

Pictures at a (Rail Transport) Exhibition

"...it looks like some kind of
monster that sits on London..."



Pictures at a (Rail Transport) Exhibition

In 2023 UK Office of Road and Rail published a new dataset that allows anyone to explore almost 1 billion journeys from every one of its more than 2,580 train stations in Great Britain, and updated this to include all journeys from 2018 to 2023

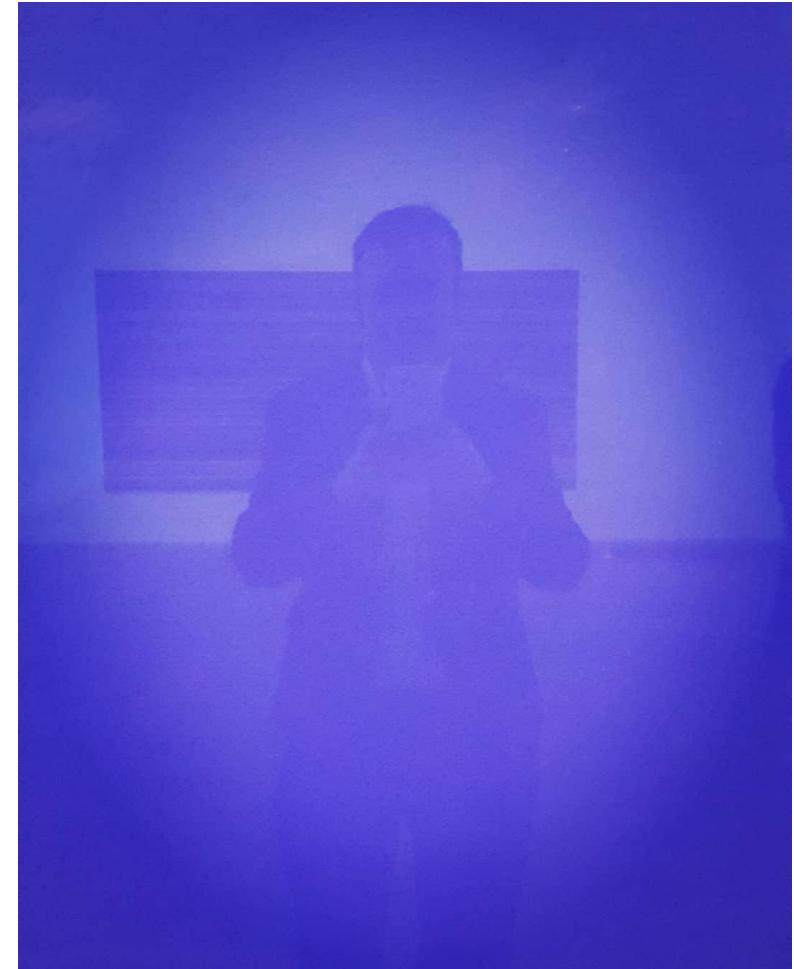
This talk looks at using this data along with other open datasets to host a visualisation for each station, and an aggregated view of rail travel in Britain, also known as the 'monster over London'



Introduction



Leeds
Digital
Festival
2024



Will Deakin

With 25-years of being paid to work with technology, by day I am the Network Rail Trains Portfolio Architect and European Infrastructure Manager speaker at the European Agency for Railways data assurance board

At night I use data science™ to think about things like where people go on trains

**@wnd@fosstodon.org
X/Twitter @WillDeakin1**



You may also know me from...



LEEDS DIGITAL FESTIVAL | 2022



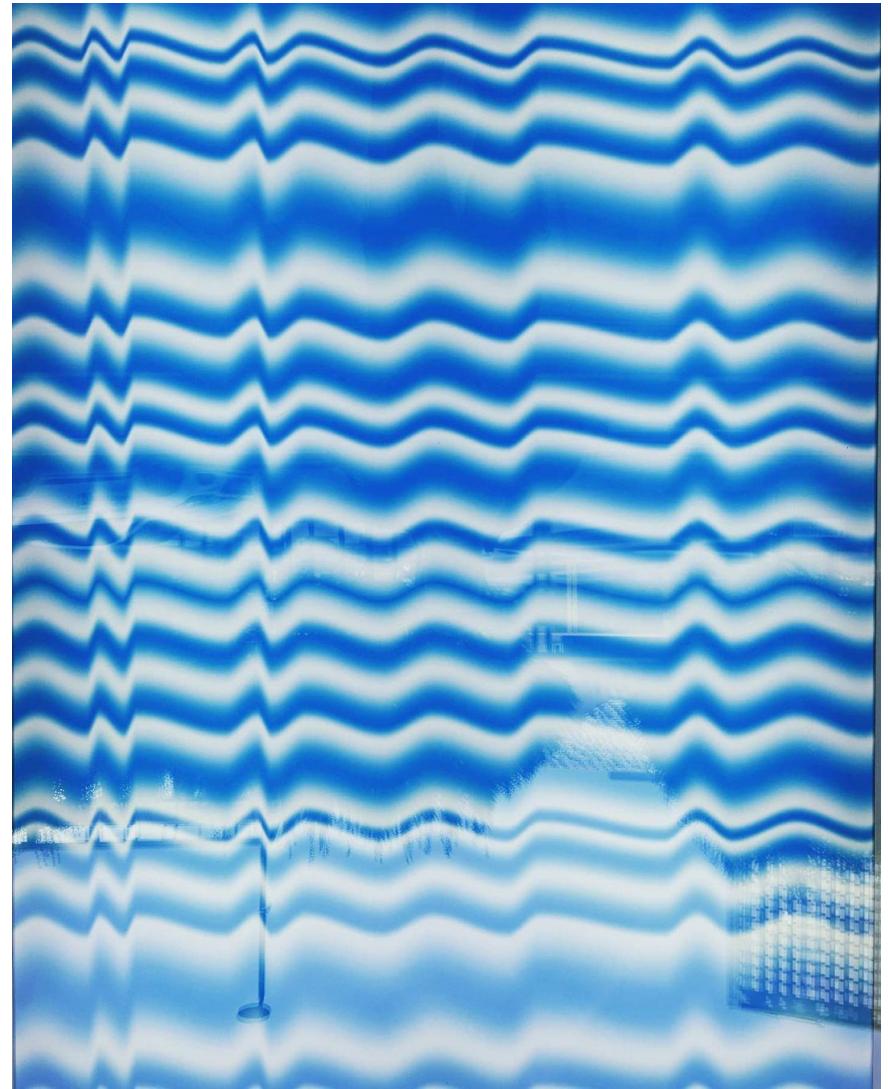
Leeds Digital
Festival 2023

COM3523
Software Re-engineering

INF4000 Data
Visualisation

TRAN5340M
Transport Data Science

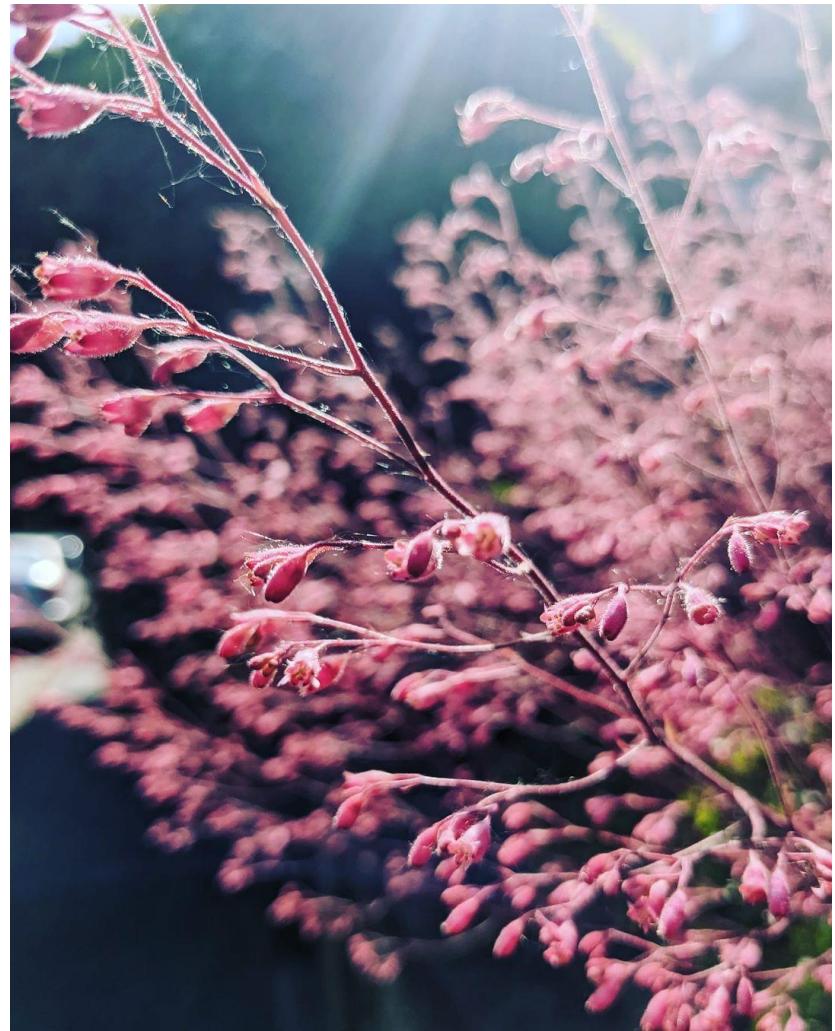
INF4001 Information
Visualisation for Decision
Making



Where did it
all begin?



Background



Background

“Over a weekend Deakin collected several [open datasets](#) about travel on the national rail network and combined them into a series of some 2,500 maps, one for every rail station, depicting 894 million journeys. The width of each line shows the frequency of travel between two points. So the result shows a rough approximation of how millions of people used the country’s near 10,000 miles (16,000 kilometers) of track in the 2021-2022 financial year.”



Parasocial Activities



The Big Boys Made Me Do It!

Social Media Inspired projects

The National Electronic Sectional Appendix (NESA) PDF loading-gauge tables [into a spreadsheet](#)

30GB of Microsoft inferred CSV road location data to a map

Let me tell you about this [spherical cow](#).

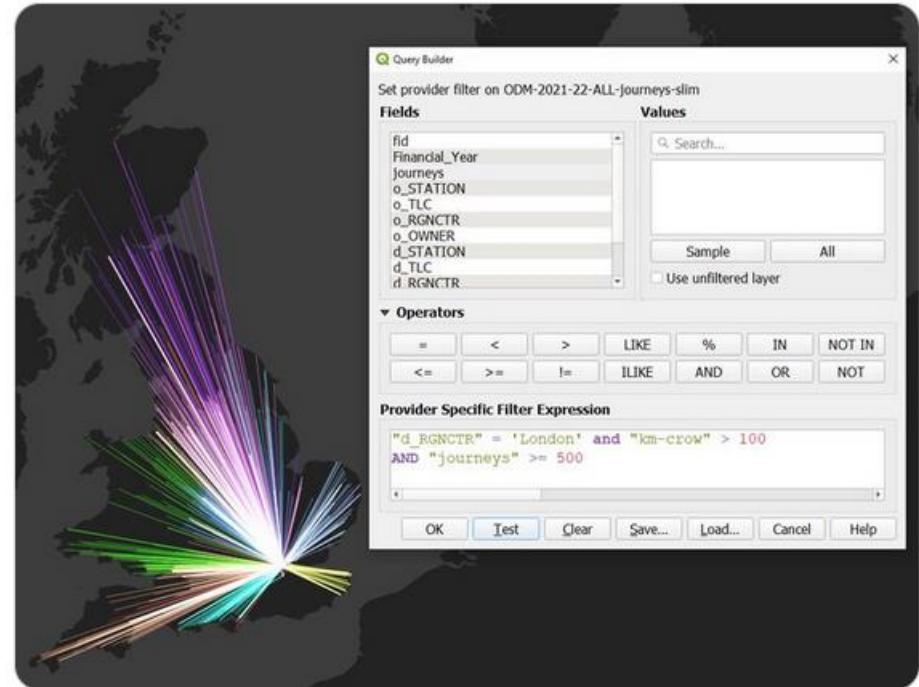


Alasdair Rae
@undertheraedar

...

The new origin-destination rail dataset is really very interesting and if you want a mappable version you can grab the file I put together here (longer journeys to London stations in this example, coloured by station owner)

automaticknowledge.org/flowdata/



2:19 PM · Dec 8, 2023 · 9,985 Views



4



9



54



29



Parasocial Activities II

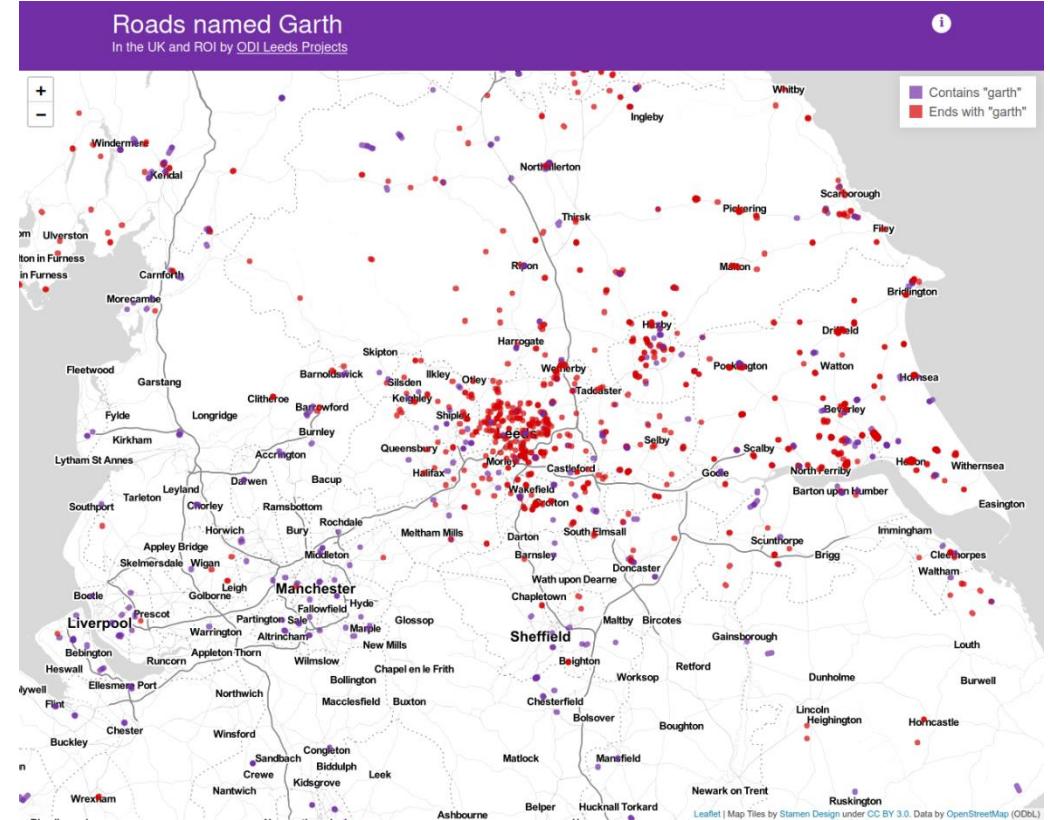


The Garthiness of Leeds

'It turns out **Leeds** is a bit of a **Garth** hotspot and their distribution generally correlates with regions settled by the Vikings around 1000 years ago.

