Network-based Mobility Analytics

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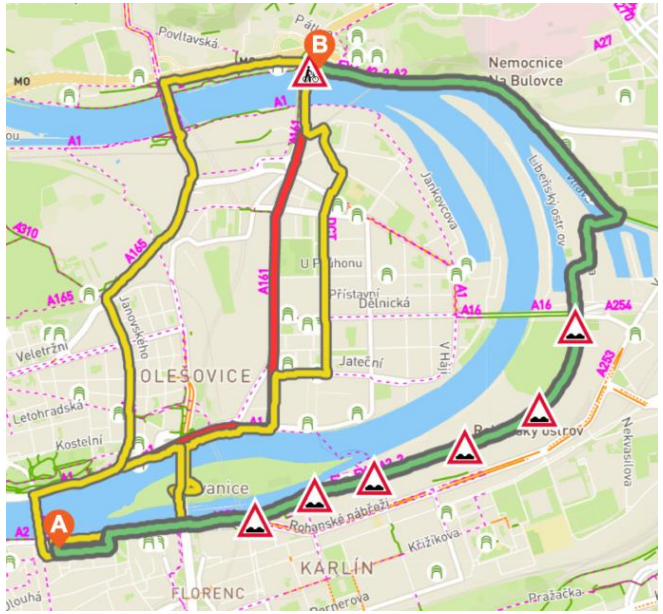
umotional.com

About **Umotional**

Technology company developing **AI-based solutions** for **sustainable mobility**

