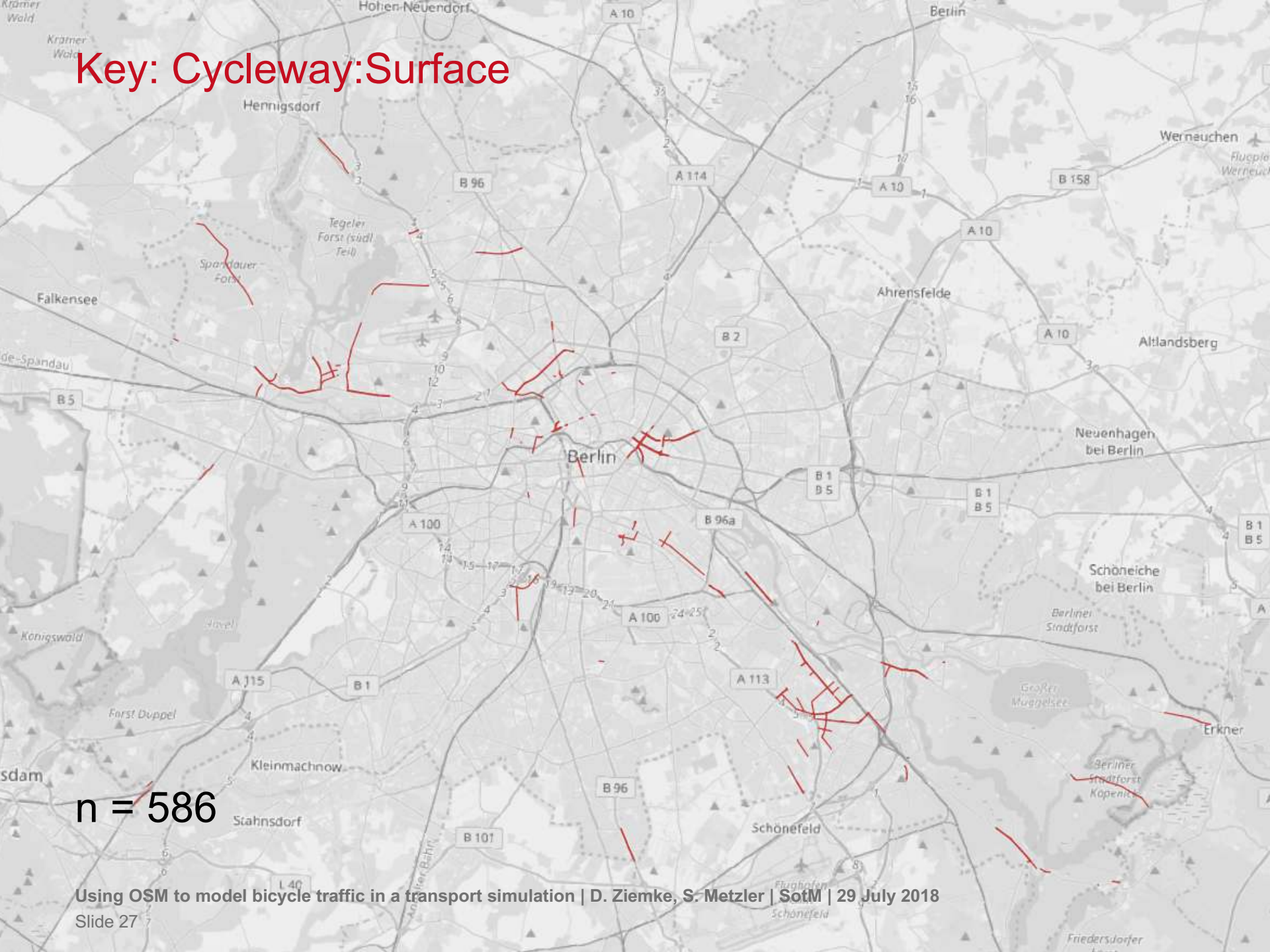
n = 9204

Key: Cycleway:Smoothness



n = 252

Key: Cycleway:Surface

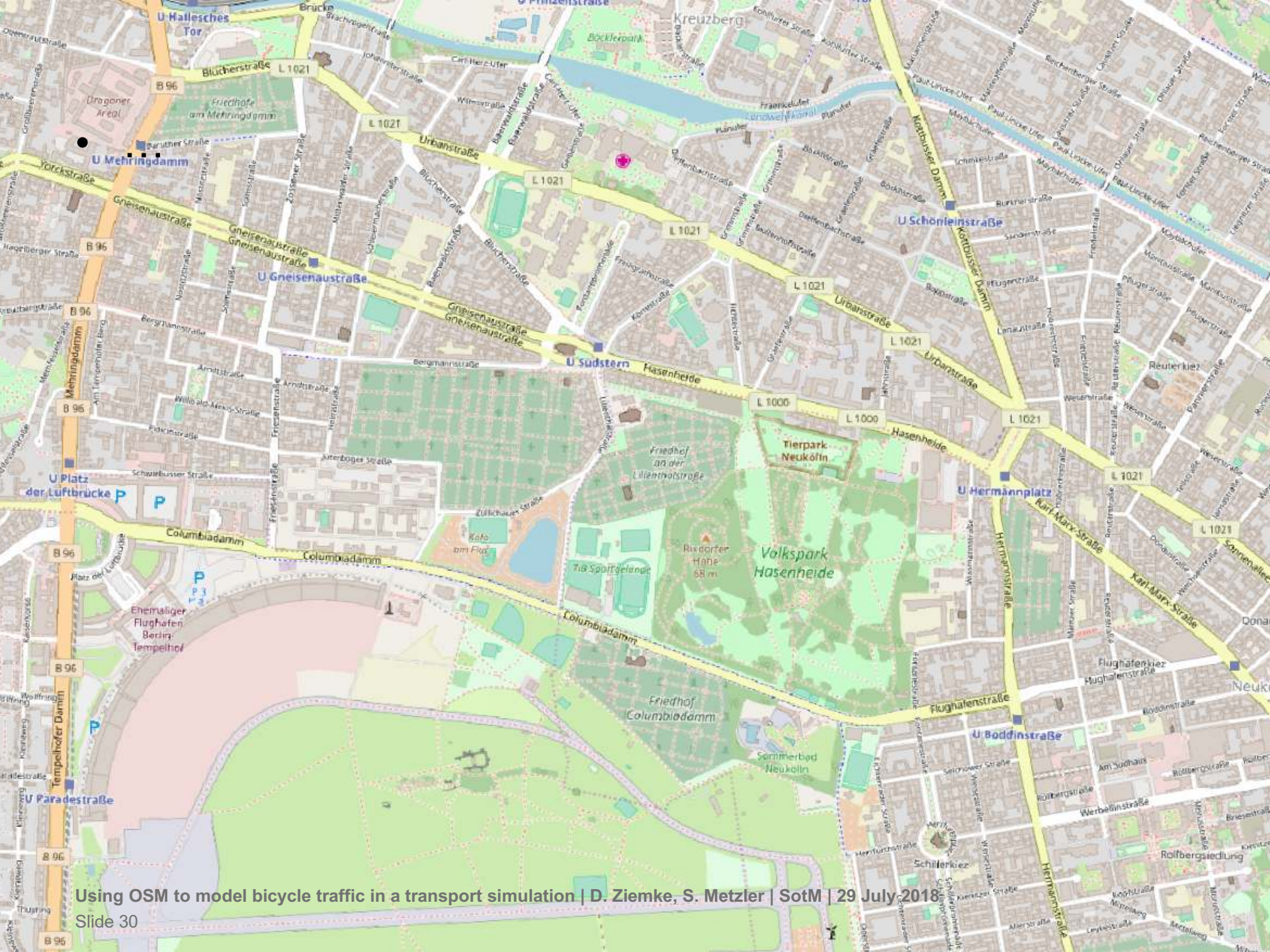


n = 586

GRADIENT

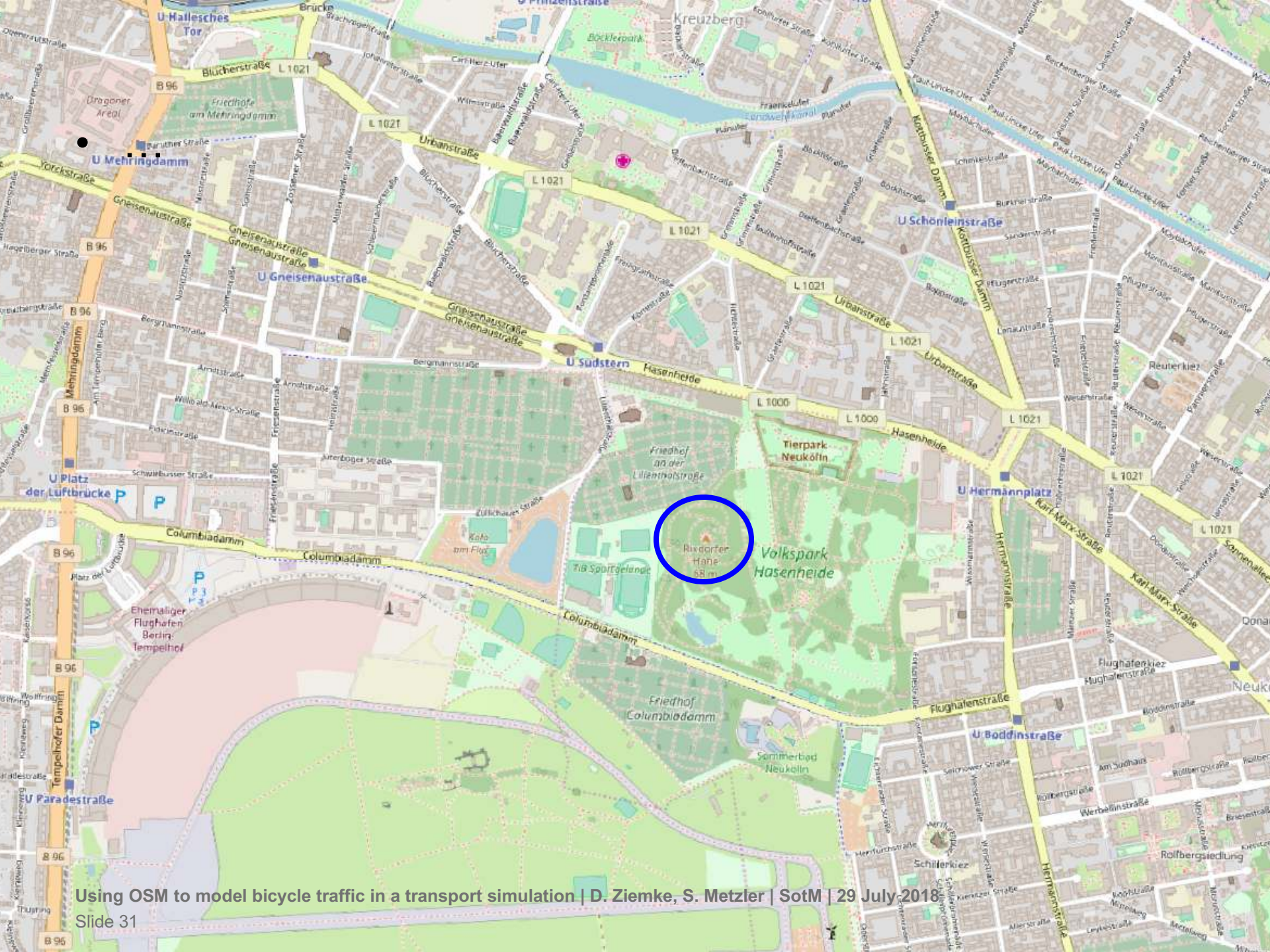
Gradient

- Tag `elevation` on OSM, but mainly intended for `natural = peak`
 - “...not try to be a general elevation database...” (OSM Wiki)
 - Digital elevation model (DEM)
 - Digital surface models (DSM)
 - Satellite imaging
 - Surface of earth incl. all objects on it, e.g. buildings
 - E.g. SRTM (Shuttle Radar Topography Mission)
 - Digital terrain models (DTM)
 - Photogrammetric measurement using aerial picturing and laser scanning
 - Ground surface of the earth without objects on it
- Enrich MATSim network nodes with z-Coordinate

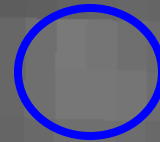


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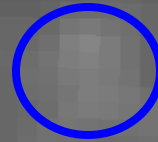
Slide 30