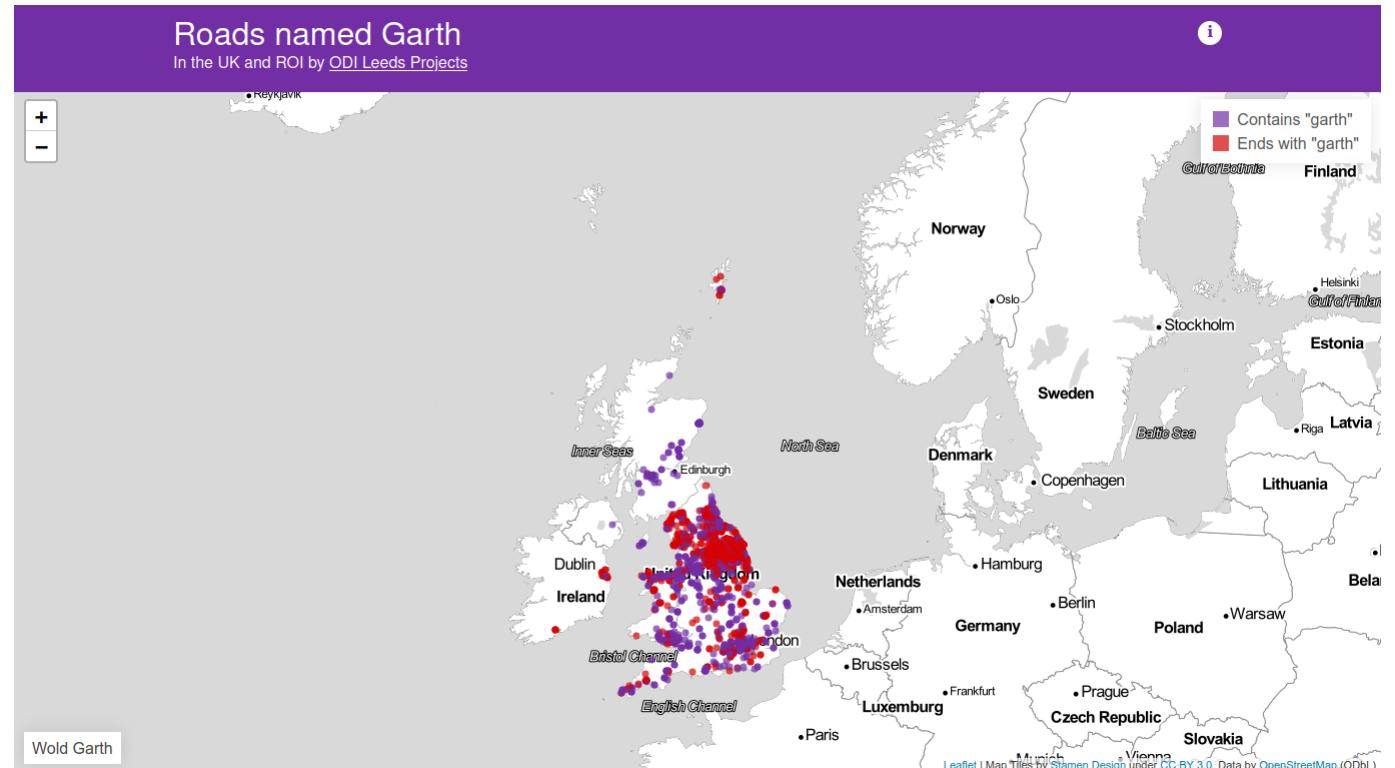
Party on!

Stuart, ODI Leeds



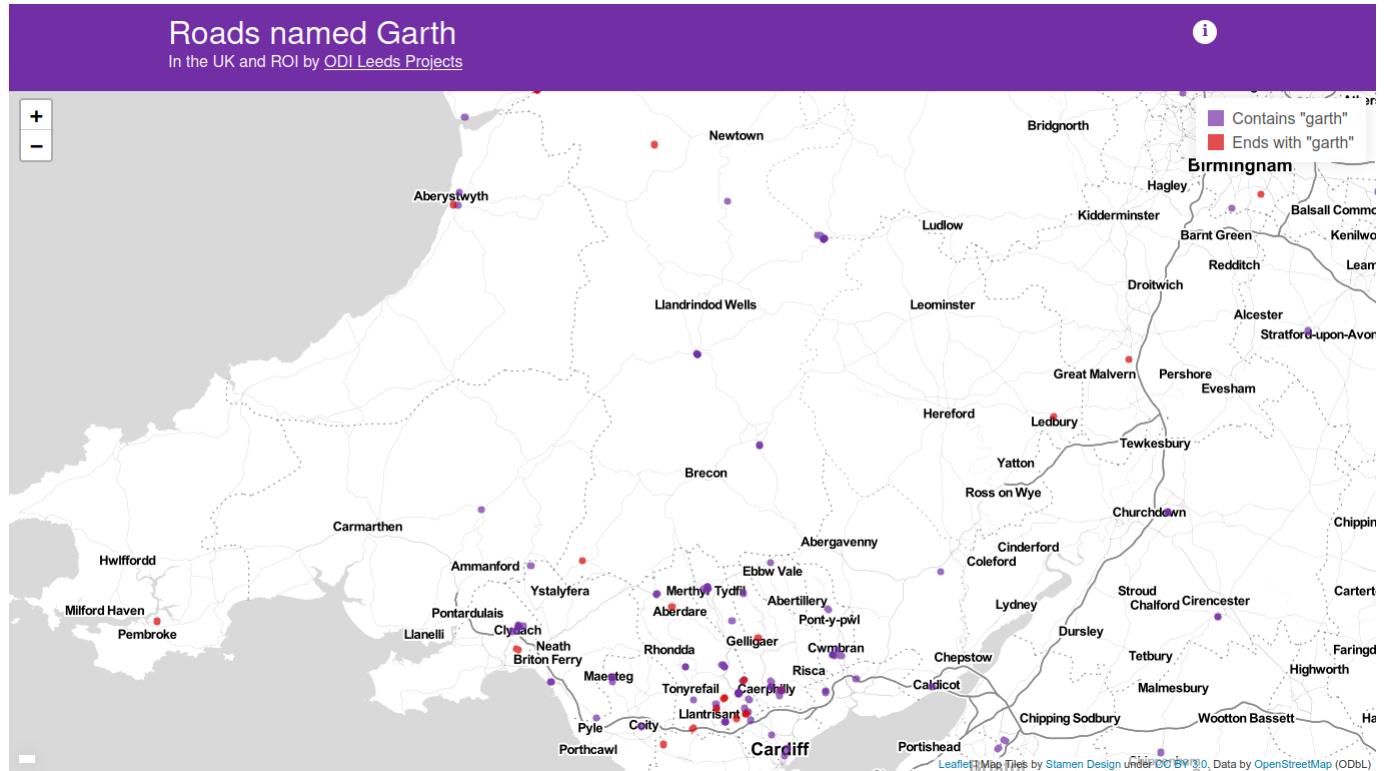
Hiraeth of Irfon Valley C.P. School

Hiraeth: a mixture of longing, yearning, nostalgia, wistfulness or an earnest desire for the Wales of the past



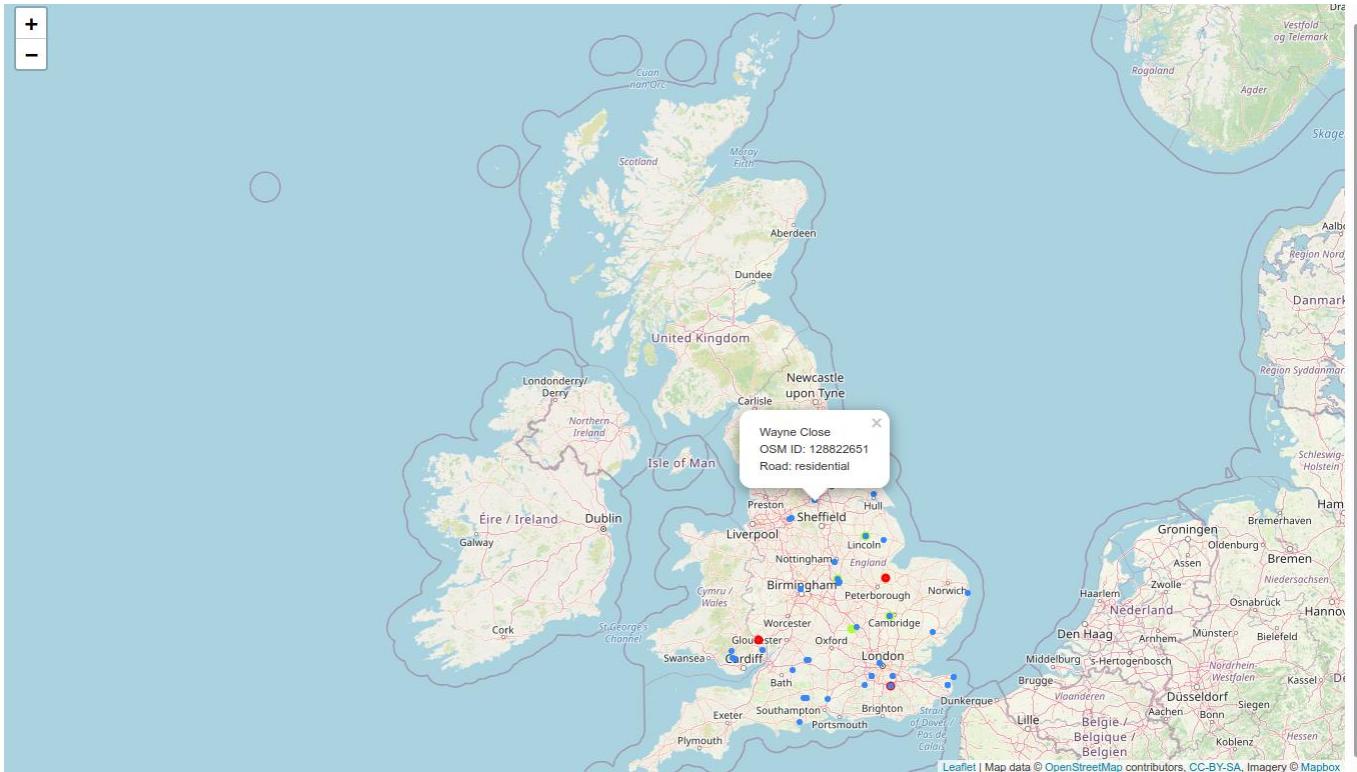
Party On!

But where was Garth?



British Map of Wayne!

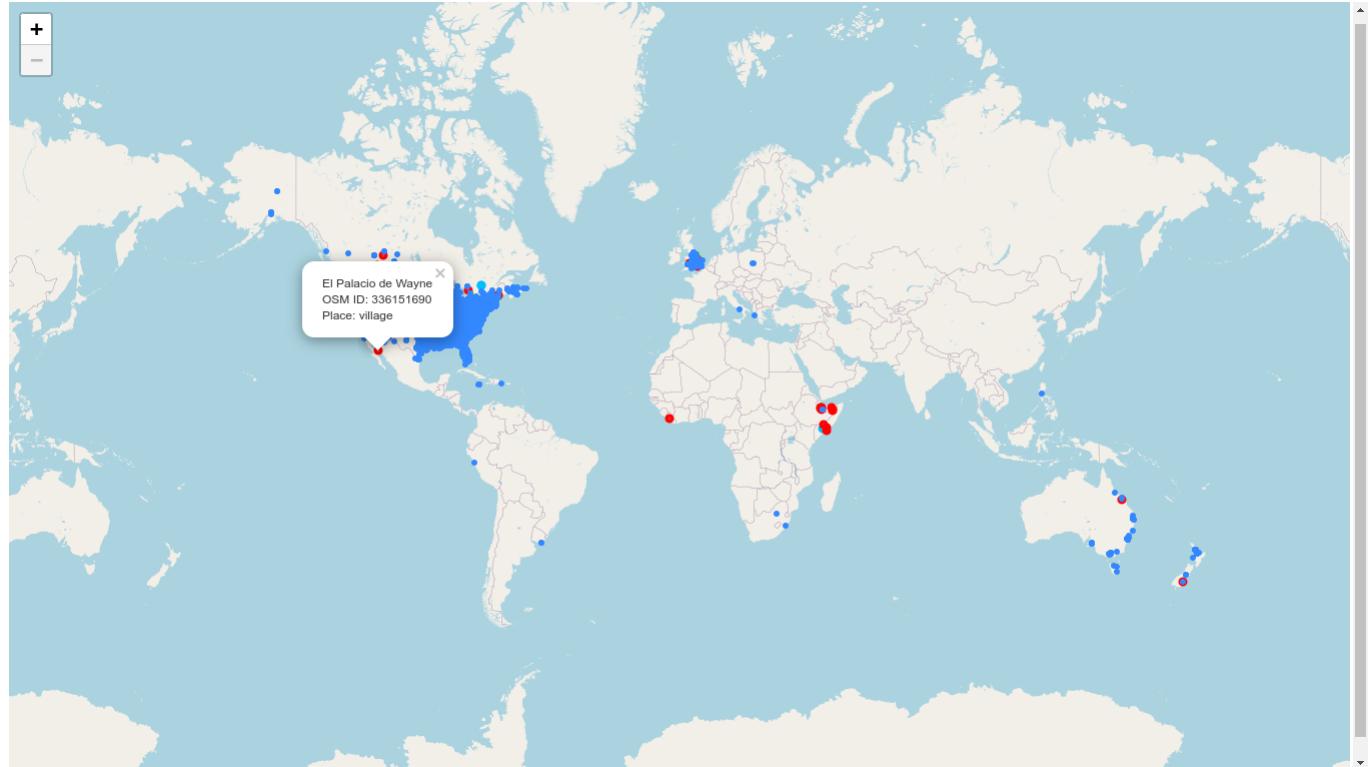
British Wayne



The Global Map of Wayne!

'In tribute to the work of the Open Data Institute Leeds I bring you global mapping of Wayne, or as it were, Wayne's World'

Excellent! Excellent!