Data Analytics & Optimization

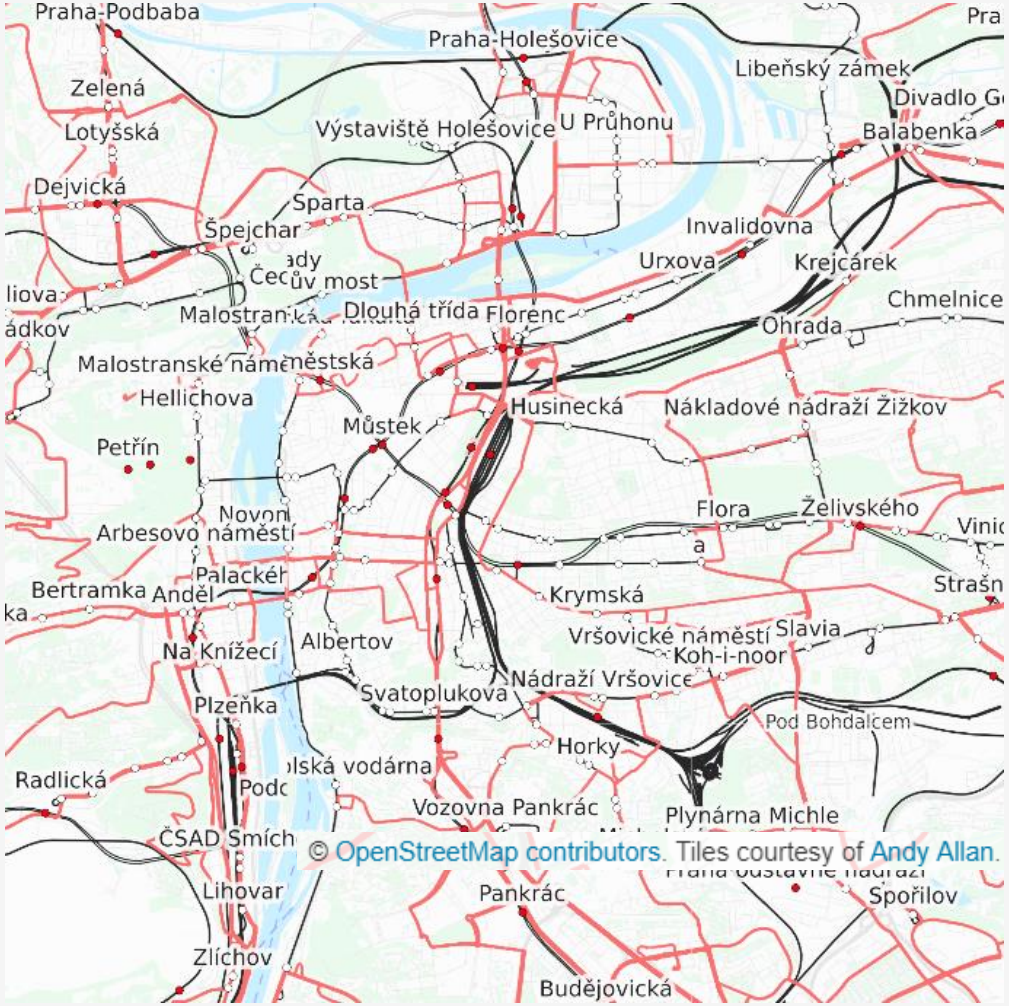
Routing & Navigation



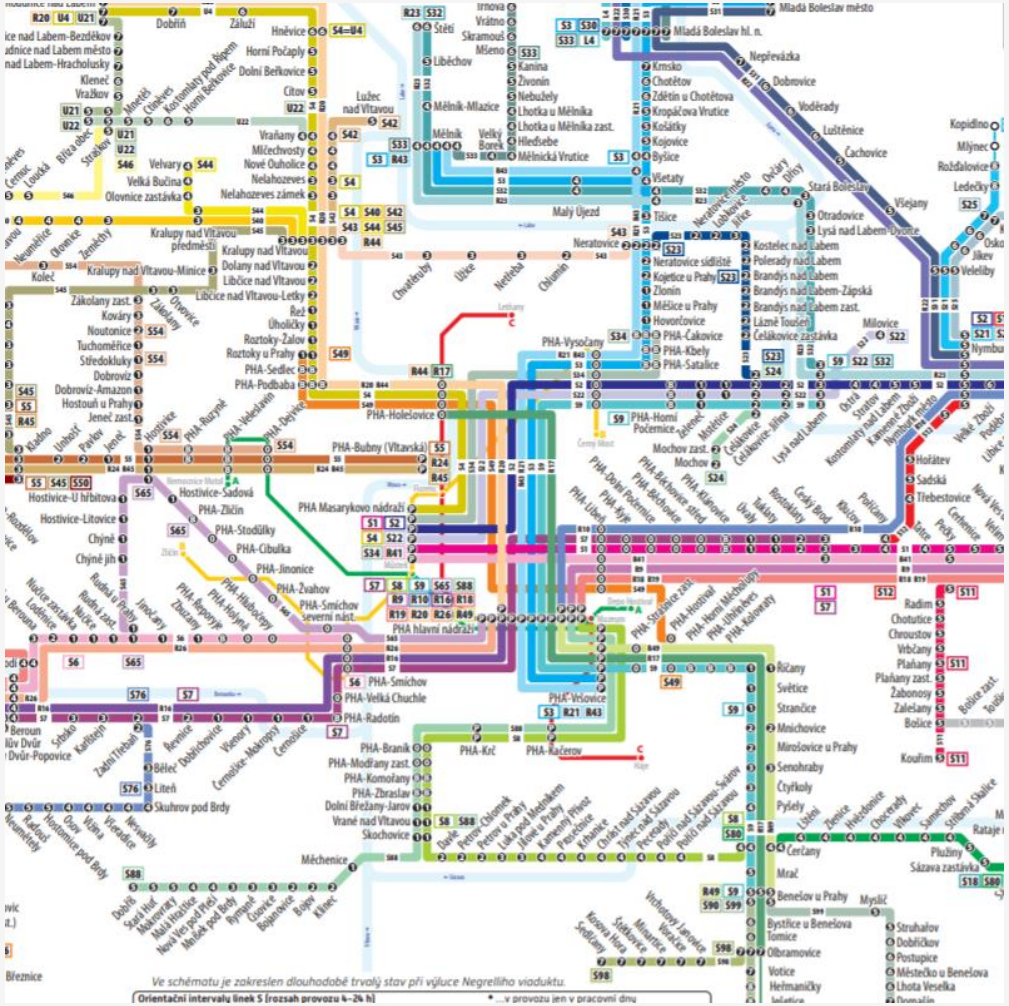
Apps & Tools

Let’s talk about Networks

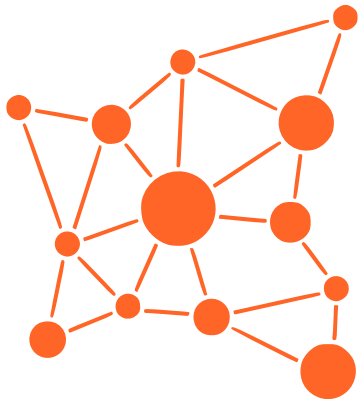
Mobility Happens on Networks



PHYSICAL/INFRASTRUCTURE networks



LOGICAL/SERVICE networks



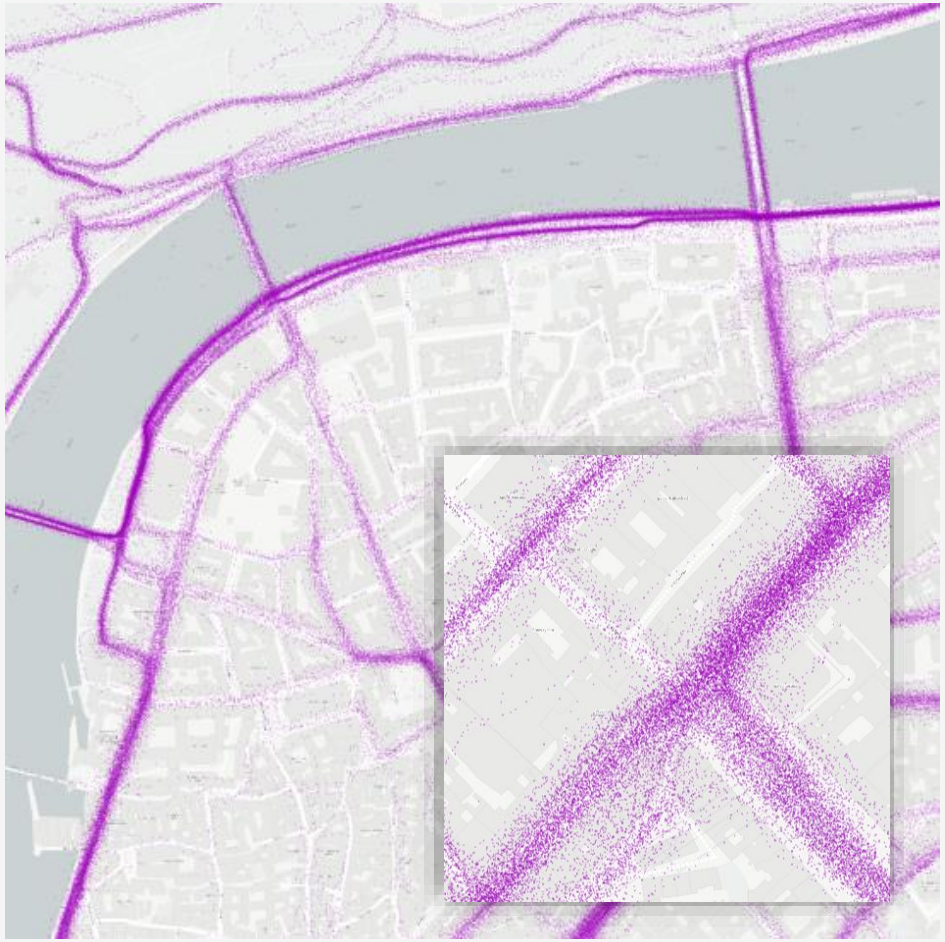
networks help

1 **UNDERSTAND**
mobility data

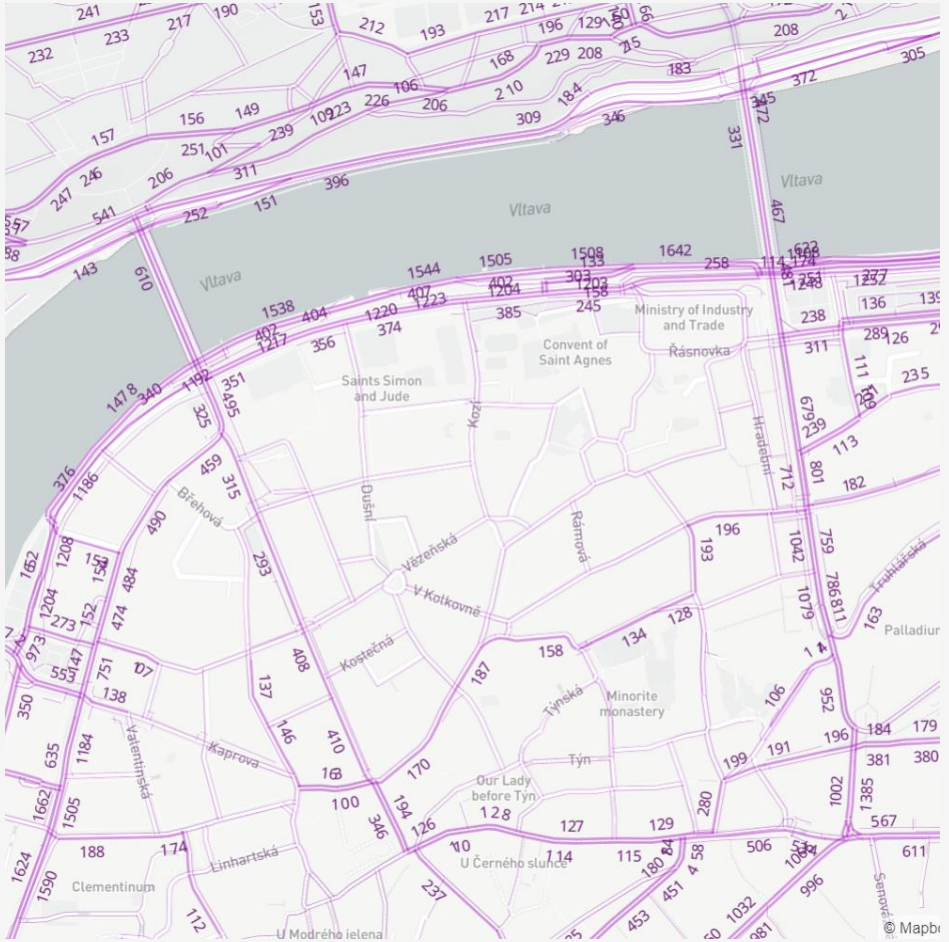
2 **STRUCTURE**
mobility data

Example Network-based Analysis

Noisy GPS points

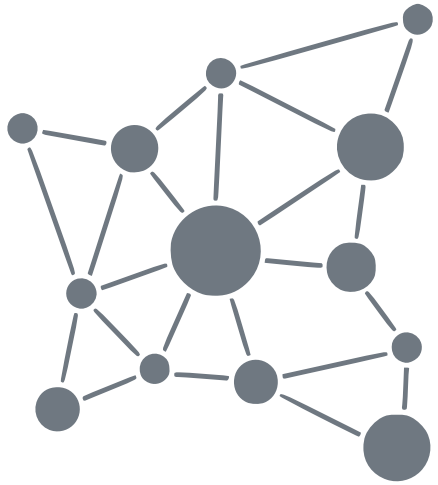


Trips on each street



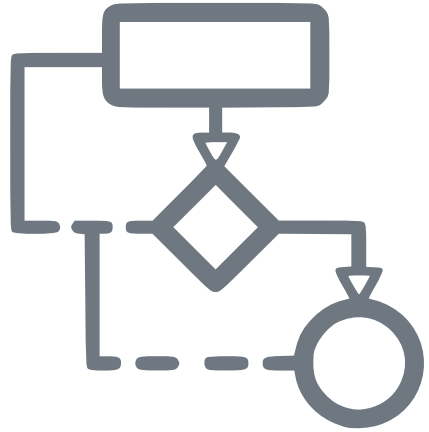
Network-based Mobility Analytics

Digitized transport **networks**



High-fidelity and computation-efficient

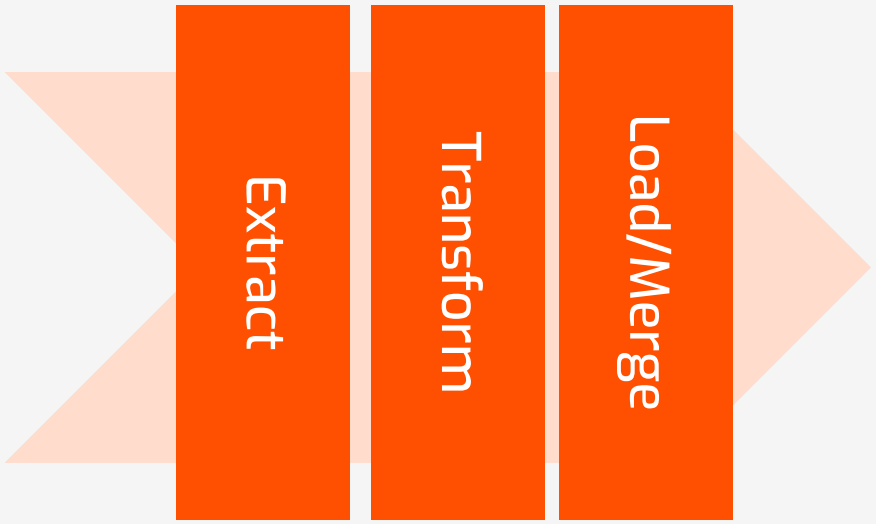
Network analytics **algorithms**



Fast and flexible

Building Digitized Transport Networks

Maps
Digital elevation
Speed profiles
EV charging stations
Timetables
Tariff structures
PT stops
Bike sharing stations
…



1 **Data**
(OSM, GTFS, JDF, DATEX, SIRI, …)

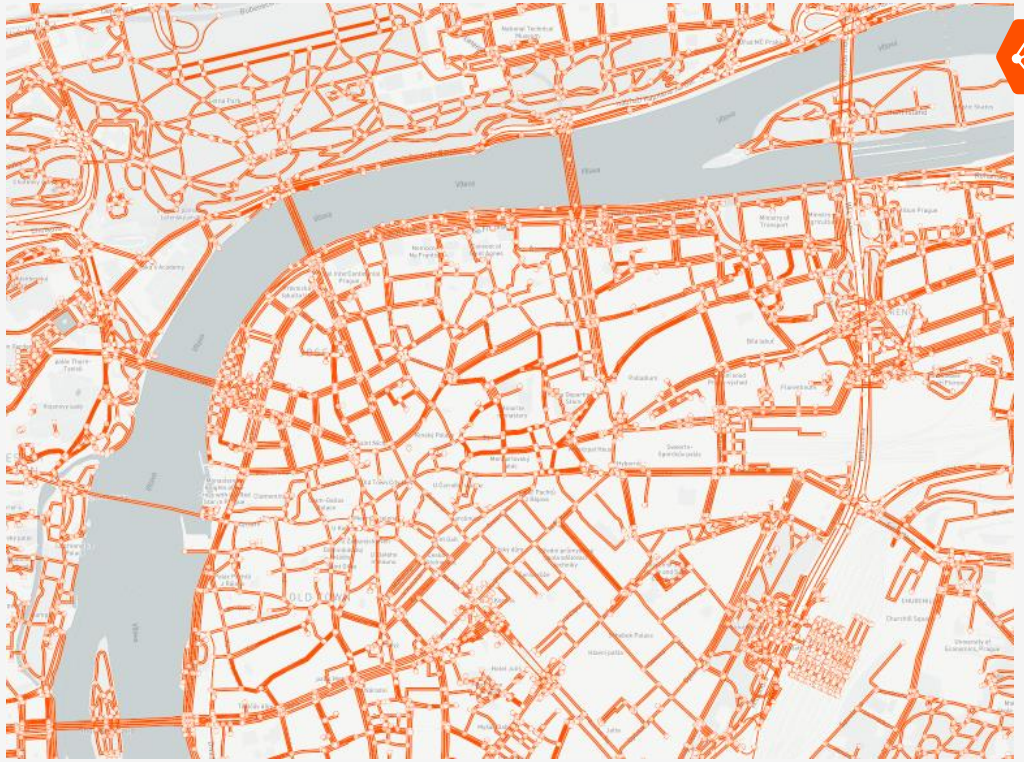
2 **Data importers**
(Java, Python, Osmosis, Pandas, PostGIS, Hadoop/Spark…)