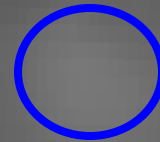
Elevation Data: SRTM3



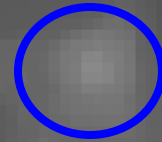
Elevation Data: SRTM1



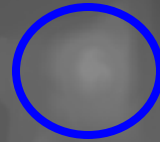
Elevation Data: EU-DEM



Elevation Data: LIDAR 20m



Elevation Data: LIDAR 1m

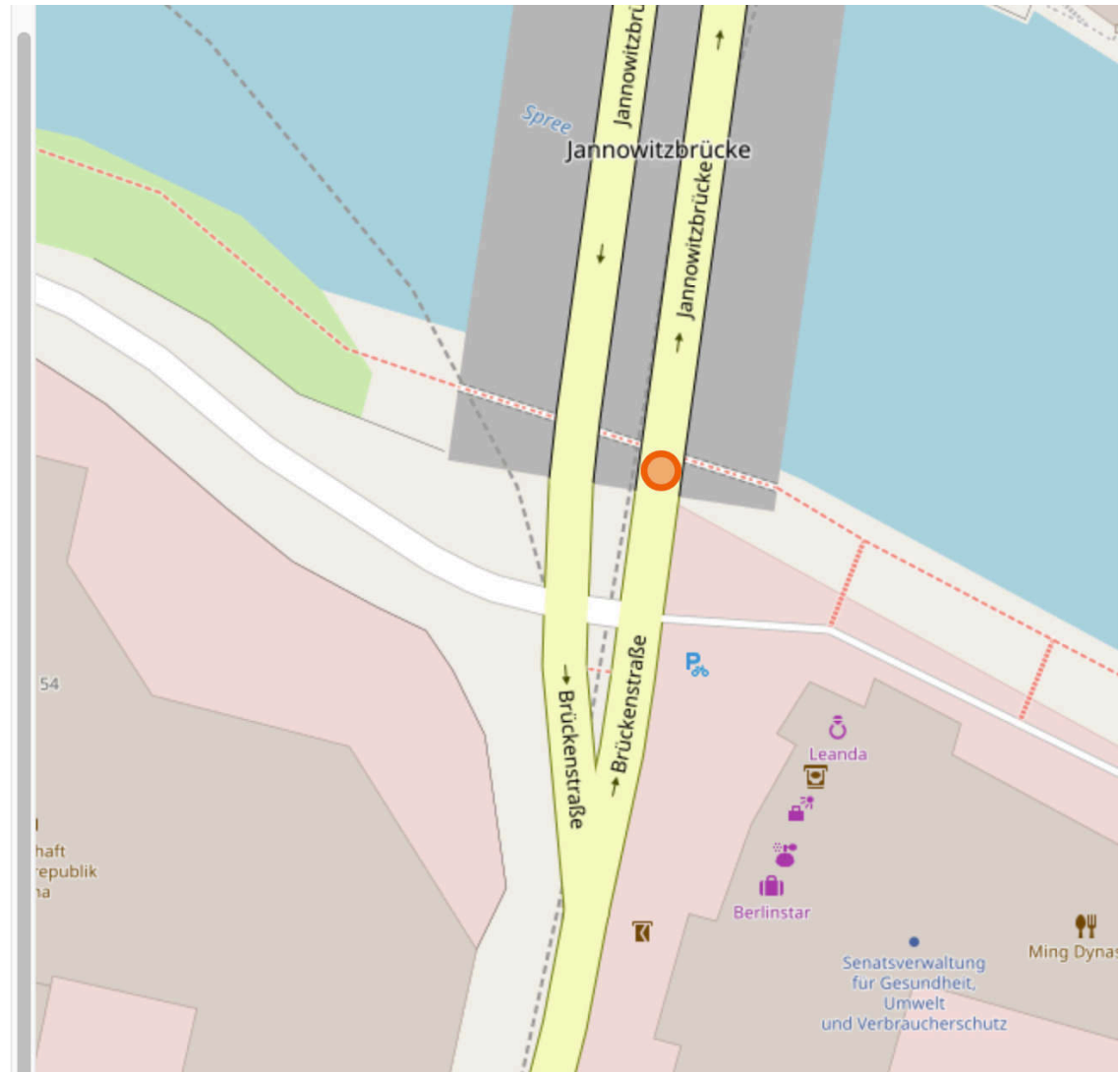


OTHER INFORMATION ON OSM

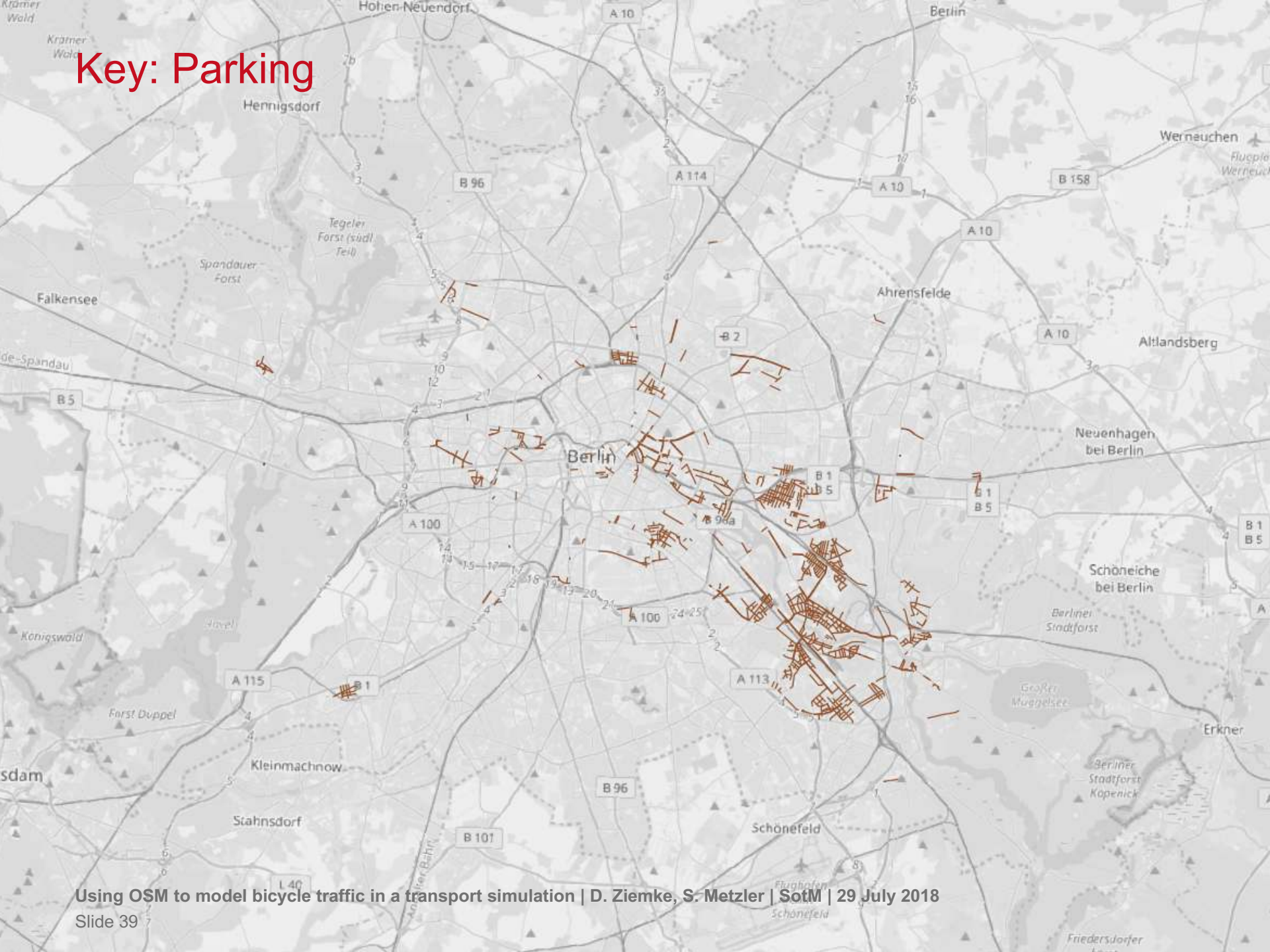
Monitoring Station

Tags

description	Kontaktschleife der Fahrradzählstelle
display	no
man_made	monitoring_station
monitoring:bicycle	yes
monitoring:traffic	yes
name	Zählstelle Jannowitzbrücke Richtung Alexanderplatz
operator	Senatsverwaltung für Stadtentwicklung Berlin
recording	yes
recording:automated	yes
website	http://www.stadtentwicklung.berlin.de/verkehr/lenkung/vlb/de/radzahlungen.shtml
website2	http://www.eco-public.com/public2/?id=102024661



Key: Parking



Conclusion

- OSM very useful resource for transport modeling
- Tagging system specific enough for high-resolution bicycle transport modeling
- Some cycling-relevant tags not so frequently used
- MATSim transport simulation is open source
 - Check out www.matsim.org and run a small bicycle example: www.matsim.org/extensions → Bicycle → RunBicycleExample

References

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 - Zilske, M., A. Neumann, K. Nagel, K. (2011). OpenStreetMap for traffic simulation. In M. Schmidt, M., G. Gartner. Proceedings of the 1st European State of the Map – OpenStreetMap conference, 11-10, 126–134, Vienna.
- Passing of vehicles
 - Agarwal A., M. Zilske, K.R. Rao, K. Nagel (2015). An Elegant and Computationally Efficient Approach for Heterogeneous Traffic Modelling Using Agent Based Simulation. Procedia Computer Science, 52, 962-967.
- Bicycle routing and scoring
 - Ziemke, D., S. Metzler und K. Nagel (2017) Modeling bicycle traffic in an agent-based transport simulation. Procedia Computer Science, 109, 923–928
 - Ziemke, D., S. Metzler und K. Nagel (2017) Bicycle traffic and its interaction with motorized traffic in an agent-based transport simulation framework. VSP WP 17-15
- Network creation based on OSM for lanes and signal
 - Thunig, T., K. Nagel (2018). Modeling traffic signals in an agent-based transport simulation based on OpenStreetMap data. Poster at SotM 2018

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