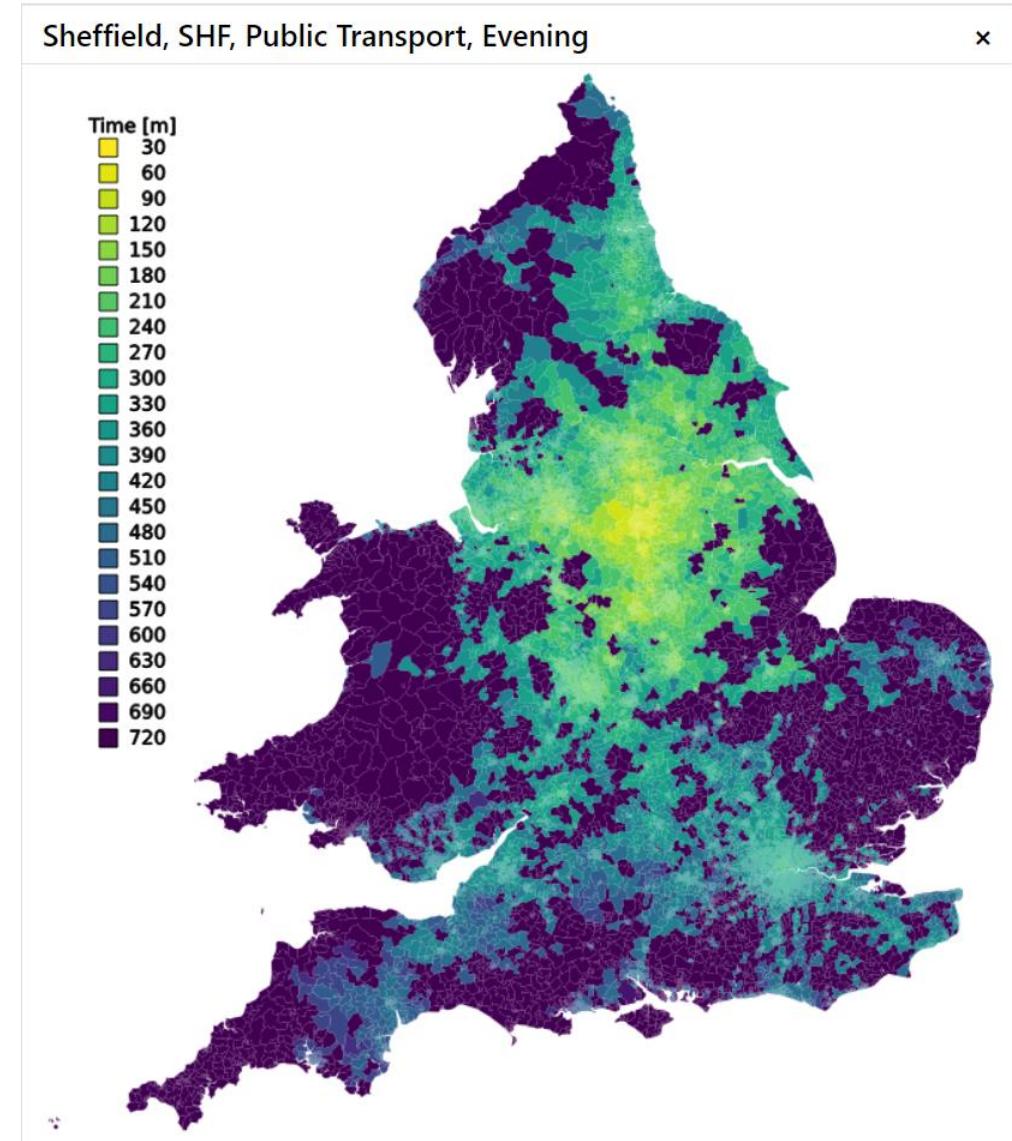
Spanning the Genres



Public Transport Travel

Department for Transport (DfT)
2001/2011 travel-time
chloropleths for train-station
public transport for England and
Wales

Office for National Statistics (ONS) Lower Layer
Super Output Areas (LSOA) geography

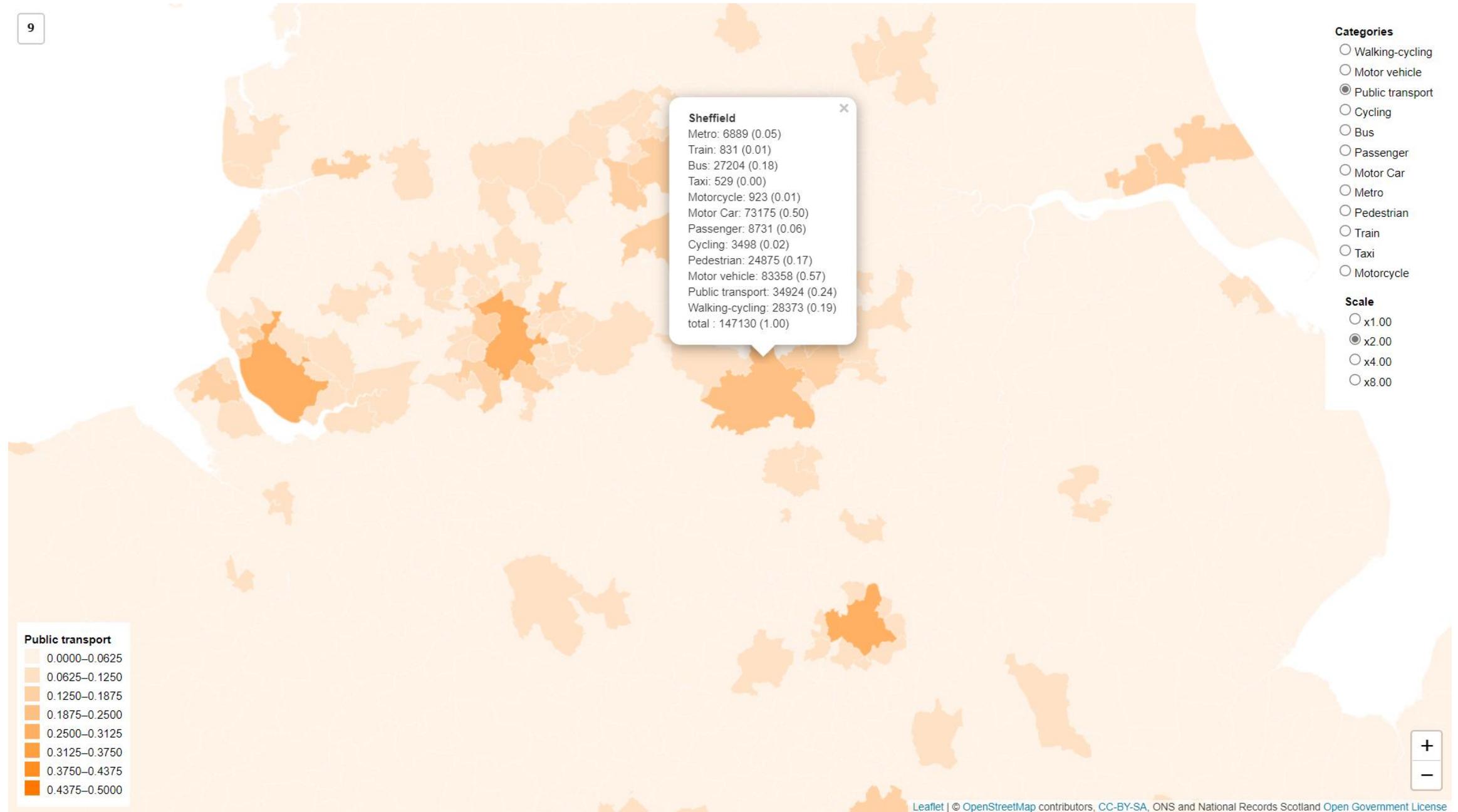


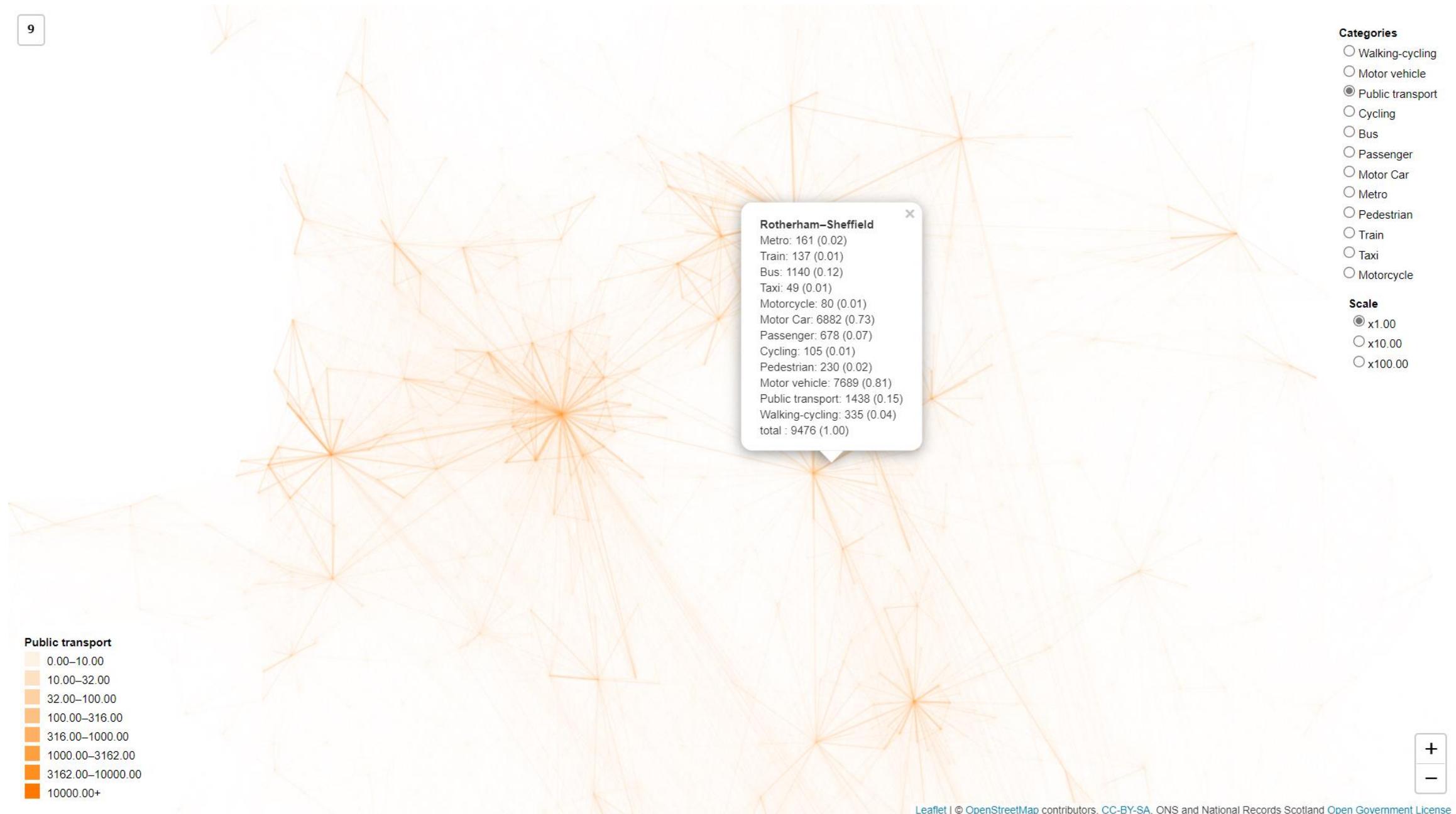
Where my Railway Goes

Using 2011 Census data

- station-location data from National Passenger Transport Access Node (NaPTAN)
- Super Output Area (SOA) population data
- Middle MSOA travel data







Rail Electrification



Rail Electrification

‘Once upon a time on a hot day in May 2020 amidst a pandemic lockdown, a rail engineer tweeted....’



Garry Keenor (He/Him)
@25kV

...

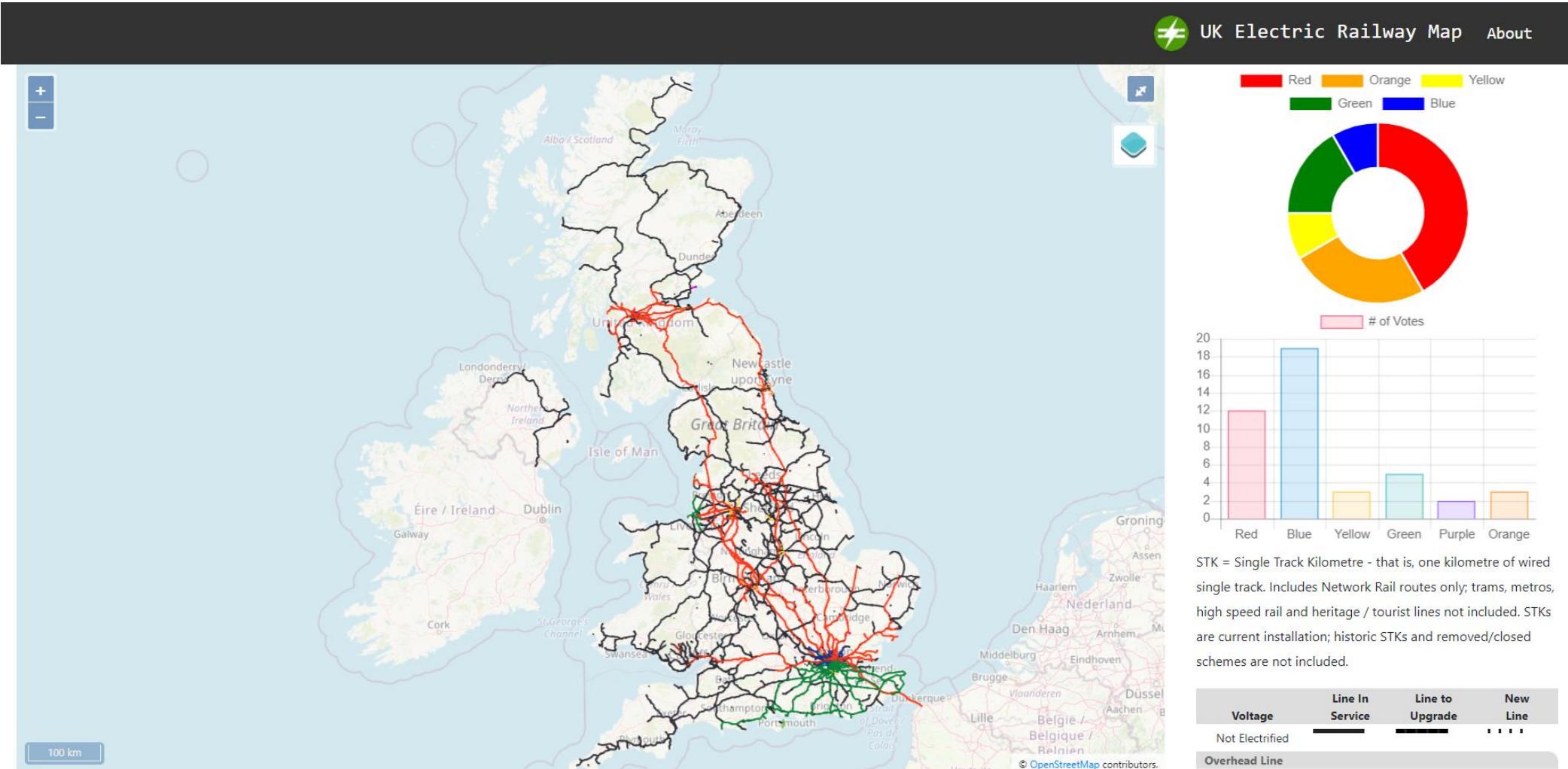
If anyone out there has experience of building an instance of [@openstreetmap](#), could you get in touch? I've had a dangerous idea, but I don't have all the necessary technical skills to implement