3 **Computation-efficient network data structures**
(Java/JVM, PostGIS, …)

No end-to-end off-the self tools yet – custom analytics pipeline needed

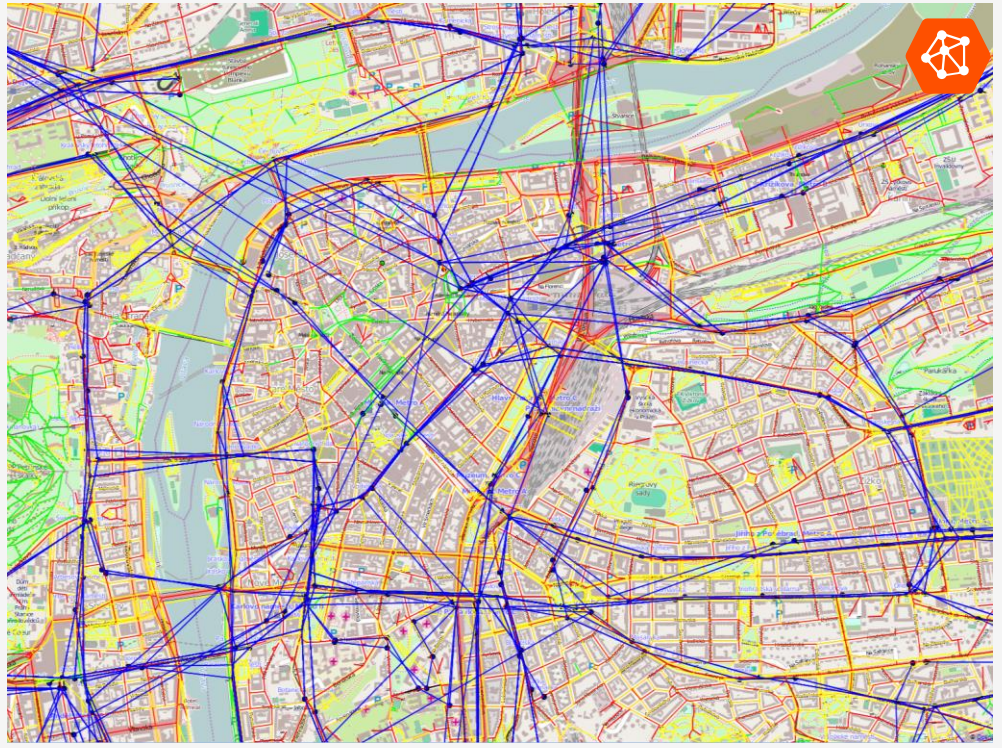
Example Transport Networks

OSM GPX SRTM TTF ...



Prague cycling network
(209k nodes, 564k edges)

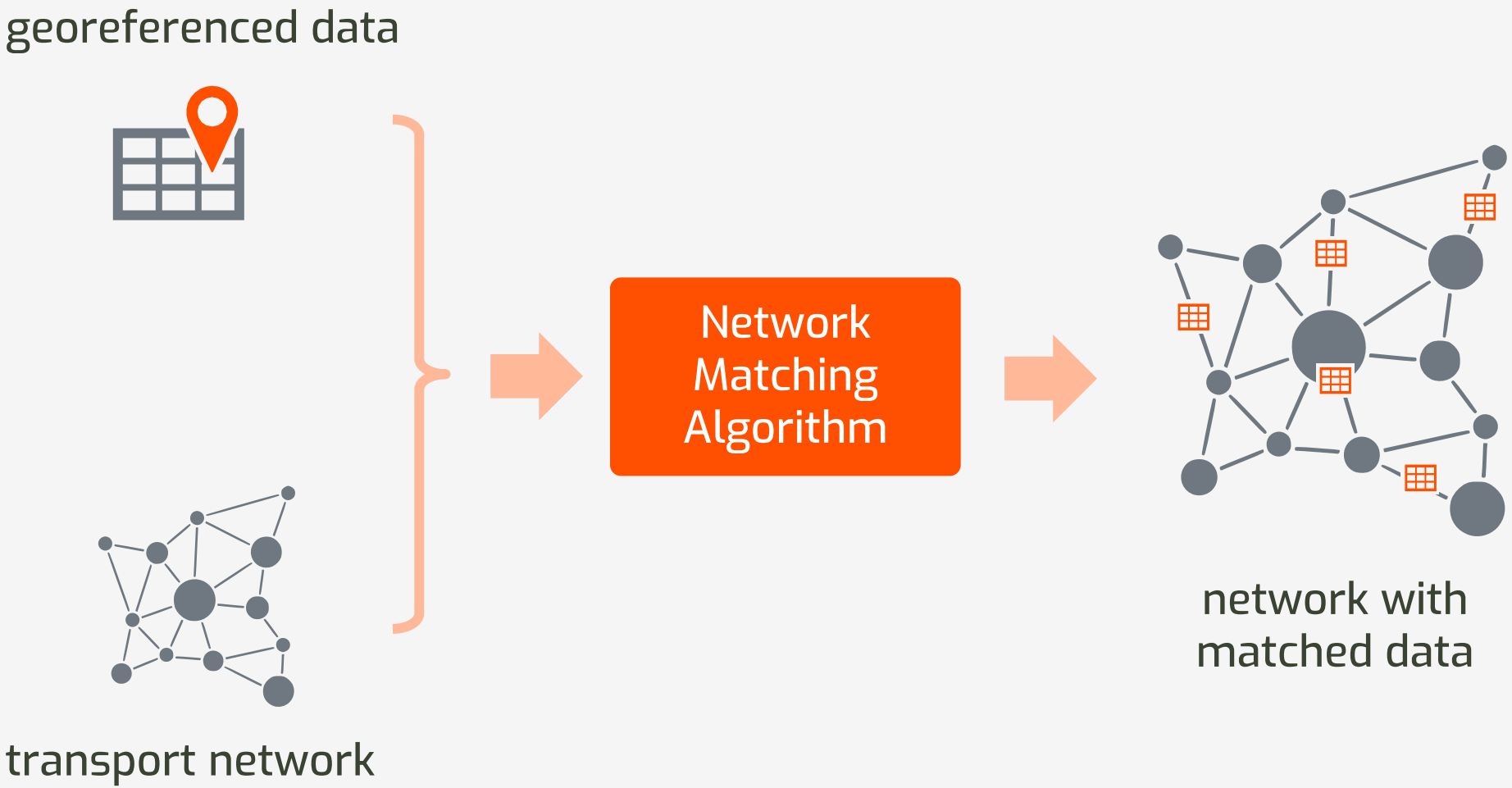
GTFS JDF OSM P+R GBFS ...



Prague intermodal transport network
(314k nodes, 674k edges)