10:42 am · 25 May 2020 · Twitter for Android

1 Retweet 12 Likes

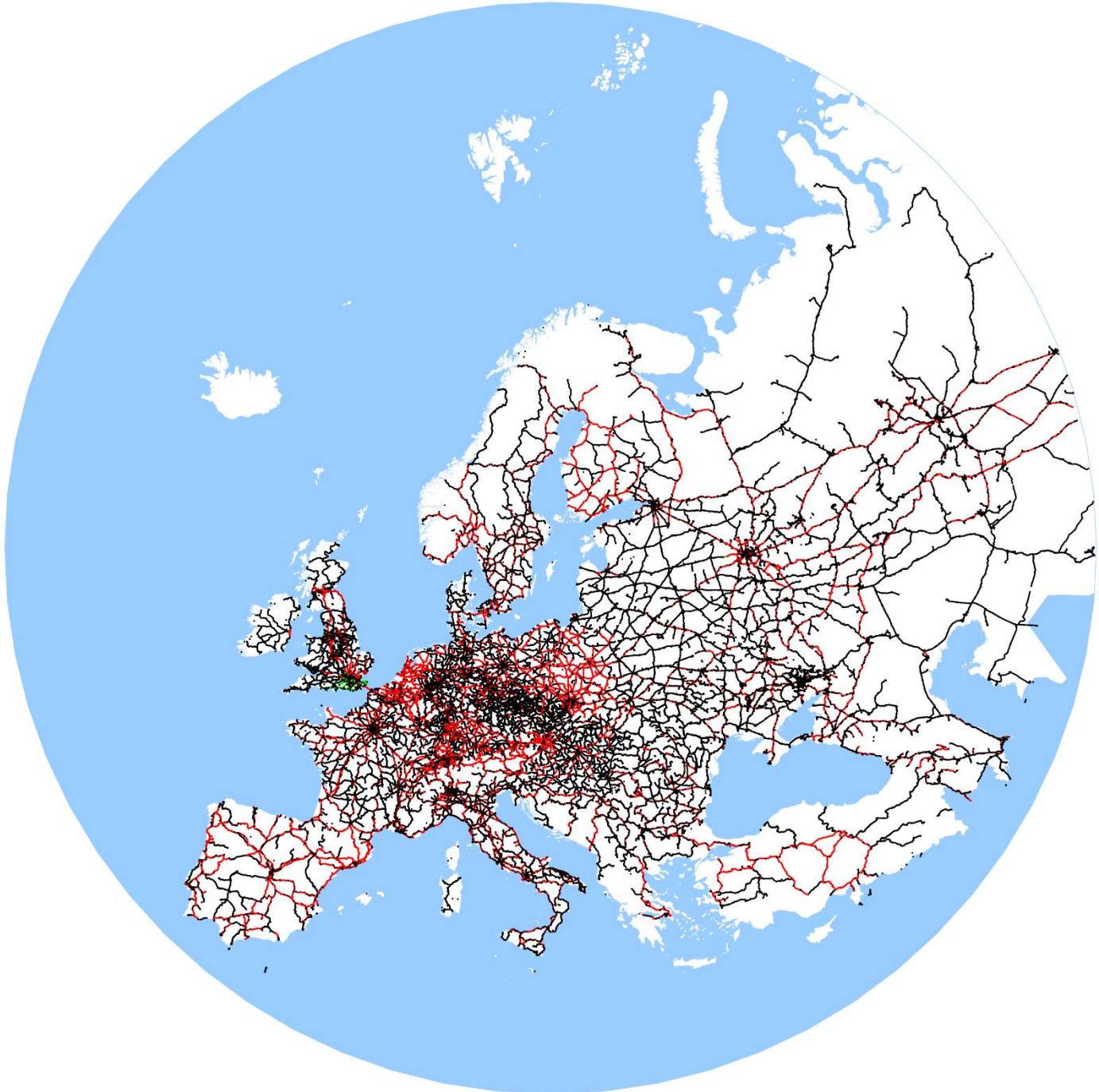


Rail Electrification



Rail Electrification

A rail map showing
European electrification
using Open Streetmap Data



Passenger Flow



Origin and Destination Matrix (ODM) Data



Distances

Fol centre-line track-model
to find the shortest-path
distance between ORR
passenger-flow stations

How hard could it be?

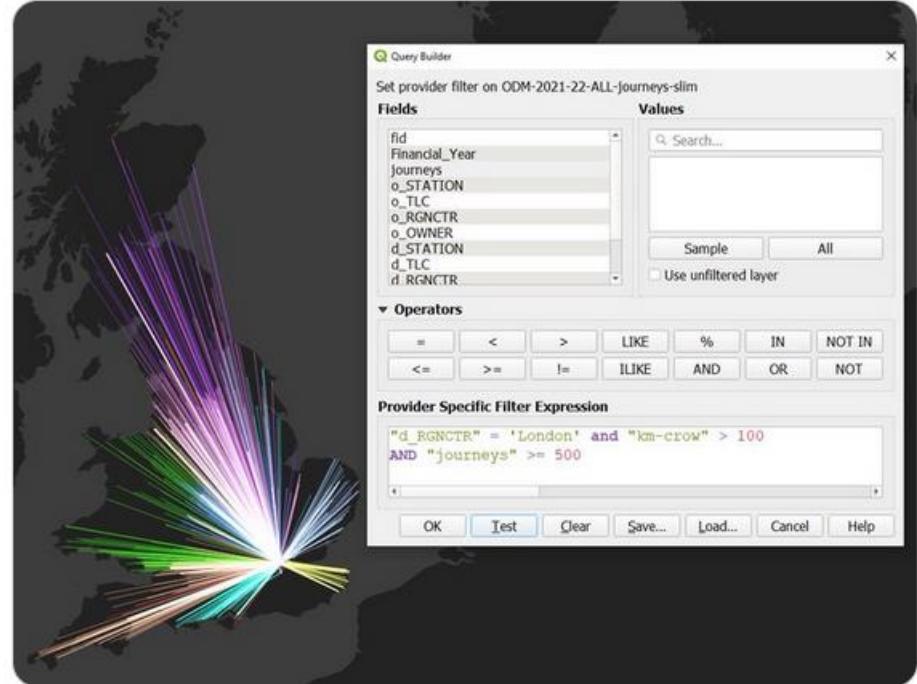


Alasdair Rae
@undertheraedar

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automaticknowledge.org/flowdata/



2:19 PM · Dec 8, 2023 · 9,985 Views



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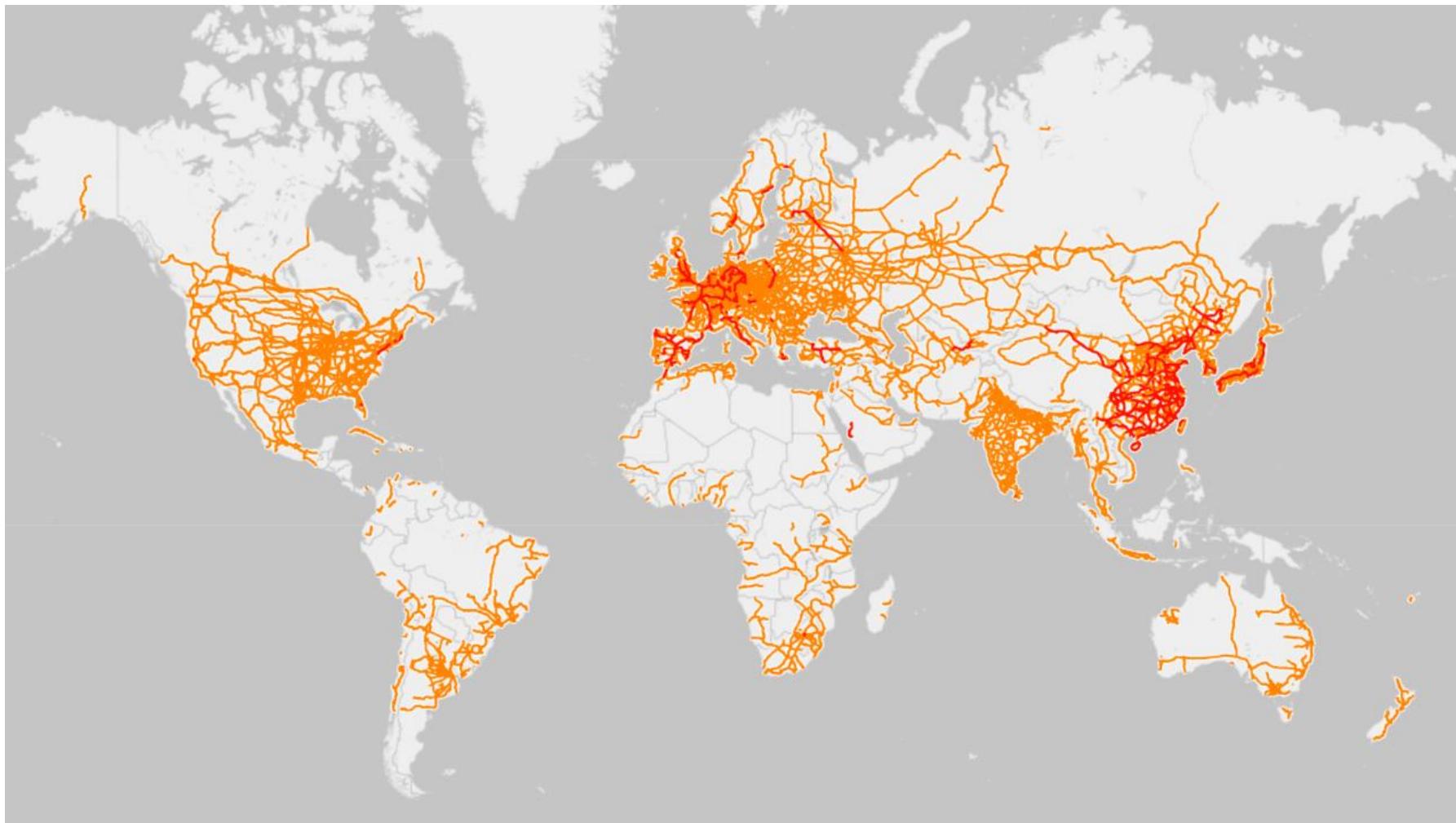
29



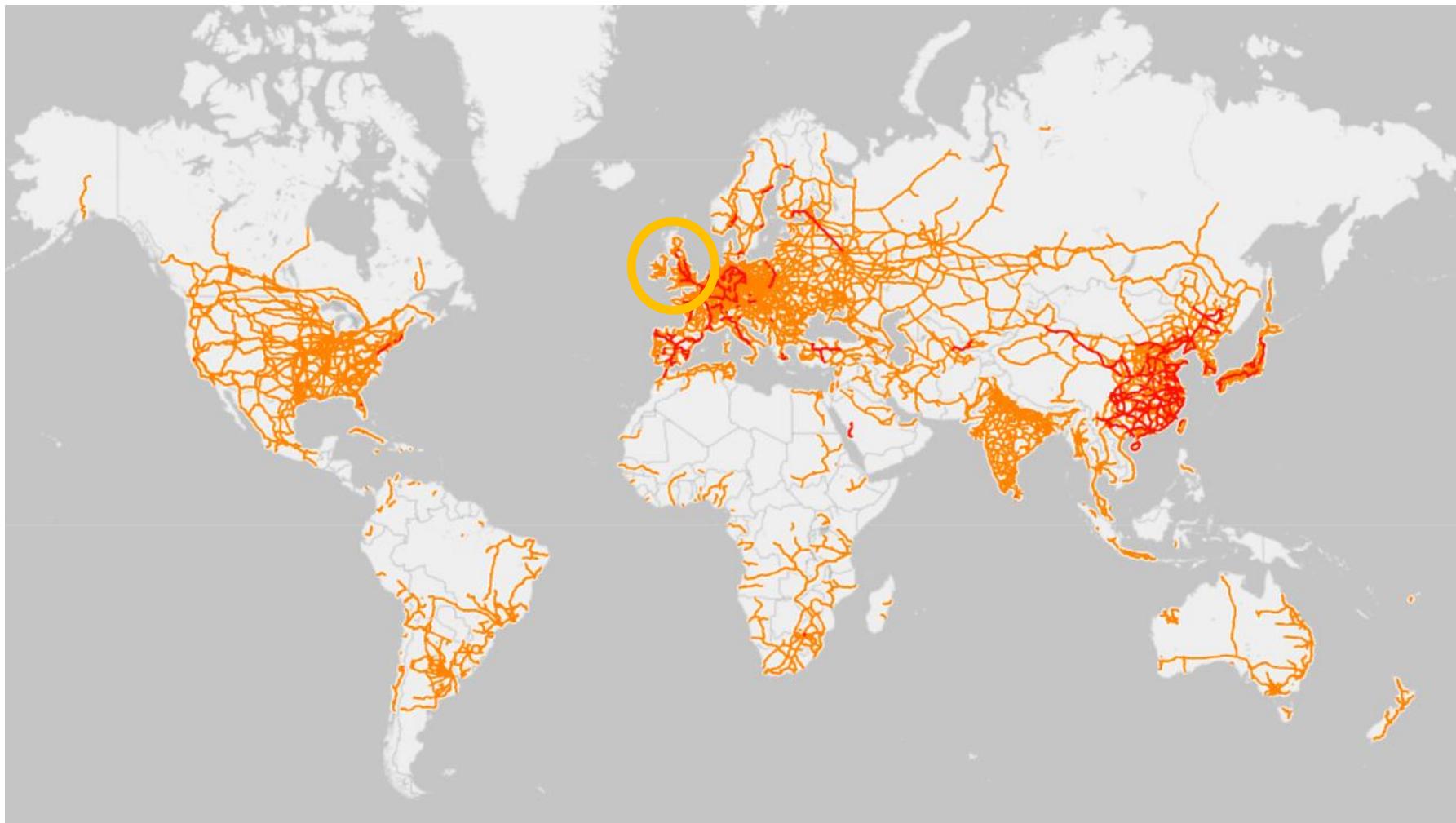
Open Data



Railway Maps



Railway Maps



The Railway



[Open Railway Map](#)