Network-based Analytics Algorithms: **Network Matching**

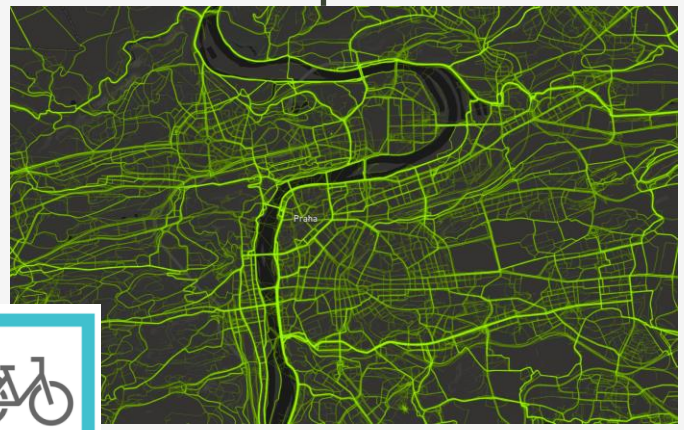
Network-Matching

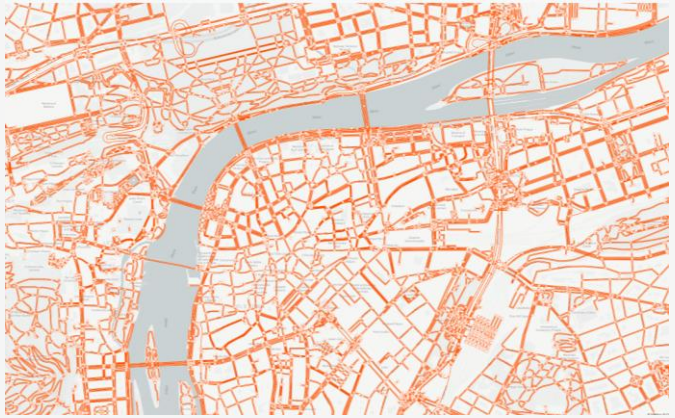


Cycling Intensities

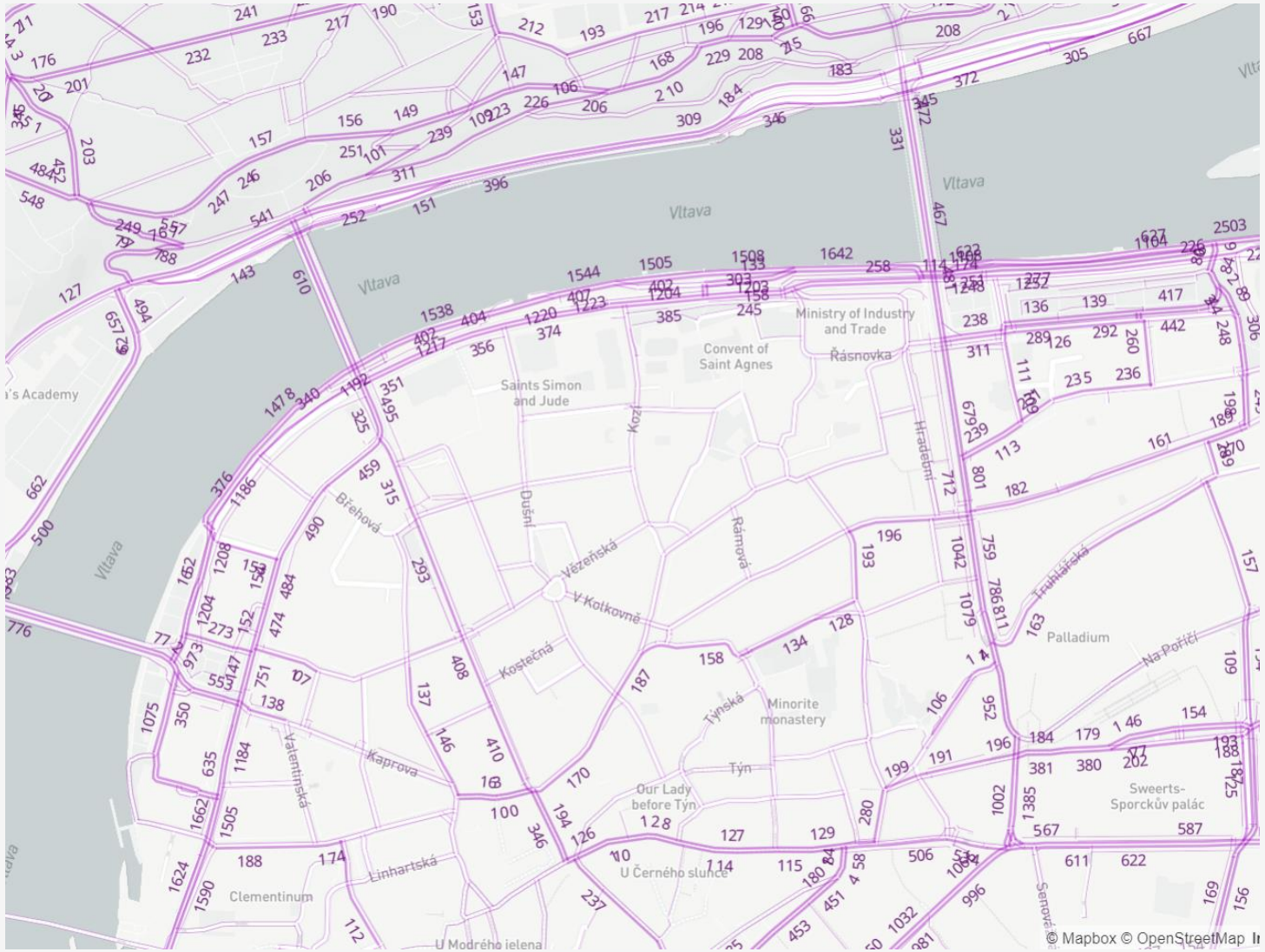
in collaboration with

100M+ GPS points





Prague cycling network

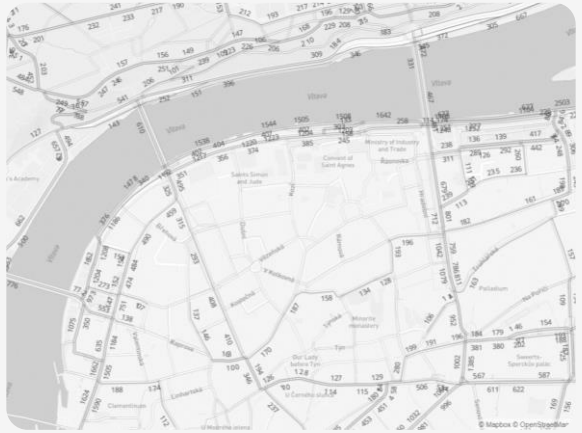


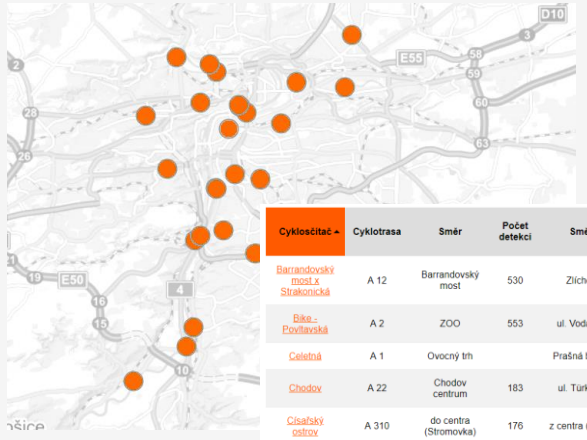
recorded trips per segment

Cycling Intensities

in collaboration with

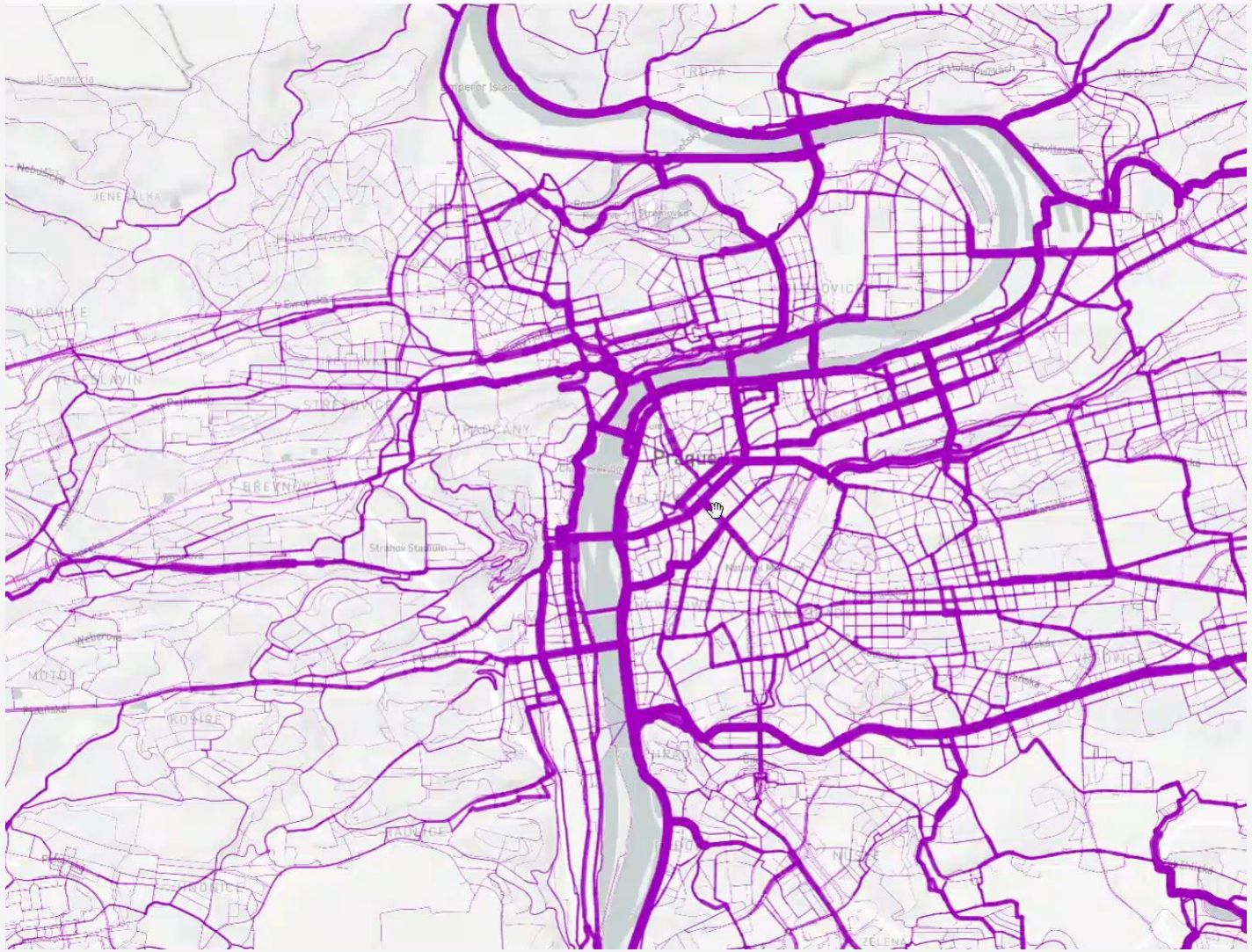
Rides per segment





Cyklosčítač	Cyklotrasa	Směr	Počet detekcí	Směr
Barrandovský most x Strakonická	A 12	Barrandovský most	530	Zlíchov
Bike - Povltavská	A 2	ZOO	553	ul. Vodácká
Celetná	A 1	Ovocný trh		Prašná brána
Chodov	A 22	Chodov centrum	183	ul. Türkova
Císařský ostrov	A 310	do centra (Stromovka)	176	z centra (Trója)

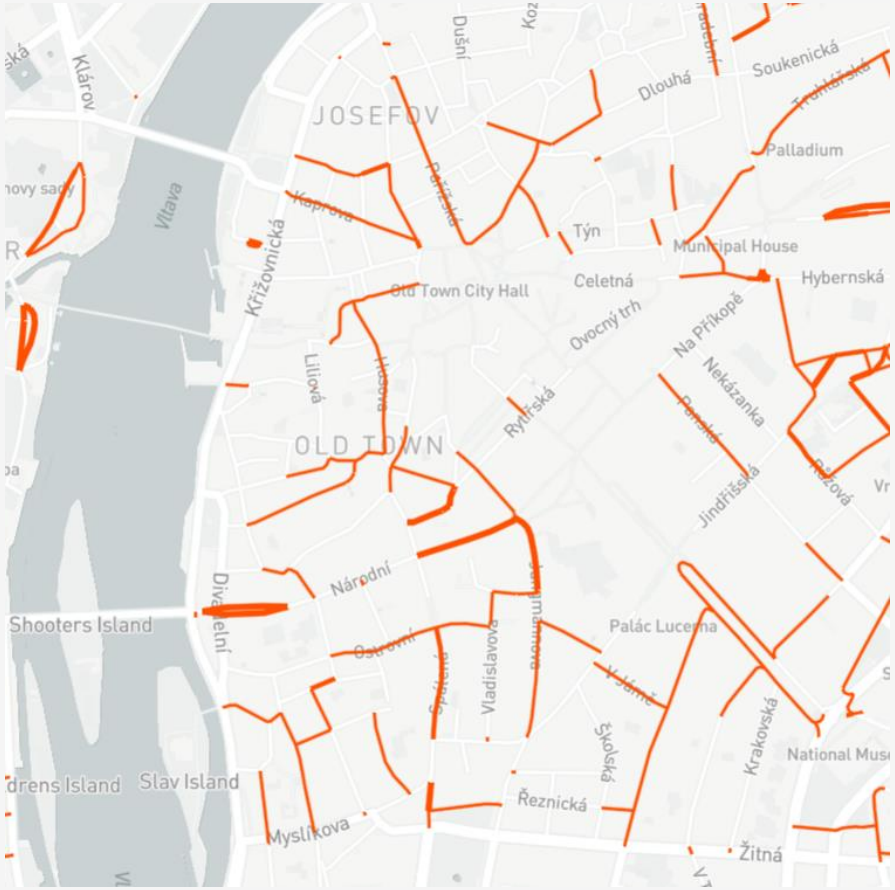
Data from 25 static bike counters



Estimated average daily rides

Cycling Contraflows Analysis

in collaboration with



Segments with recorded contraflows

Additional analysis and data

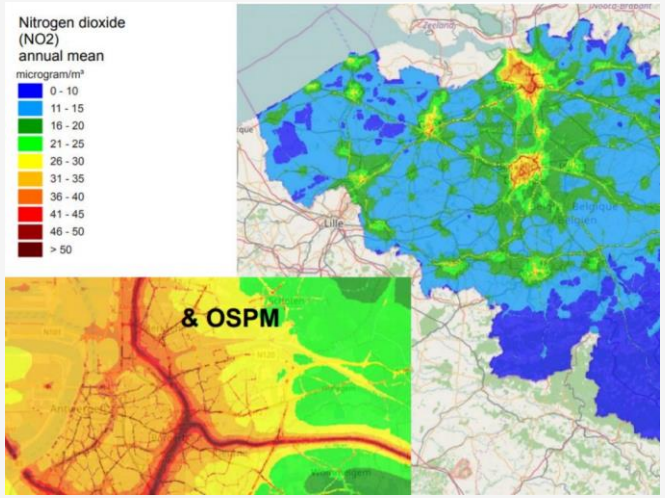
Foto: Dan Mourek

Proposed infrastructure changes

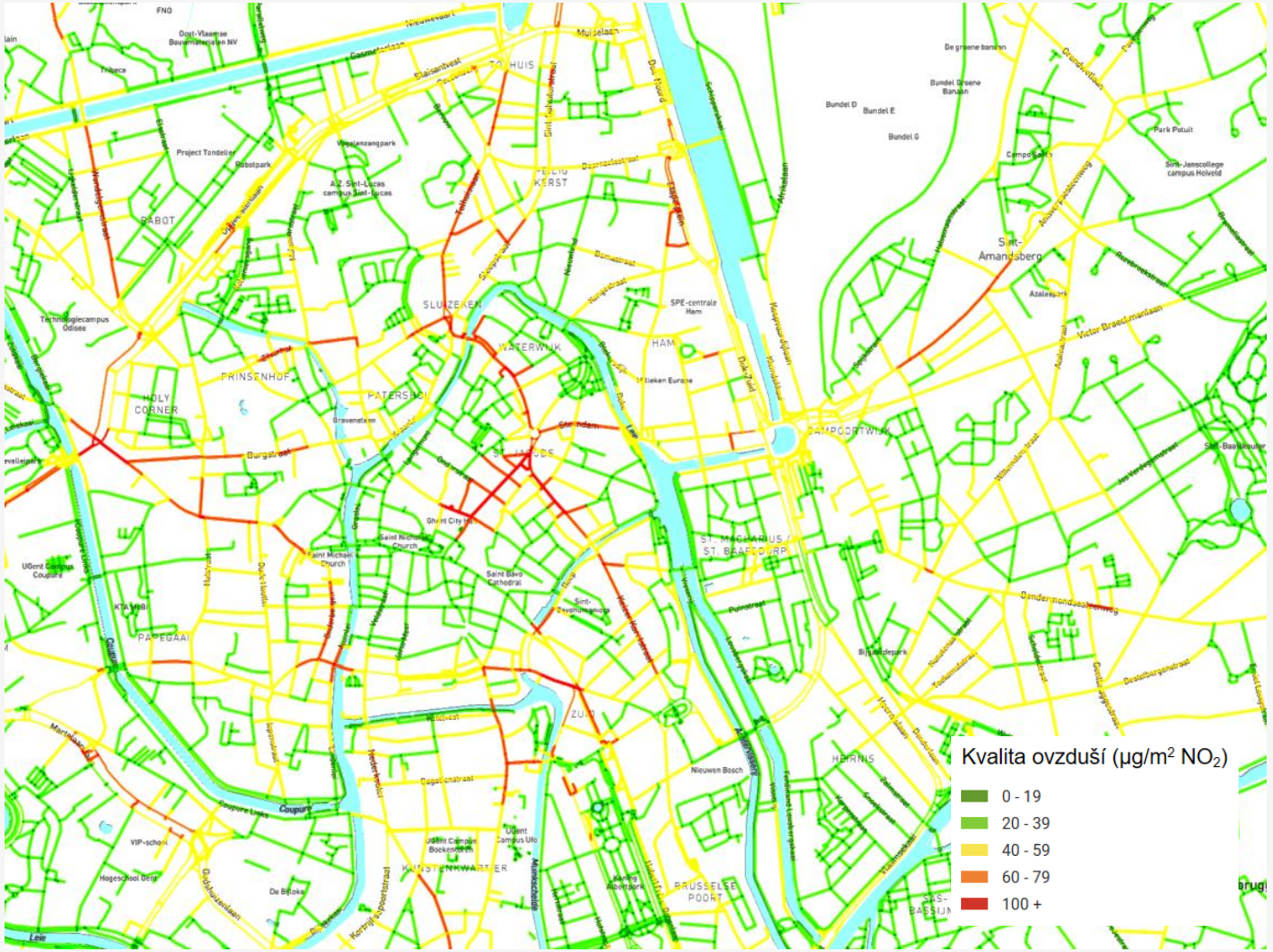
Air Quality Network Matching

In collaboration with irCELine

High-res pollution maps



Flanders foot/cyclepath network



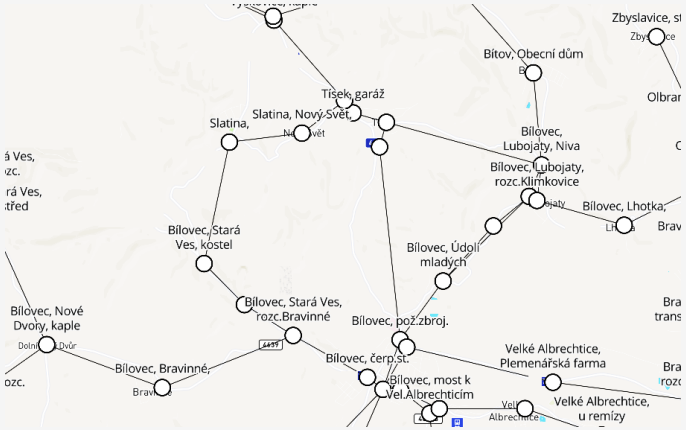
Flanders Flanders foot/cyclepath network
with pollutant concentrations

Public Transport Network Matching

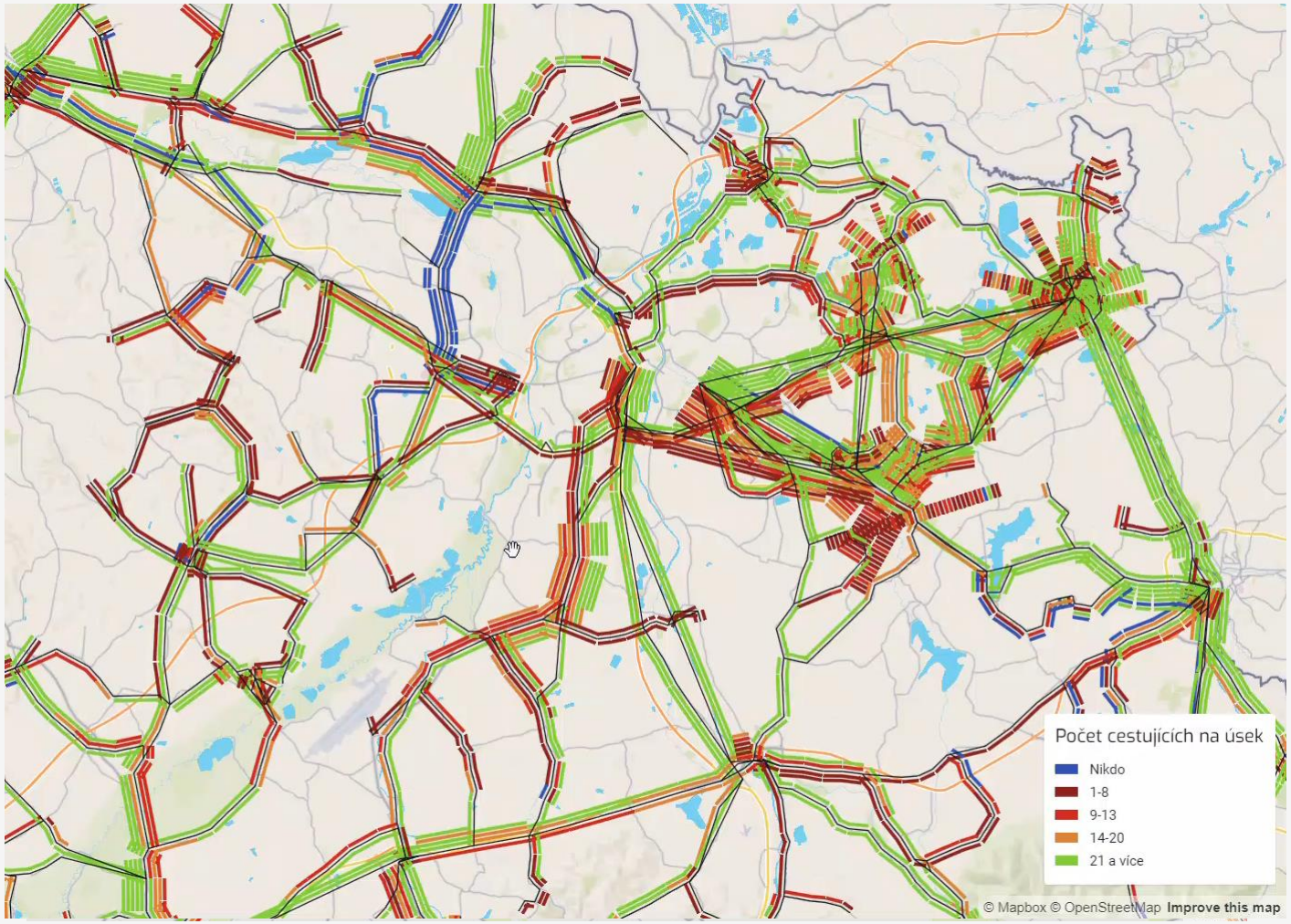
in collaboration with KODIS Koordinátor ODIS s.r.o.