Labels

03 30

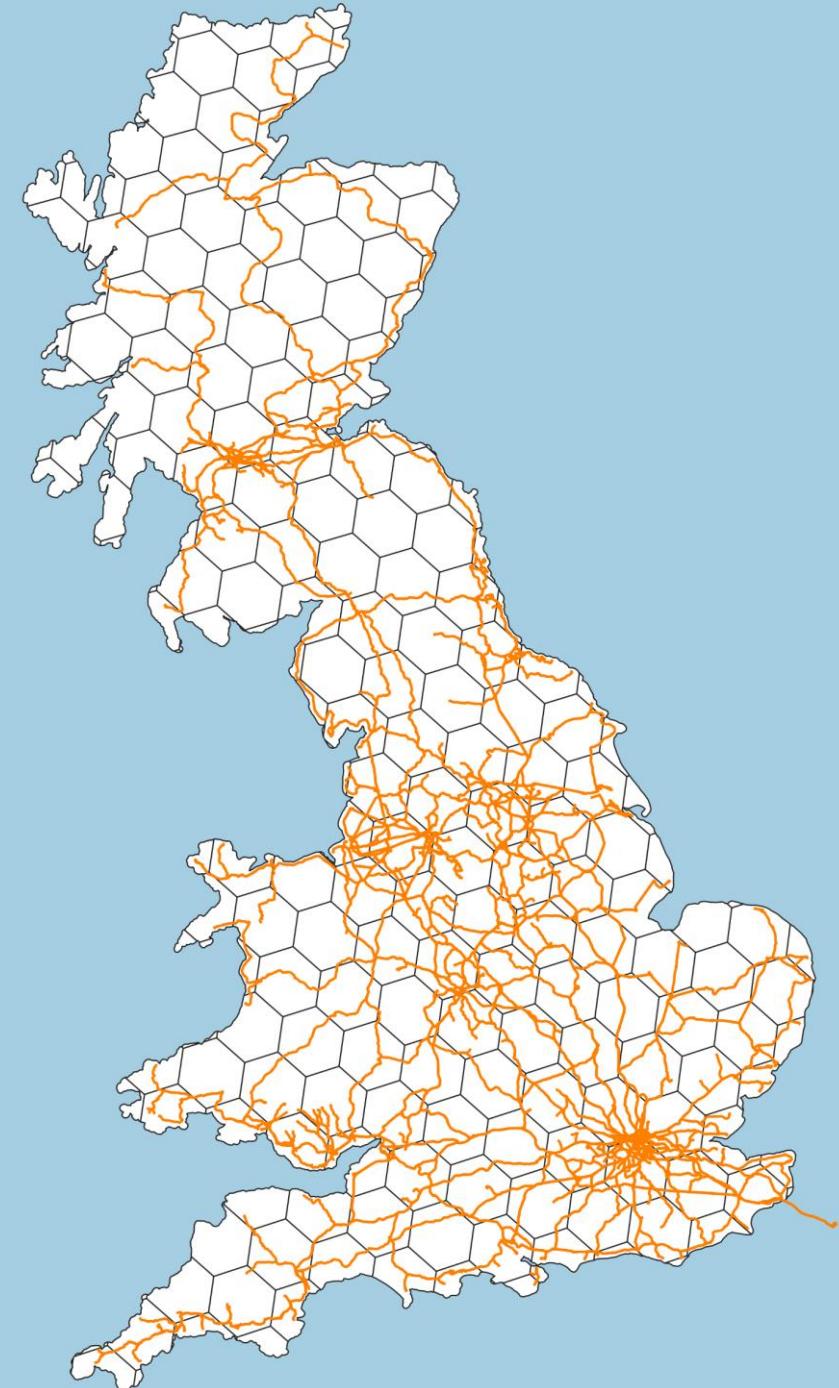


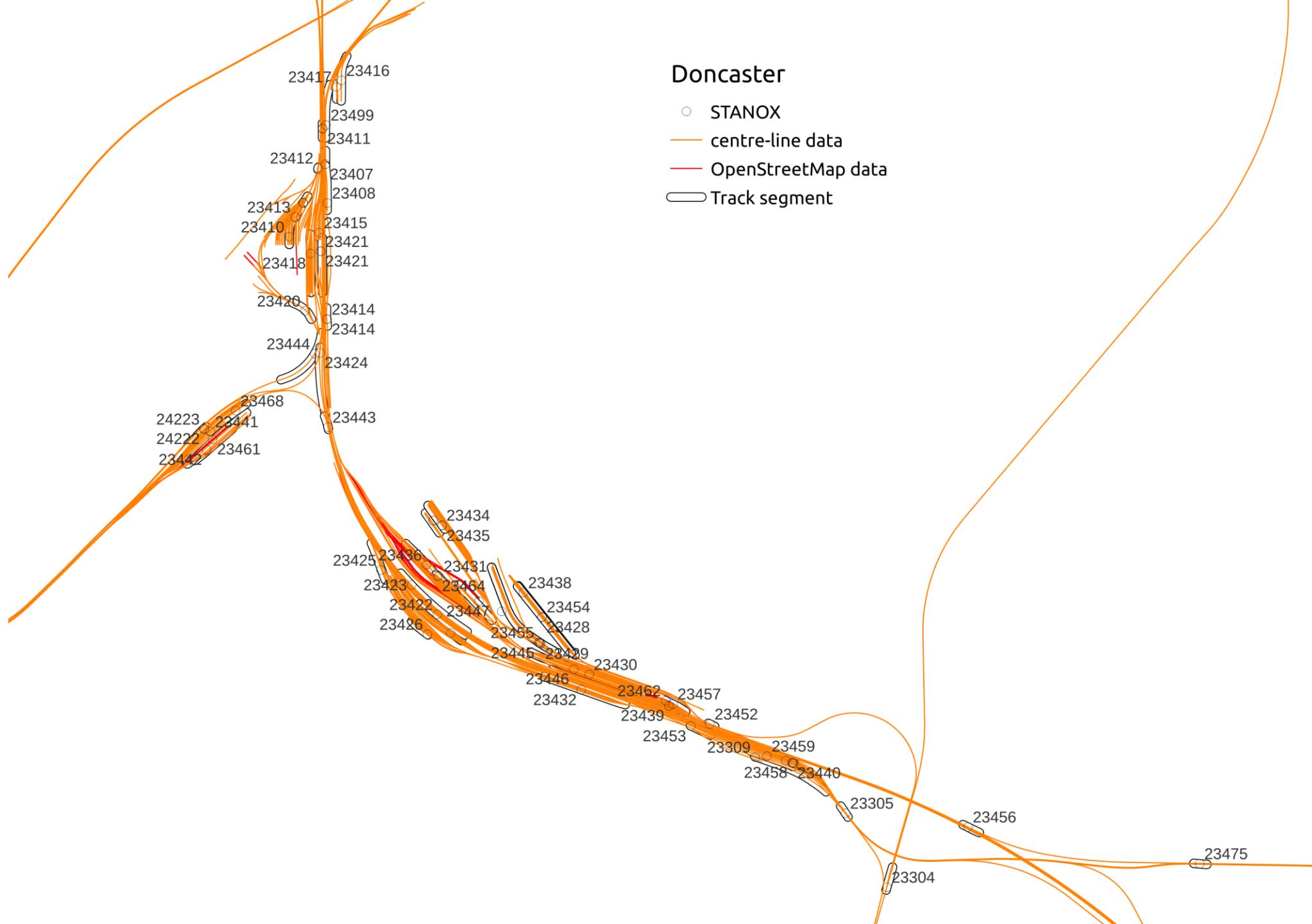
Freedom of Information



The Railway in Maps

The Freedom of Information
(FoI) centre-line track-model



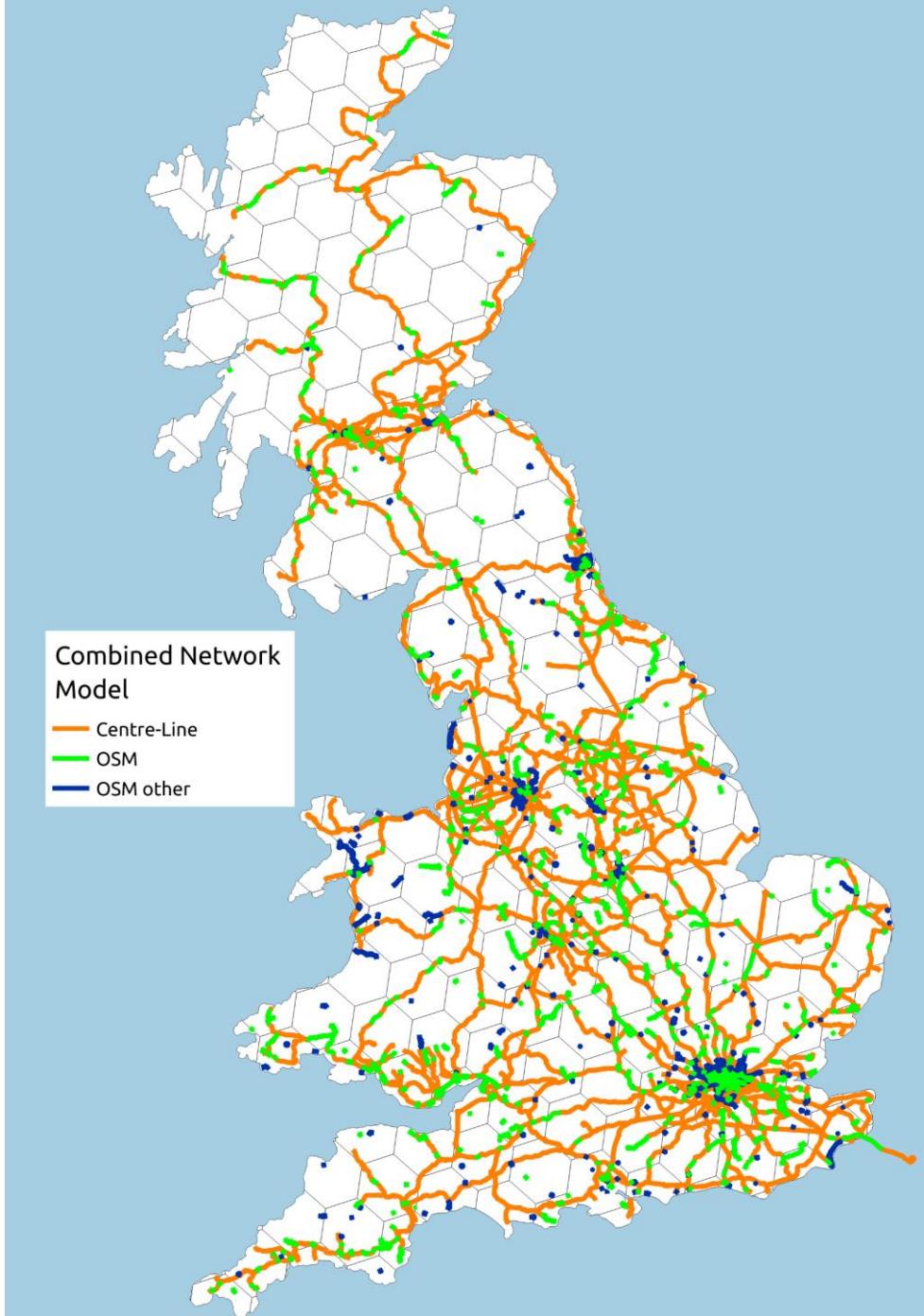


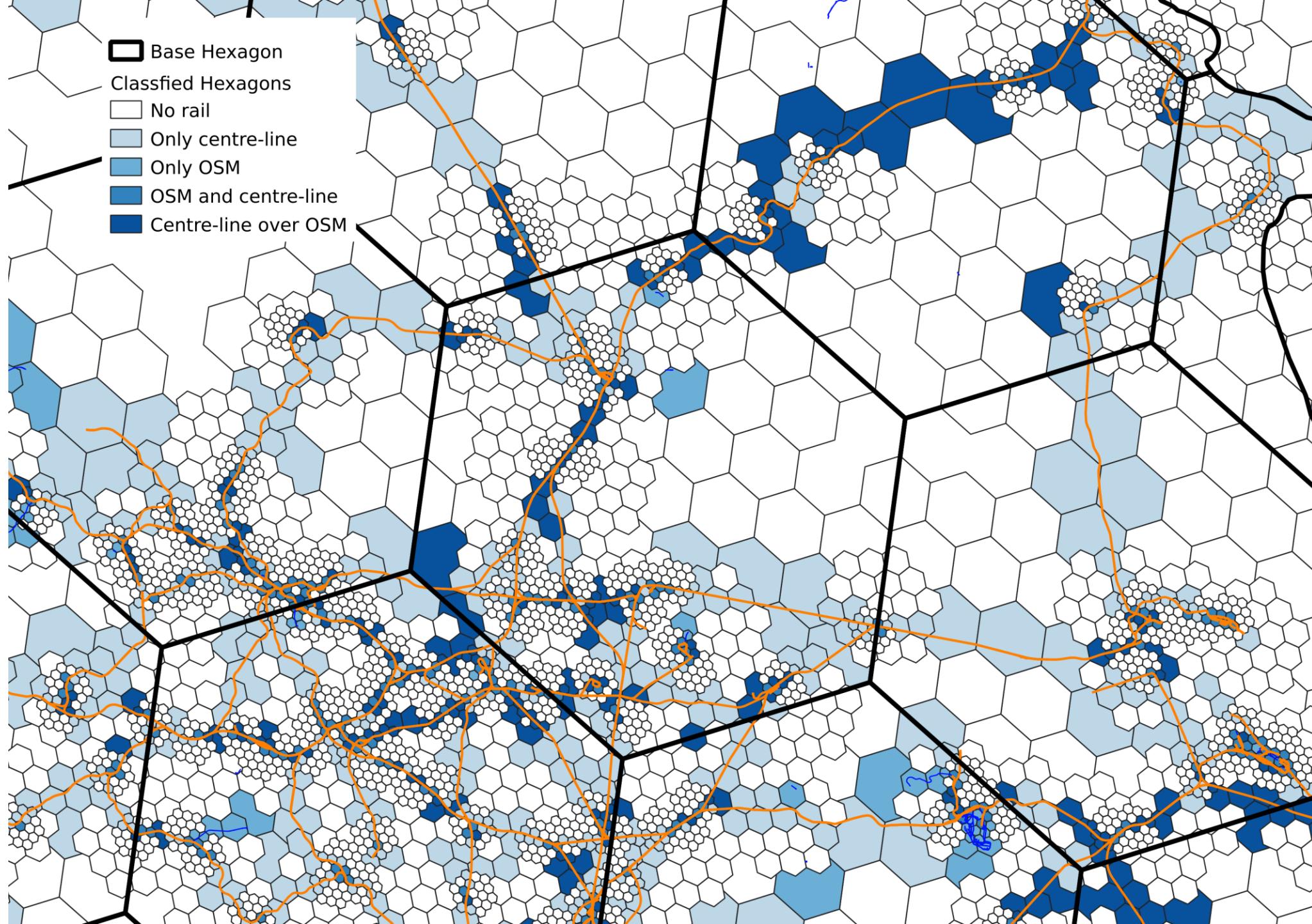
Doncaster

- STANOX
- centre-line data
- OpenStreetMap data
- Track segment

The Railway Compared

Centre-line track-model
versus OpenStreetMap data





Base Hexagon

Classified Hexagons

No rail

Only centre-line

Only OSM

OSM and centre-line

Centre-line over OSM

So it begins



In Media Res?



Distances

Use the Fol centre-line track-model to find the shortest-path distance between ORR passenger-flow stations

How hard could it be?

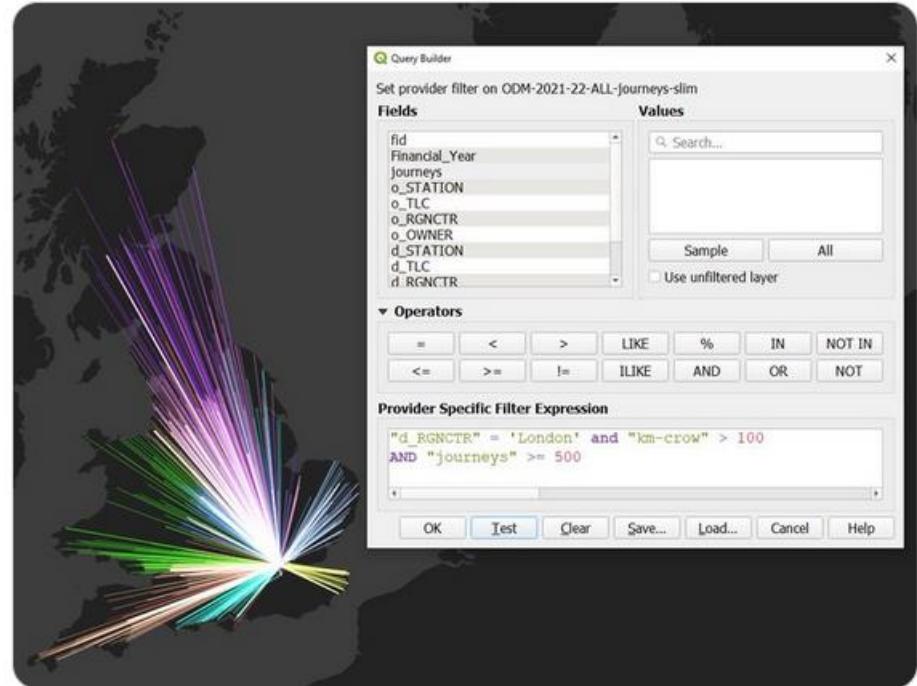


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Passenger Origin Destination Matrix