Transaction data

linka	spo	nástupní zastávka	výstupní zastávka	čas nástupu	profil zákazníka
900231	40	Klimkovice,,hřbitov	Klimkovice,Josefovice,rozc.	15:05	dospělý 15+
862781	228	Mosty u Jablunkova,,Obecní úřad	Mosty u Jablunkova,,Lupinsk	20:44	dospělý 15+
900253	61	Opava,,Východní nádraží	Oldřišov,,U Kříže	16:22	dospělý 15+
862783	238	Jablunkov,,aut.st.	Třinec,,aut.st.	20:51	dospělý 15+
880644	211	Štramberk,,sídl.Bařiny	Štramberk,Libotín,koupaliště	8:03	senior nad 70 le
880644	312	Štramberk,Libotín,koupaliště	Štramberk,,sídl.Bařiny	10:44	senior nad 70 le
862783	202	Písečná,,škola	Třinec,,aut.st.	4:40	dospělý 15+
862783	227	Třinec,,aut.st.pod Kanadou	Jablunkov,,aut.st.	14:15	dospělý 15+
862783	229	Jablunkov,,aut.st.	Písečná,,škola	15:03	dospělý 15+
880697	218	Životice u N.Jičína,,obecní úřad	Nový Jičín,,Bezručova	12:32	senior nad 70 le
880665	223	Nový Jičín,,Bezručova	Životice u N.Jičína,,obecní úř	14:15	senior nad 70 le
862783	238	Třinec,Lyžbice,nám.T.G.Masaryka	Třinec,,aut.st.pod Kanadou	21:12	dospělý 15+
880621	208	Příbor,,Tatra	Nový Jičín,,SÚS	5:44	student 15-26
862783	226	Třinec,Lyžbice,nám.T.G.Masaryka	Třinec,,aut.st.pod Kanadou	13:19	dospělý 15+
862771	223	Třinec,,aut.st.pod Kanadou	Třinec,,aut.st.	22:15	dospělý 15+
900245	6	Hradec n.Moravicí,Žimrovice,res	Hradec n.Moravicí,,zámek	7:01	senior nad 70 le
885611	14	Studénka,,žel.st.	Studénka,,jesle	14:07	dospělý 15+
910675	232	Bítov,,Obecní dům	Bílovec,Lubojaty,rozc.Klimko	12:25	dospělý 15+
910672	232	Bílovec,Lubojaty,rozc.Klimkovice	Ostrava,Svinov,mosty dolní z	12:29	dospělý 15+
910671	335	Klimkovice,,centrum	Bítov,,Obecní dům	19:03	dospělý 15+



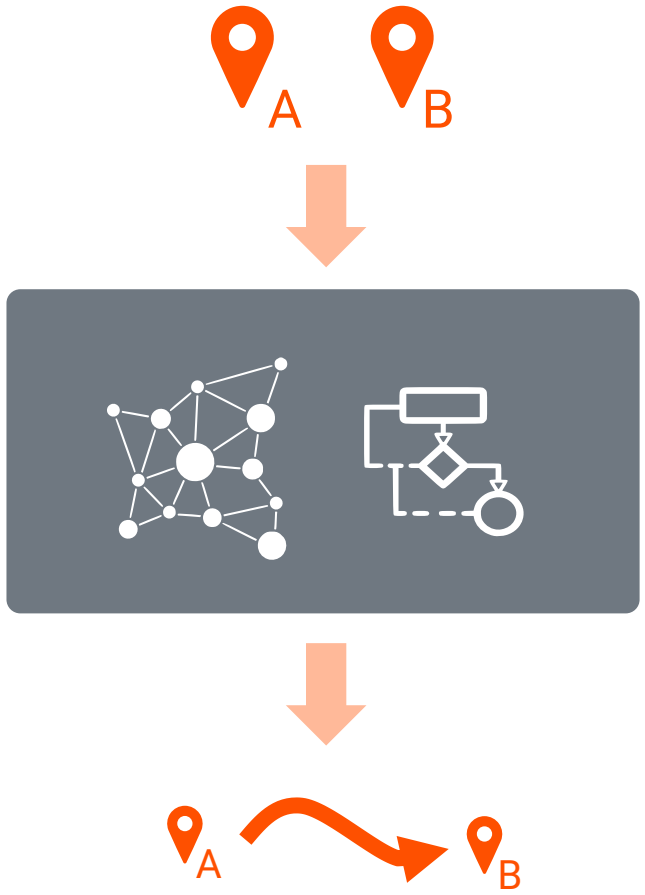
ODIS Public transport network

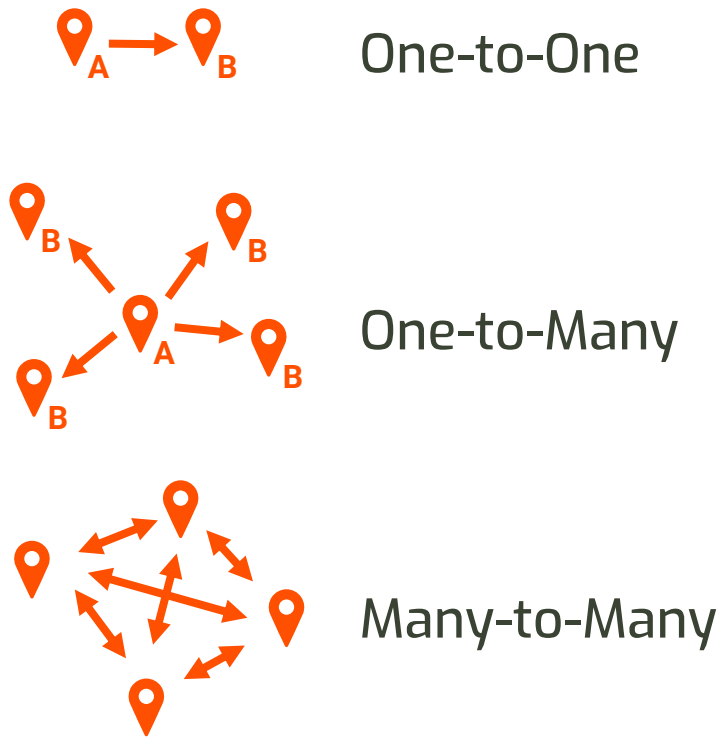


Ridership statistics
(per line segment and hours)