Rail Data Market Place data set
Financial Year 2018-19
**1,534,186 line Comma Separated
Variable (CSV) file**
Origin and Destination by
Computer Reservation System
(CRS) code

| File | Edit | View | Search | Terminal | Help |
|---|------|------|--------|----------|------|
| Financial Year,origin nlc,origin station name,origin station group,origin region,destination nlc,destination station name,destination station group,destination region,journeys | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,577,Farringdon,LONDON BR,London,3 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1006,Birmingham Snow Hill,BIRMINGHAM BR,West Midlands,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1087,Rugby,,West Midlands,2 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1127,Birmingham New Street,BIRMINGHAM BR,West Midlands,17 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1215,Birmingham International,,West Midlands,3 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1221,Holmes Chapel,North West,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1243,Crewe,North West,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1305,Longport,,West Midlands,10 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1314,Stoke-On-Trent,,West Midlands,3 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1322,Tamworth,,West Midlands,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1423,Wembley Central,,London,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1444,London Euston,LONDON BR,London,11 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1447,Kensal Green,,London,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1475,London Marylebone,LONDON BR,London,2 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1555,London St Pancras International,LONDON BR,London,4 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1823,Derby,,East Midlands,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1826,Nottingham,,East Midlands,3 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,1978,Windermere,North West,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2242,Liverpool Central,LIVERPOOL BR,North West,2 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2246,Liverpool Lime Street,LIVERPOOL BR,North West,3 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2262,Southport,,North West,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2422,Buckley,,Wales,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2437,Holyhead,,Wales,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2450,Blaenau Ffestiniog,,Wales,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2685,Lancaster,,North West,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2728,Skipton,Yorkshire and The Humber,2 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2739,Blackpool North,,North West,8 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2753,Preston (Lancs),,North West,2 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2771,Stockport,,North West,3 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2966,Manchester Oxford Road,MANCHESTER BR,North West,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2968,Manchester Piccadilly,MANCHESTER BR,North West,10 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,2970,Manchester Victoria,MANCHESTER BR,North West,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3030,Didcot Parkway,,South East,3 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3087,London Paddington,LONDON BR,London,7 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3092,Kensington Olympia,,London,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3115,Oxford,,South East,4 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3146,Henley-On-Thames,,South East,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3149,Reading,READING BR,South East,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3174,West Drayton,,London,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3206,Shirehampton,,South West,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3219,Oldfield Park,,South West,3 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3225,Lawrence Hill,,South West,2 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3230,Bristol Parkway,,South West,27 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3231,Bristol Temple Meads,,South West,181 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3235,Filton Abbey Wood,,South West,5 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3237,Keynsham,,South West,1 | | | | | |
| 20182019,375,Energlyn and Churchill Park,,Wales,3245,Bedminster,,South West,2 | | | | | |

Wrinkles and Data Wrangling

Add station point locations

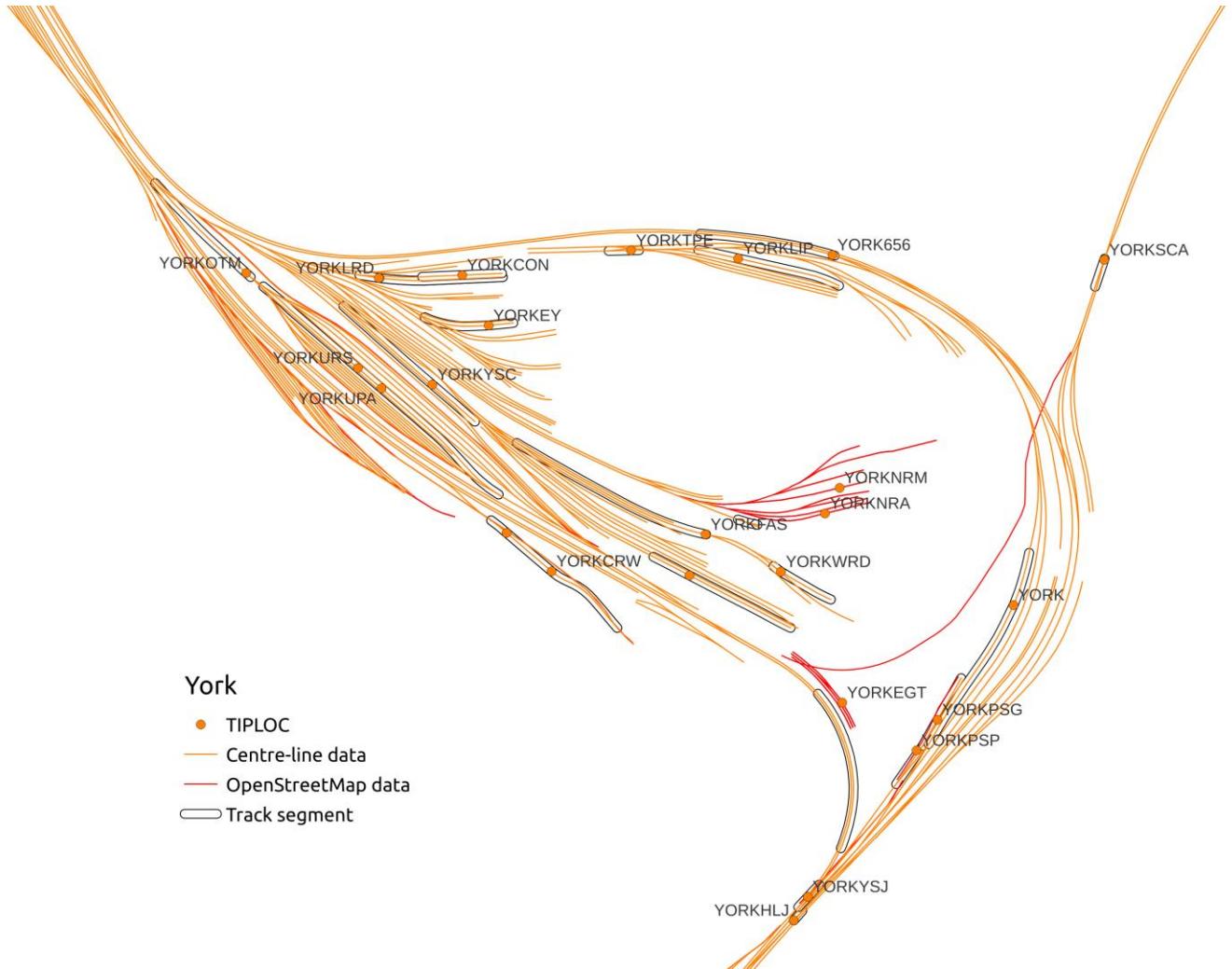
- Use National Public Transport Access Network gazette ([NaPTAN](#))
- NaPTAN has Timing Point LOCations (TIPLOC) codes Map TIPLOC to CRS using CORPUS Network Rail open data
- Fix the six wrong TIPLOCs matches
 - Use OpenStreetMap to find the four missing CRS



Wrinkles and Data Wrangling

Combine with the centre-line track-model

- Simplify to remove simple connected links
- Snap the station locations to track on the network model
- Split the track at snapped station locations



Distances Part Deux

For the 2,579 stations with CRS codes

The maximum path 1478.23km Wick and St Ives

Wick and Bodmin Parkway, 1396.26km and 23-hours

Dorchester over the Glenfinnan Viaduct takes 14-hours

Walk between

- Southend Central and Southend Victoria
- Dorking Deepdene and Dorking

Larbert to Shanklin commute is nine train changes and 10 hours plus a ferry trip



What I planned

Deliver a nation passenger flow for the 2018-
2019 ORR dataset ↗



What I did

A passenger flow for
each station in the 2018-
2019 ORR data

EUS



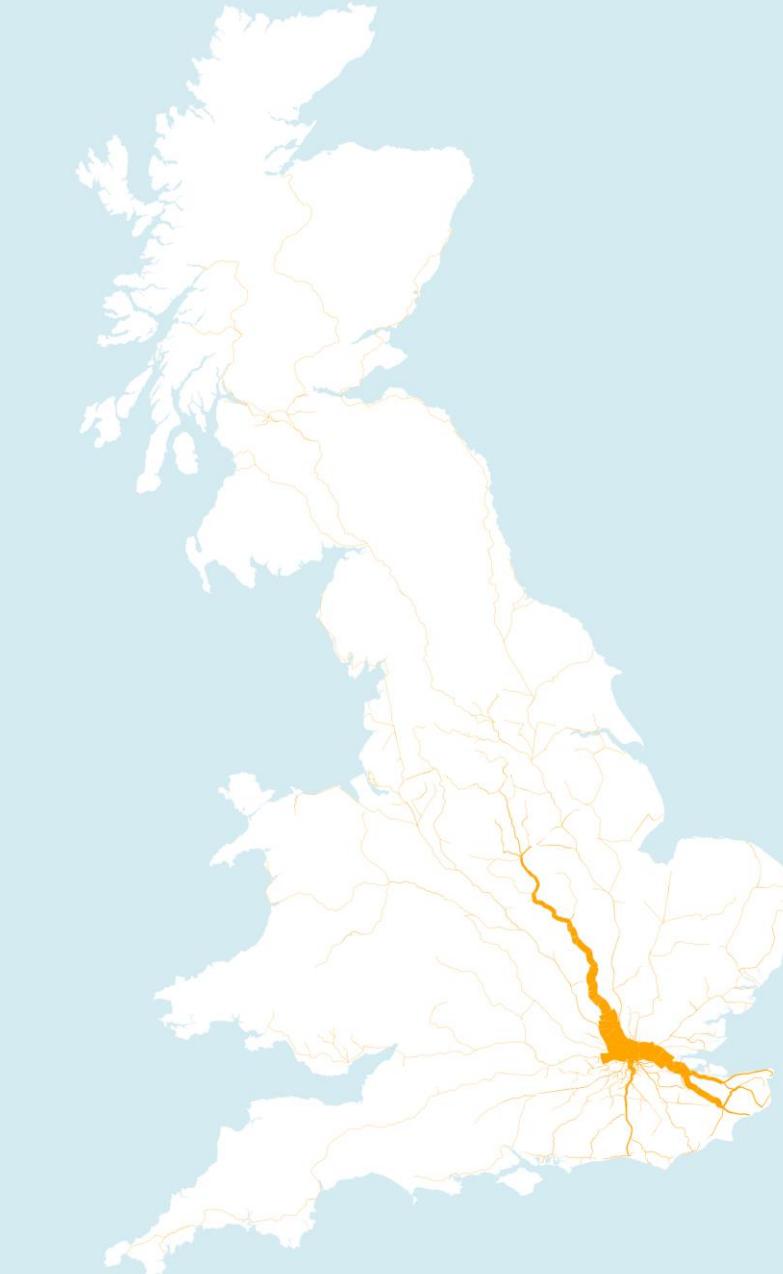
KGX



What I did

A passenger flow for
each station in the 2018-
2019 ORR data

STP



WAT



So what?



Social Media Redux



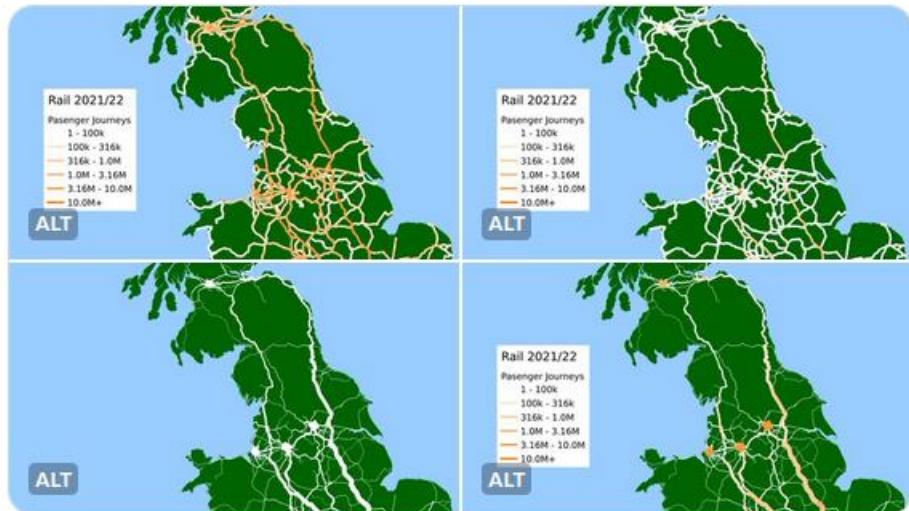
Will Deakin @wnd@fosstodon.org
@WillDeakin1

Promote ...

For those interested in such things, here are cuts of the [@railandroad](#) 2021/22 passenger travel data projected onto a shortest-path network using the centre-line track-model with log and linear colour gradient and line width

Thanks to [@undertheraedar](#) [@poggs](#)

#rail #DataVis



Alasdair Rae
@undertheraedar

...

🎉 [@WillDeakin1](#) has now done a passenger flow map for every station in Britain - all 2,657 of them - you can find them here:

github.com/anisotropi4/ki...



7:56 PM · Jan 2, 2024 · 495.2K Views

107

601

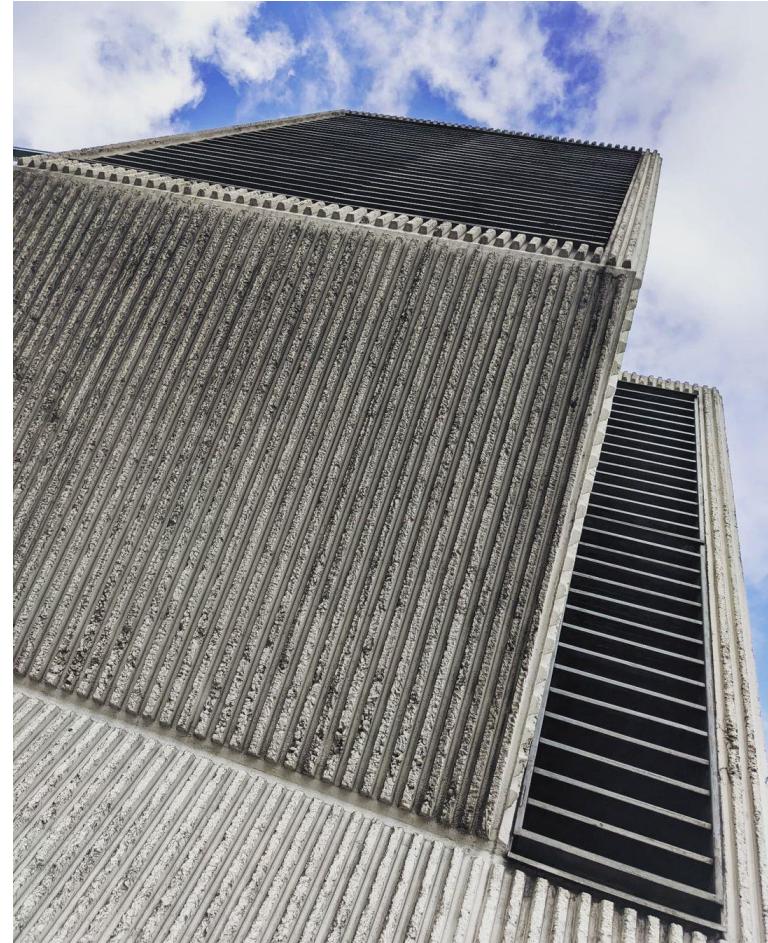
3.9K

1.7K

↑

What Happened Next?!?

UX is very v important
Hosting Gremlins with
GitHub
The Isle of Wight
Open Data



One
Column
Only



What Did People Think?

- 90 % amazing, wow, love it - unreal piece of work
- 5 % MY StATION isNT ListED
- 3 % It's all fake, this guy doesn't know anything about trains
- 2 % Have you considered x, y, z approach that actually isn't possible anyway?