Network-based Analytics Algorithms: **Route Planning**

Route Planning





Travel Times to the City Center

in collaboration with

IPR PRAHA

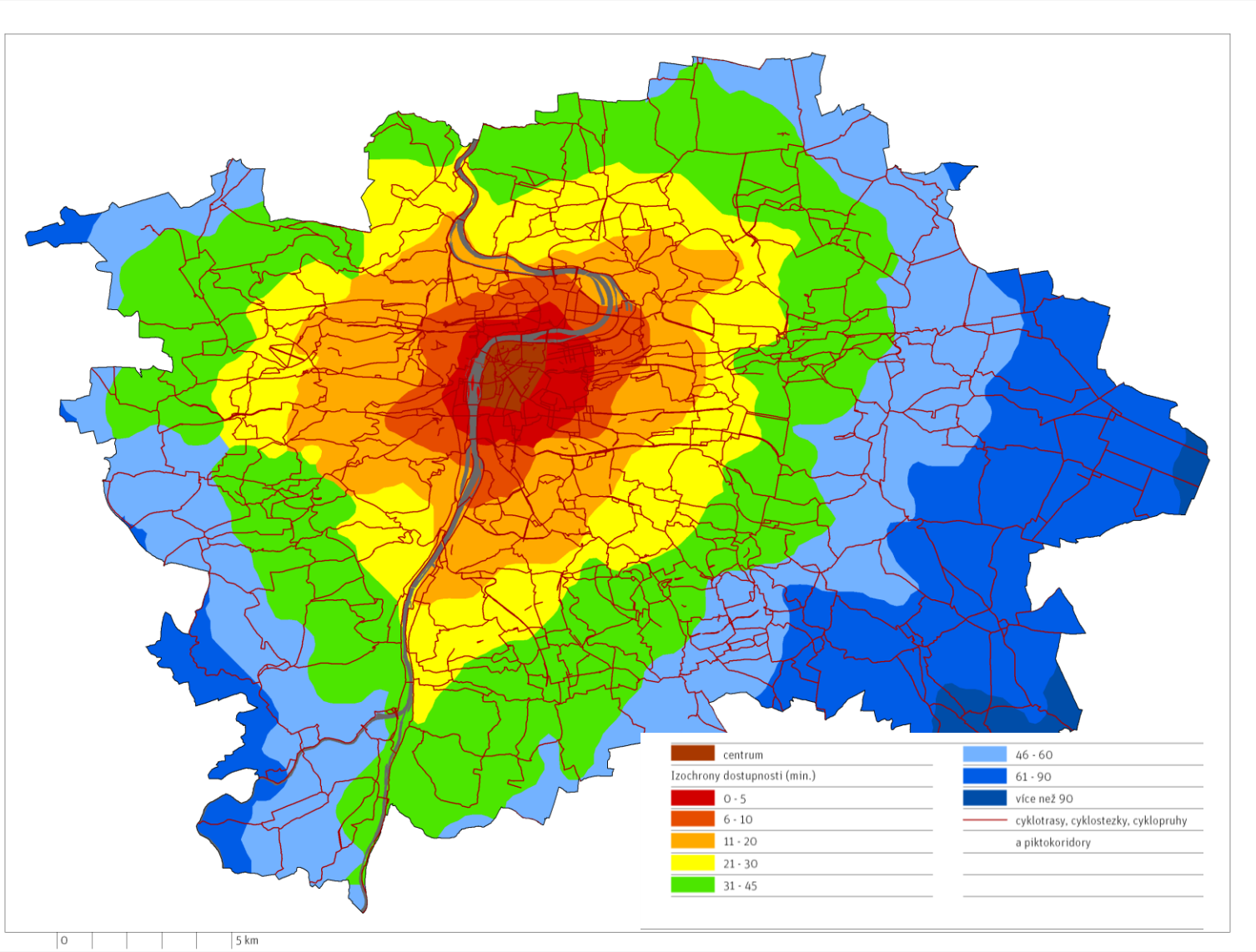
GPX tracks

+

Transport network

+

Routing algorithms

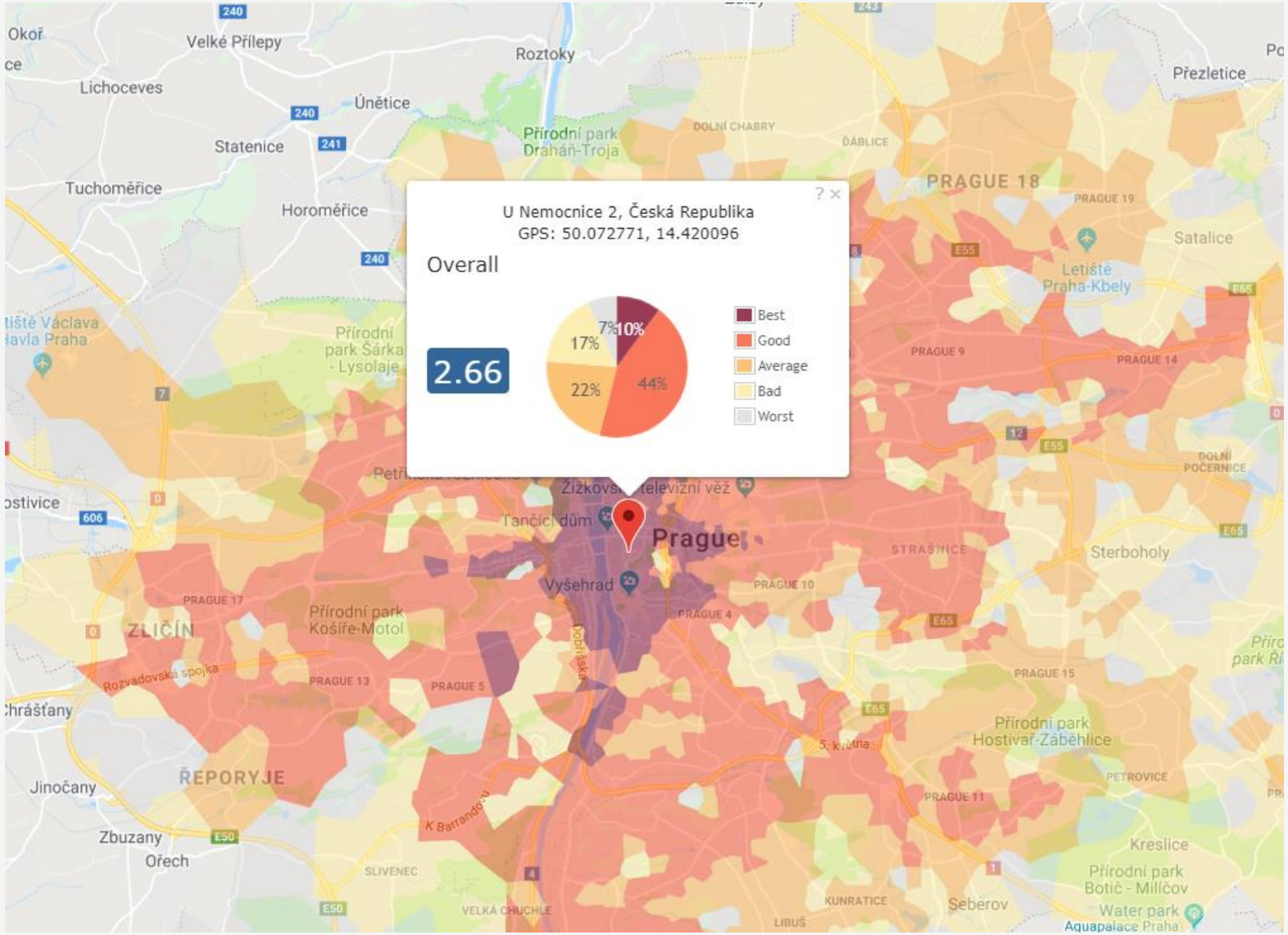


Public Transport **Coverage Analysis**

Multimodal network

+

Multimodal routing algorithms

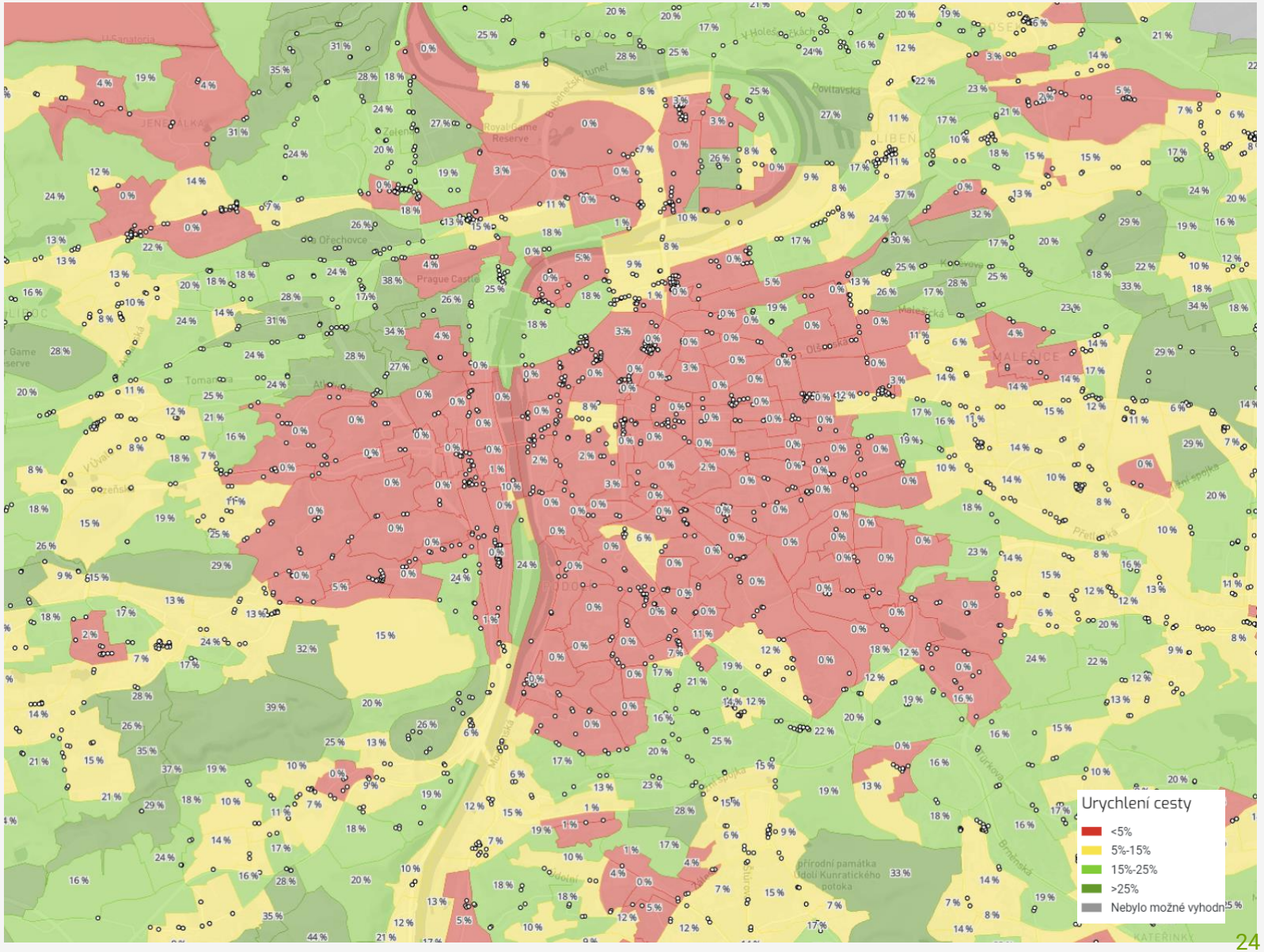


Analysis of B+R Potential (with train / metro / tram)