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601

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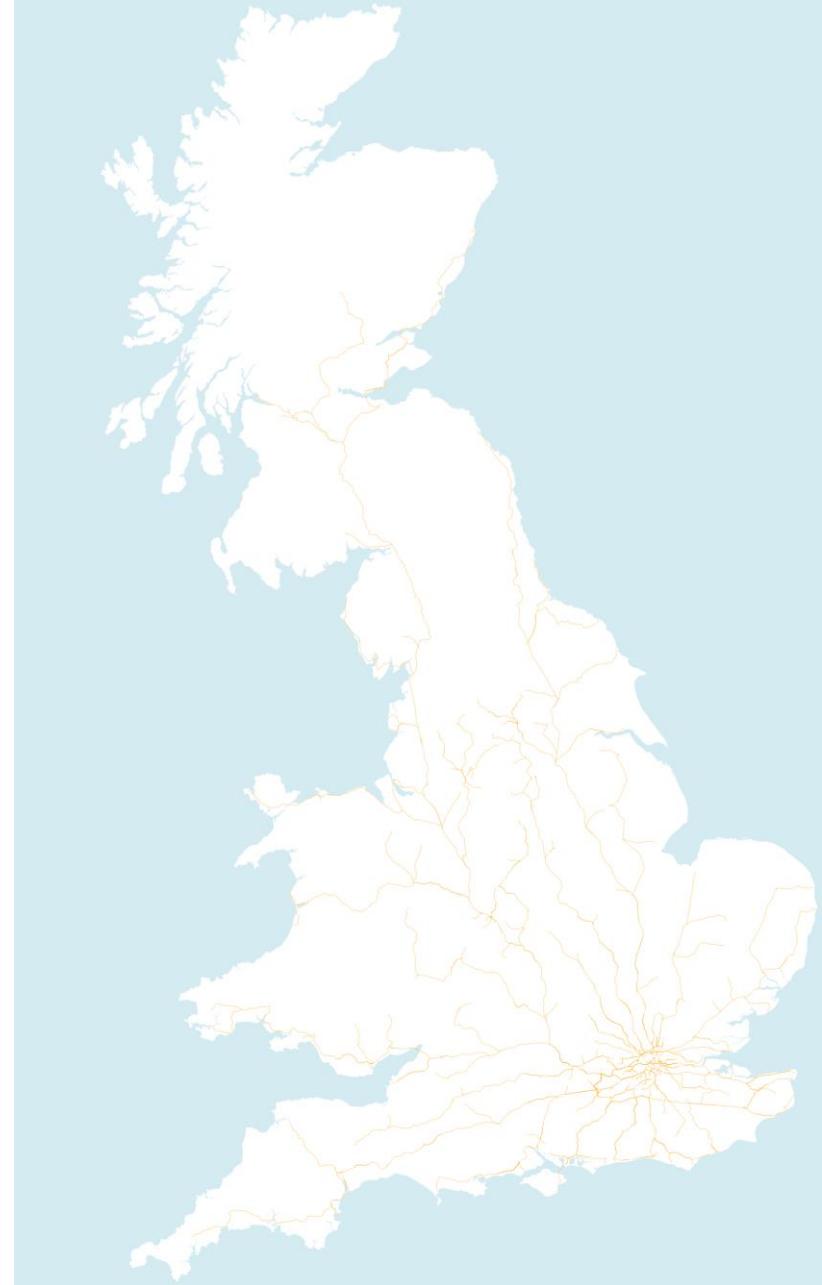


State of the Art Cloud Hosting



CAM

L'enfer c'est les autres



Open Data



Open Data (Current attribution)

All data used on the basis that it under open or permissive license.

1. The base map of mainland Britain is derived from the [WorldPop](#) base maps under [CC 4.0 by deed](#) retrieved 2023-09-07.
2. The centre-line track-model is hosted by [OpenRailData](#) under the [Open Government License](#) by Network Rail, retrieved 2023-07-11.
3. The Origin Destination Matrix data, for example [ODM 2022-23](#), were published by the [Office of Road and Rail](#) on the Rail Development Group Rail Data Marketplace, under the [Open Government License](#). Retrieved 2024-02-18.
4. The [Station Attributes for All-Mainline Stations](#) published by the [Office of Road and Rail](#) under the [Open Government License](#). Retrieved 2024-02-18.
5. The [Network Rail CORPUS dataset](#) is an open data feed which is released under a [OGL](#). Retrieved 2023-11-29 as a local copy.
6. The National Public Transport Access Network [NaPTAN](#) under [OGL](#) and is updated each time the scripts are run.
7. While this implementation now uses NaPTAN and CORPUS to validate and identify six closed stations, the Isle of Wight ferry-link continues to use [OpenStreetMap data](#), licensed under [CC-BY-SA 2.0](#) through the [OverPassAPI Turbo](#) service, and is updated each time the scripts are run.

**Shadows Appear
on the
Wall of a Cave**



15 Seconds of Fame

The screenshot shows the homepage of the 15 Seconds of Fame website. At the top is a large yellow circular icon containing a black silhouette of a person. Below the icon is a navigation bar with links: 'About', 'Data & projects' (which is highlighted in red), 'Knowledge & resources', 'Sponsors', and 'Events'. To the right of the navigation bar is a search bar with a magnifying glass icon. The main title 'Passenger Journeys: Pictures at a (Rail Transport) Exhibition' is displayed in large, bold, black font on a yellow background.

Passenger Journeys: Pictures at a (Rail Transport) Exhibition

This blog is about using the Office of Road and Rail (ORR) financial year 2021/22 [passenger travel data](#) projected onto a shortest-path network, using the [centre-line track-model](#). The [project looks to create a visualisation for passenger journey numbers](#) for the active rail stations across the British rail network. This post sets out the background how it seemed to get a bit daft. I'm not sure if it went viral, at just shy of 500k page impression on X, and 15k on LinkedIn in under a week, maybe more bacterial?

Will Deakin
Trains Portfolio Architect Network Rail

Published: Monday 8 January 2024,
11:10AM

15 Seconds of Fame

Citylab | MapLab

Nine Maps Show How Britain Is on the Move

A new dataset allows anyone to explore almost 1 billion journeys from every one of its more than 2,500 train stations.

By [Conrad Quilty-Harper](#) and [Patricia Suzara](#)

8 February 2024 at 05:01 GMT

 Save

 Listen 5:03

Sign up for MapLab, CityLab's monthly newsletter about maps that reveal and shape urban spaces.

When he started playing with Great Britain's train data, Will Deakin didn't intend to create a monster.

Poor Northern Rail Links

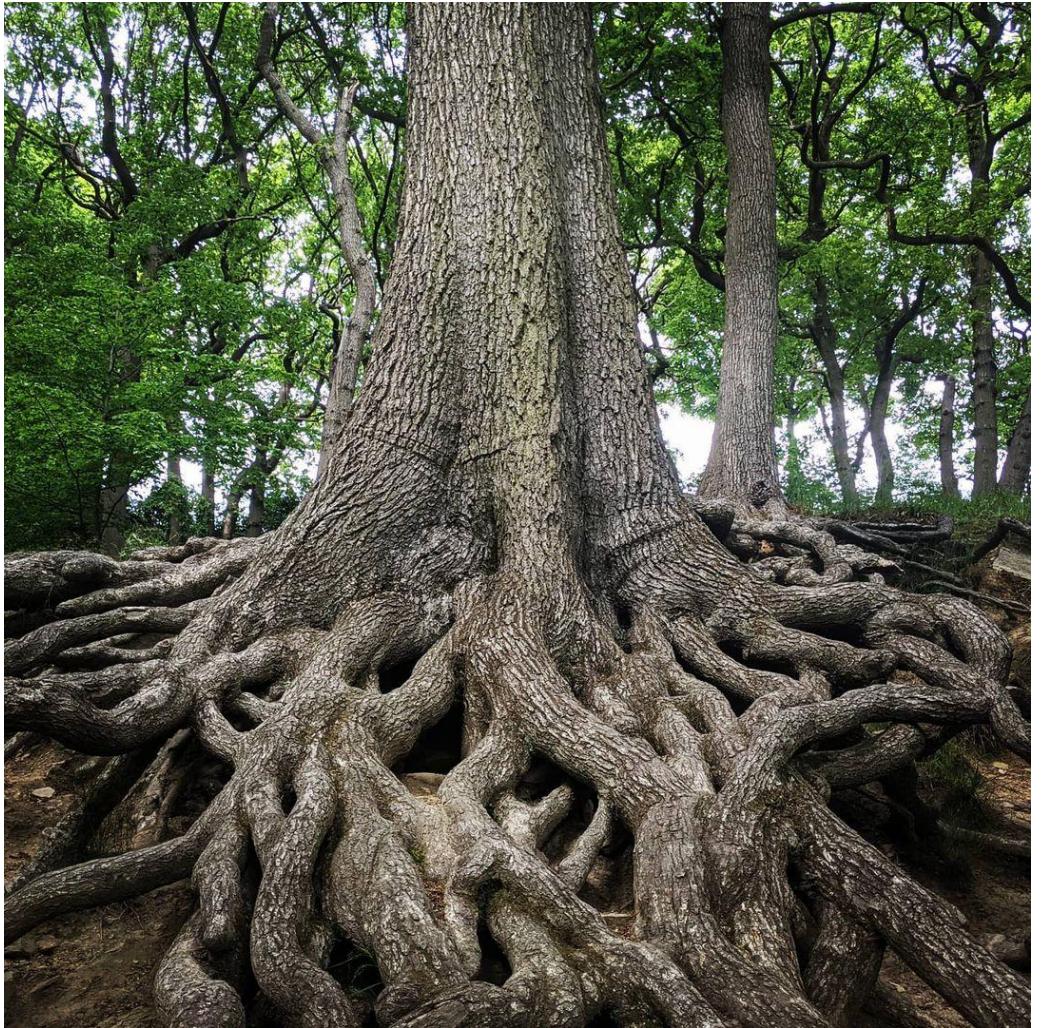
Deakin says the thinner lines between northern cities reflect lower capacity

Manchester Piccadilly

Leeds Central



Here Endth
the
First Lesson



What next?



More data



Passenger Origin Destination Matrix

LDS 2018-19



GTH 2018-19



Delta View



Passenger Origin Destination Matrix

LDS 2019-20 delta



LDS 2020-21 delta



Passenger Origin Destination Matrix

LDS 2019-20 delta



LDS 2022-23 delta



Passenger Origin Destination Matrix

KGX 2018-19 delta



KGX 2020-21 delta



Passenger Origin Destination Matrix

KGX 2018-19 delta



KGX 2022-23 delta



The then what?