Intermodal network

+

Intermodal routing algorithms



Can also be used for analysing **P+R potential**

Street **Attraction Index**

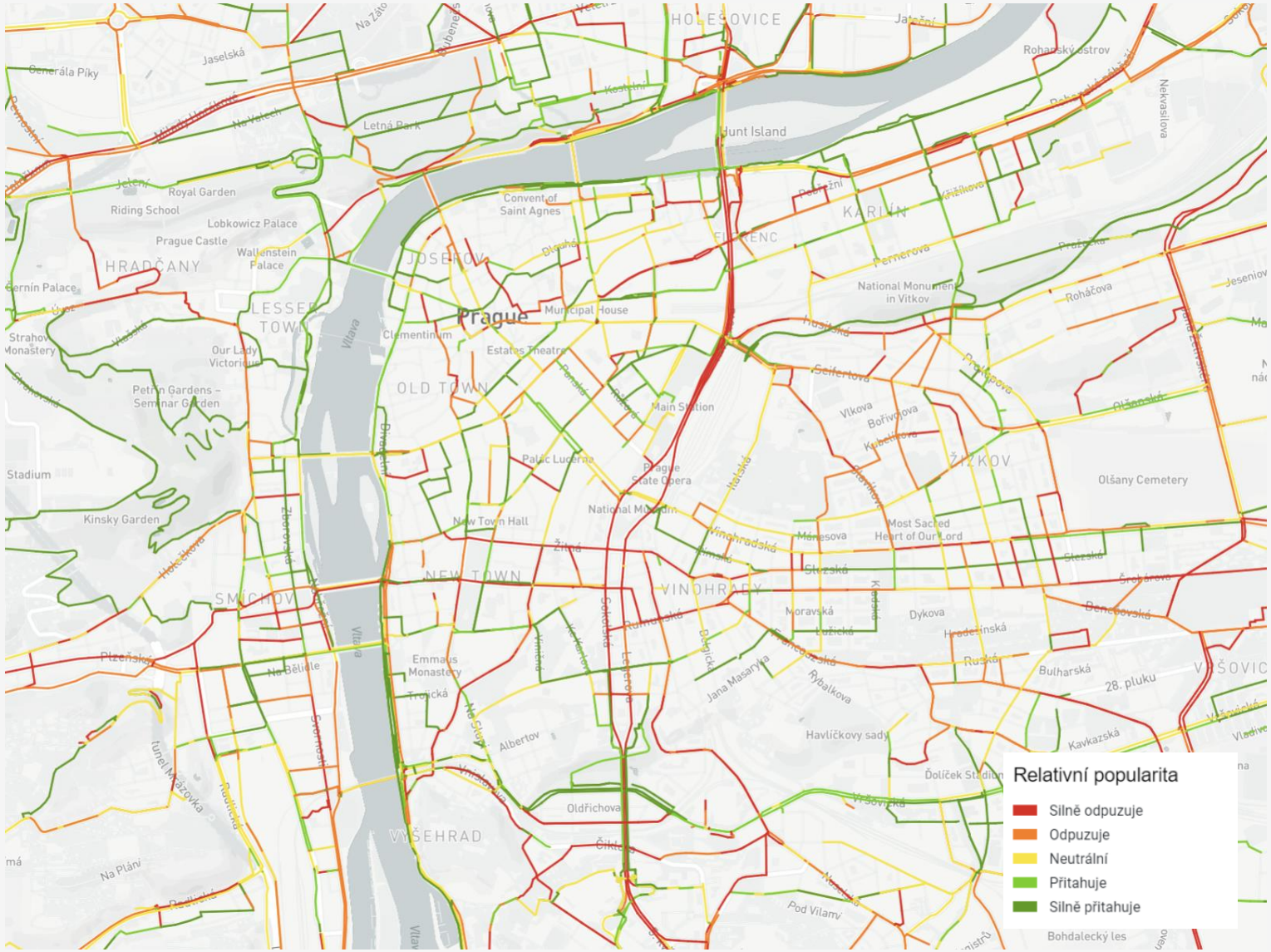
GPX tracks

+

Cycleway network

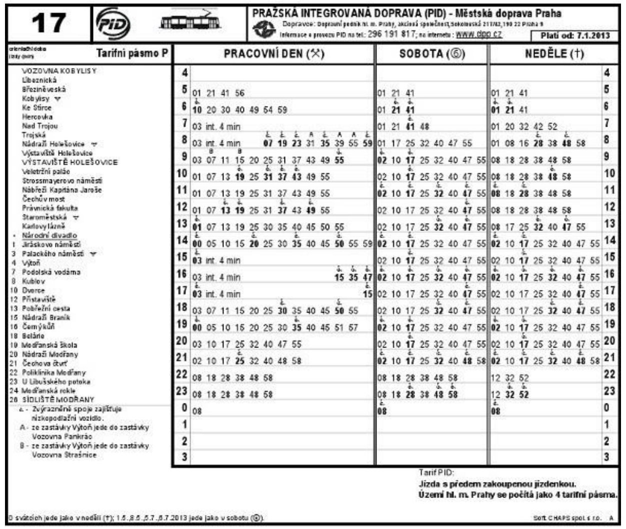
+

Cycle routing algorithms



Towards Data-Driven Mobility Optimization

Timetables



17 | PID | PRAŽSKÁ INTEGROVANÁ DOPRAVA (PID) - Městská doprava Praha

Dopravce: Dopravní podnik hl. m. Prahy, akciová společnost, Sokolovská 217/42, 190 22 Praha 9

Informace o provozu PID na tel.: 296 191 817; na internetu: www.dpp.cz

Platí od: 7.1.2013

Tarifní pásmo P

VOZOVNA KOBYLISY
Líbeznická
Březiněveská
Kobylisy
Ke Stírce
Hercovka
Nad Trojou
Trojská
Nádraží Holešovice
Výstaviště Holešovice
VÝSTAVIŠTĚ HOLEŠOVICE
Veletržní palác
Strossmayerovo náměstí
Nábřeží Kapitána Jaroše
Čechův most
Právnická fakulta
Staroměstská
Karlovy lázně
Národní divadlo
1 Jiráskovo náměstí
3 Palackého náměstí
4 Výtoň
7 Podolská vodárna
8 Kublov
10 Dvorce
12 Přístaviště
13 Pobřežní cesta
15 Nádraží Braník
16 Černý kůň
18 Belárie
19 Modřanská škola
20 Nádraží Modřany
21 Čechova čtvrť
22 Poliklinika Modřany
23 U Libušského potoka
24 Modřanská rokle
26 SÍDLIŠTĚ MODŘANY

	PRACOVNÍ DEN (⚒)	SOBOTA (⑥)	NEDĚLE (†)	
4				4
5	01 21 41 56	01 21 41	01 21 41	5
6	10 20 30 40 49 54 59	01 21 41	01 21 41	6
7	03 int. 4 min	01 21 41 48	01 20 32 42 52	7
8	03 int. 4 min 07 19 23 31 35 39 55 59	01 17 25 32 40 47 55	01 08 16 28 38 48 58	8
9	03 07 11 15 20 25 31 37 43 49 55	02 10 17 25 32 40 47 55	08 18 28 38 48 58	9
10	01 07 13 19 25 31 37 43 49 55	02 10 17 25 32 40 47 55	08 18 28 38 48 58	10
11	01 07 13 19 25 31 37 43 49 55	02 10 17 25 32 40 47 55	08 18 28 38 48 58	11
12	01 07 13 19 25 31 37 43 49 55	02 10 17 25 32 40 47 55	08 18 28 38 48 58	12
13	01 07 13 19 25 30 35 40 45 50 55	02 10 17 25 32 40 47 55	08 17 25 32 40 47 55	13
14	00 05 10 15 20 25 30 35 40 45 50 55 59	02 10 17 25 32 40 47 55	02 10 17 25 32 40 47 55	14
15	03 int. 4 min	02 10 17 25 32 40 47 55	02 10 17 25 32 40 47 55	15
16	03 int. 4 min 15 35 47	02 10 17 25 32 40 47 55	02 10 17 25 32 40 47 55	16
17	03 int. 4 min 15	02 10 17 25 32 40 47 55	02 10 17 25 32 40 47 55	17
18	03 07 11 15 20 25 30 35 40 45 50 55	02 10 17 25 32 40 47 55	02 10 17 25 32 40 47 55	18
19	00 05 10 15 20 25 30 35 40 45 51 57	02 10 17 25 32 40 47 55	02 10 17 25 32 40 47 55	19
20	03 10 17 25 32 40 47 55	02 10 17 25 32 40 47 55	02 10 17 25 32 40 47 55	20
21	02 10 17 25 32 40 48 58	02 10 17 25 32 40 48 58	02 10 17 25 32 40 48 58	21
22	08 18 28 38 48 58	08 18 28 38 48 58	12 32 52	22
23	08 18 28 38 48 58	08 18 28 38 48 58	12 32 52	23
0	08	08	08	0
1				1
2				2
3				3

♿ - Zvýrazněné spoje zajišťuje nízkopodlažní vozidlo.
A - ze zastávky Výtoň jede do zastávky Vozovna Pankrác
B - ze zastávky Výtoň jede do zastávky Vozovna Strašnice

Tarif PID:
Jízda s předem zakoupenou jízdenkou.
Území hl. m. Prahy se počítá jako 4 tarifní pásma.

O svátcích jede jako v neděli (†); 1.5.,8.5.,5.7.,6.7.2013 jede jako v sobotu (⑥).

Soft CHAPS spol. s r.o. A

Cyclepath networks

Charging station placement

Trněný Újezd 39, Středočeský

U Elektry 831/2c, Vysocany, Pr

10:00 | Options | Search

✔ Train ✔ Subway ✔ Tram ✔ Bus ✔ Taxi

✔ Bike ✔ Shared bike ✔ Car

✔ Less walk ✔ Average walk ✔ Lots of walk

✔ Cheap $ ✔ Average $$ ✔ Expensive $$$

Previous

INTERMODAL

11:06 - 12:53 — 4.39 €
S7 · B — 1 h 47 min
217 discomfort, 1085 cal, 6.1km active

10:00 - 11:16 — 7 €
B · 8 — 1 h 16 min
151 discomfort, 217 cal, 0.5km active

10:15 - 11:31 — **8 €**
B — **1 h 16 min**
188 discomfort, 589 cal, 3.2km active

10:05 - 11:21 — 8.16 €
B · S1 — 1 h 16 min
174 discomfort, 492 cal, 2.7km active

10:05 - 11:23 — 7 €

10:15 - 11:31
8 € **1 h 16 min**
188 discomfort, 589 cal, 3.2km active

10:15 A Trněný Újezd 39, Středočeský kraj
16 free slots in P+R Zličín 2

Car
21 min

10:36 **P+R Zličín 2**

Walk
2 min , 0.13 km

10:38 **Zličín**

on time
Subway B
33 min (19 stops)

11:11 **Vysočanská**

Walk
3 min , 0.19 km

11:14 **Shared bike (Čupakabra)**
50.1101, 14.5007

Shared bike Rekola
17 min, 2.83 km

11:31 B U Elektry 831/2c, Vysocany, Praha

Wrap-Up

1. **Networks** should be a **core** element of a **MaaS data stack**
2. **Networks enable deeper** mobility analytics **results**
3. Technology and expertise is **ready—time to do it**!

Thank you!

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umotional.com/analytics