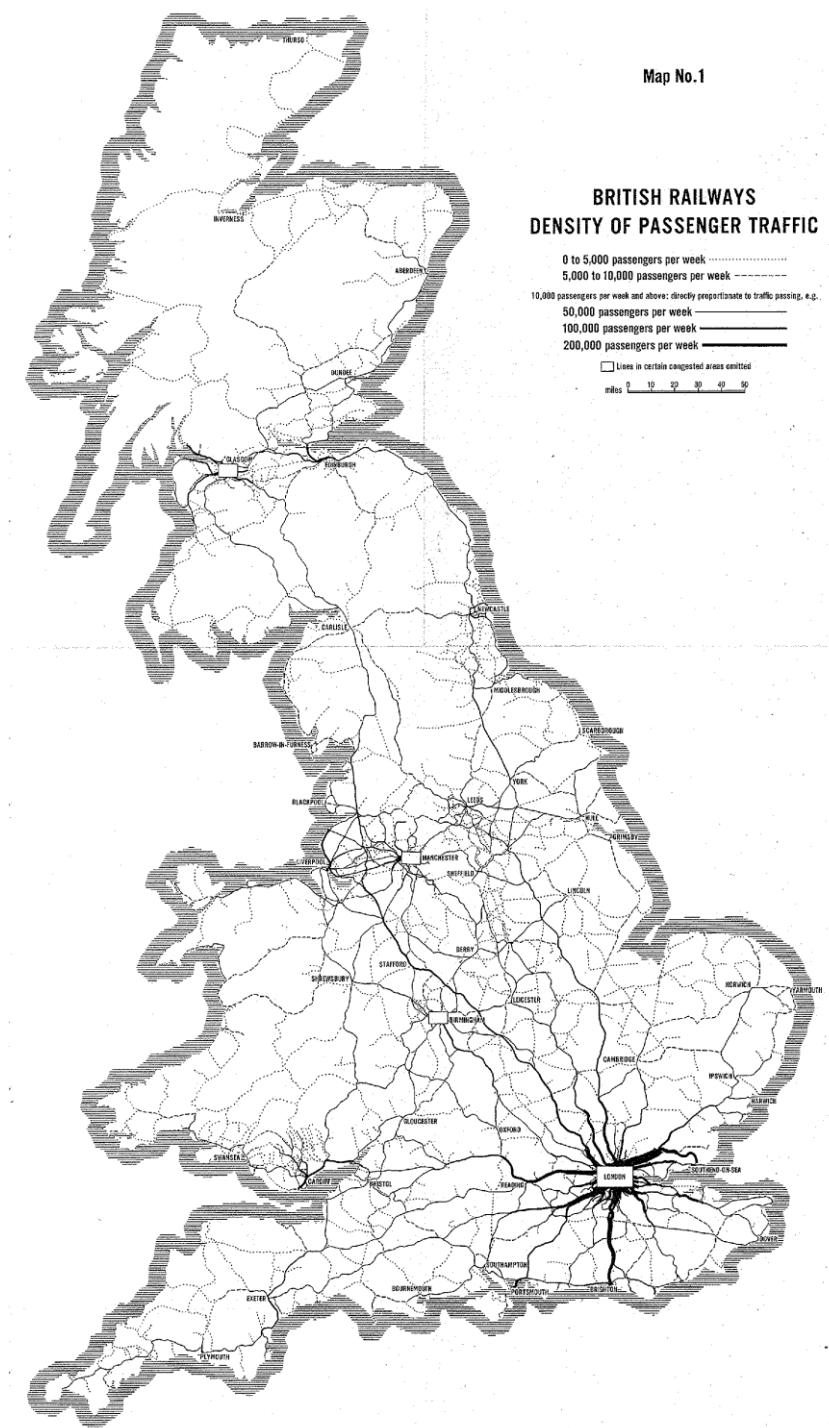
The Plan



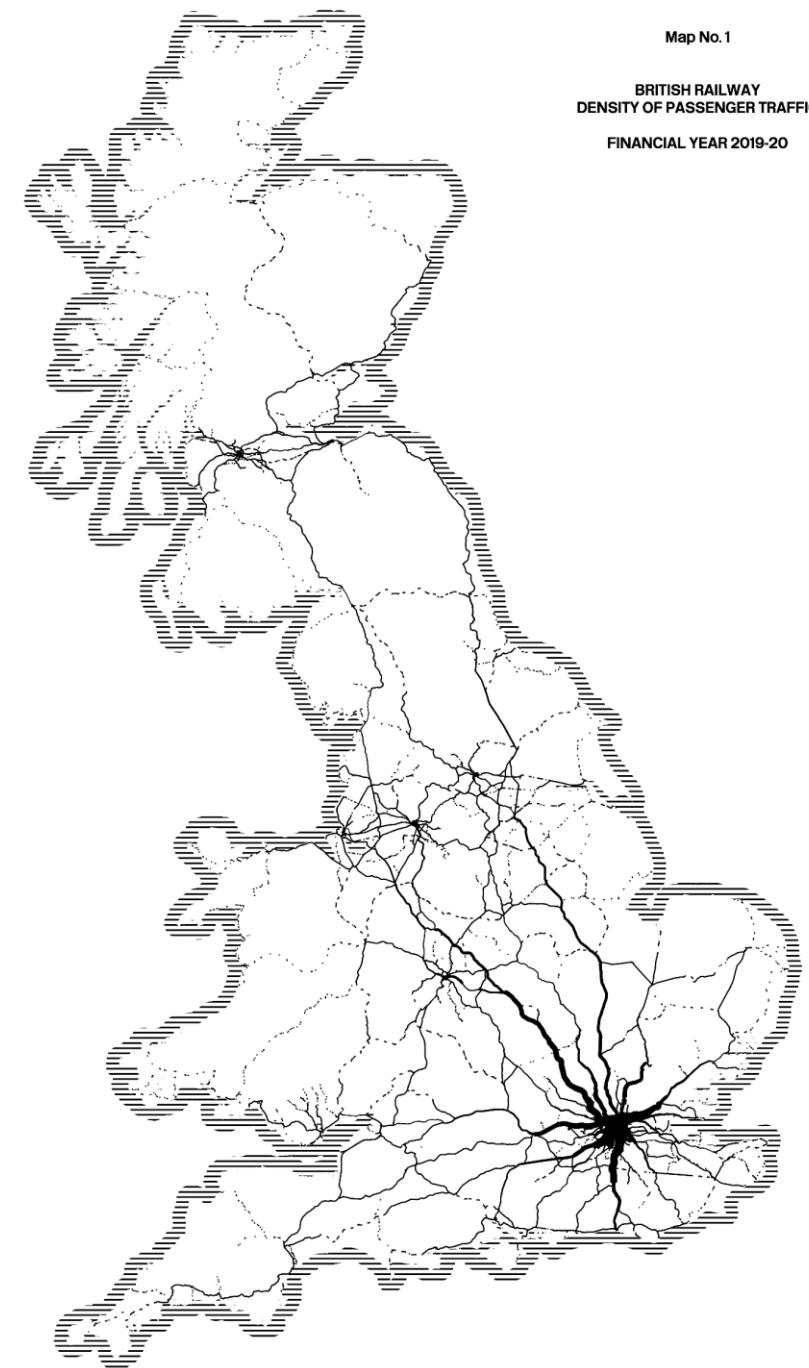
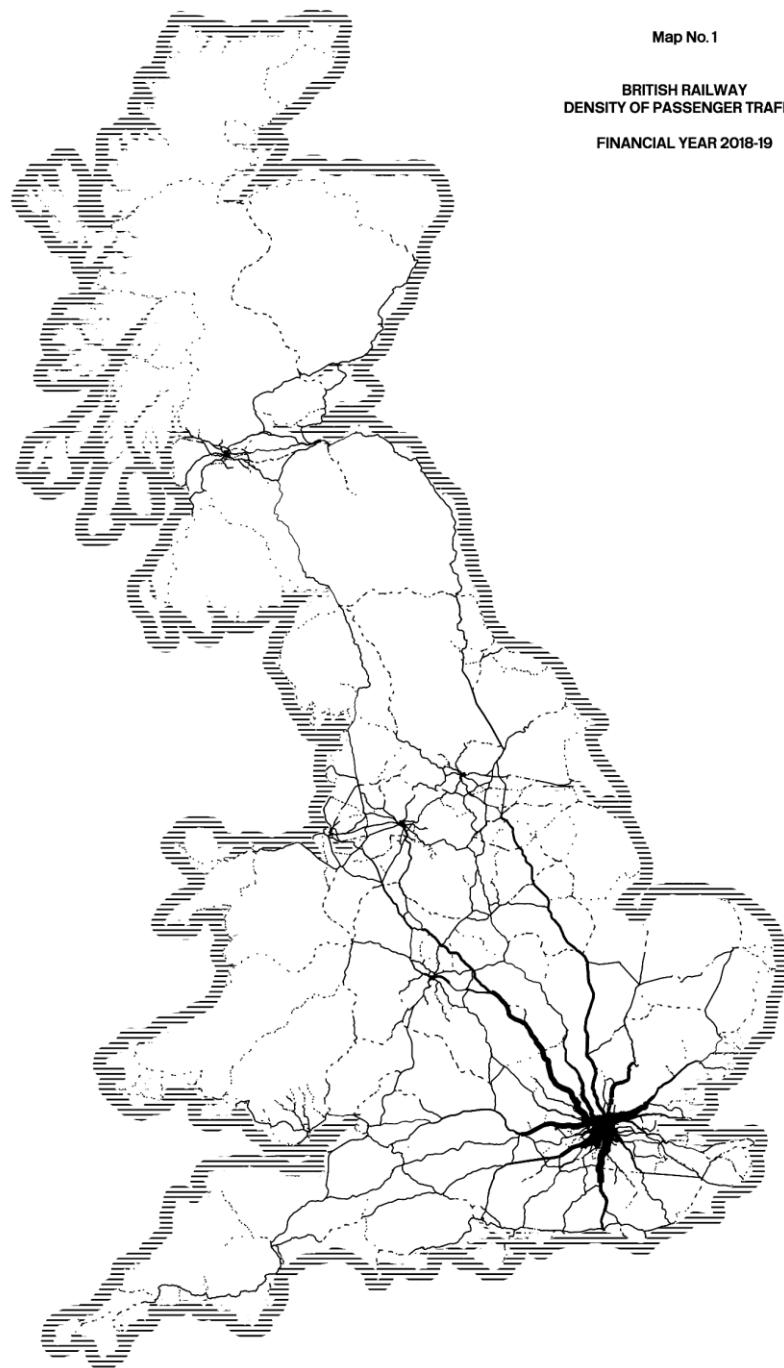
The Railway

The Reshaping of British Railways

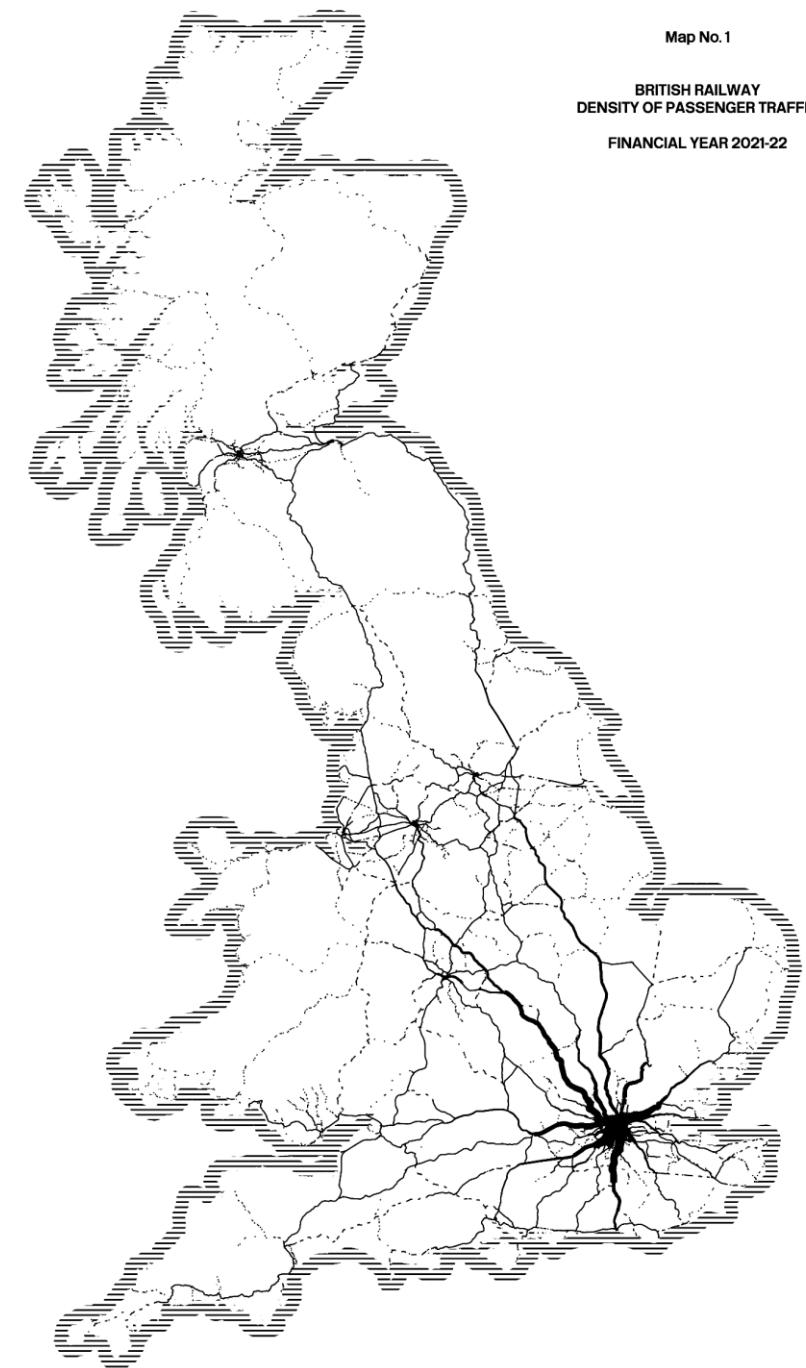
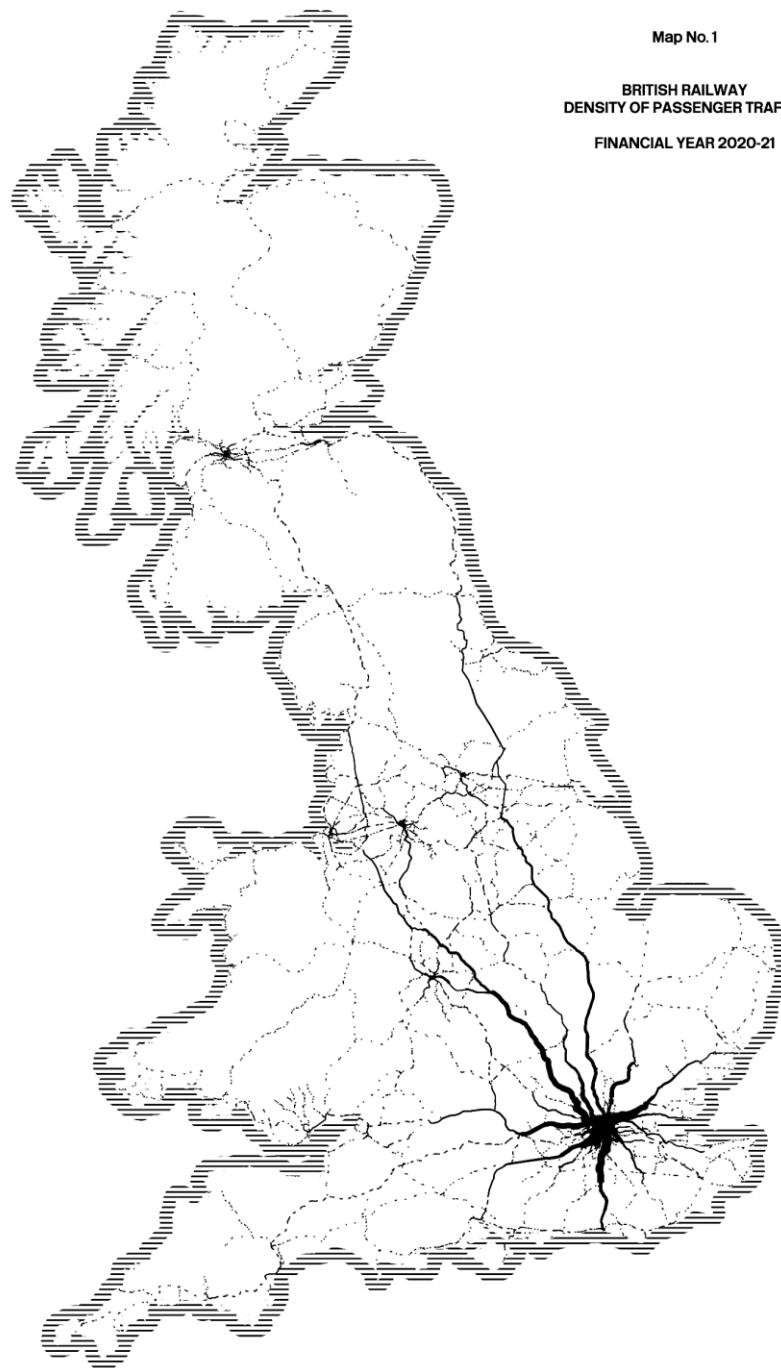
'The Beeching Report' 1963



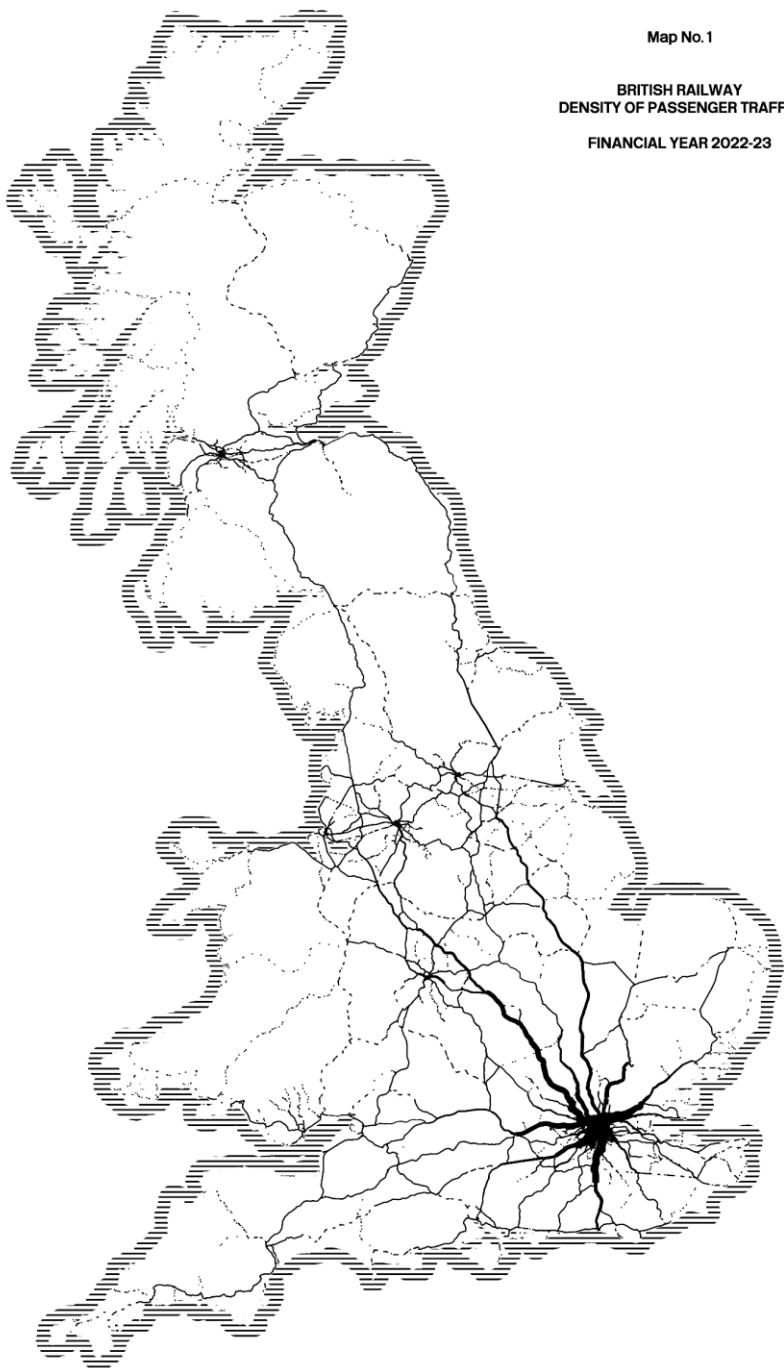
The Railway



The Railway

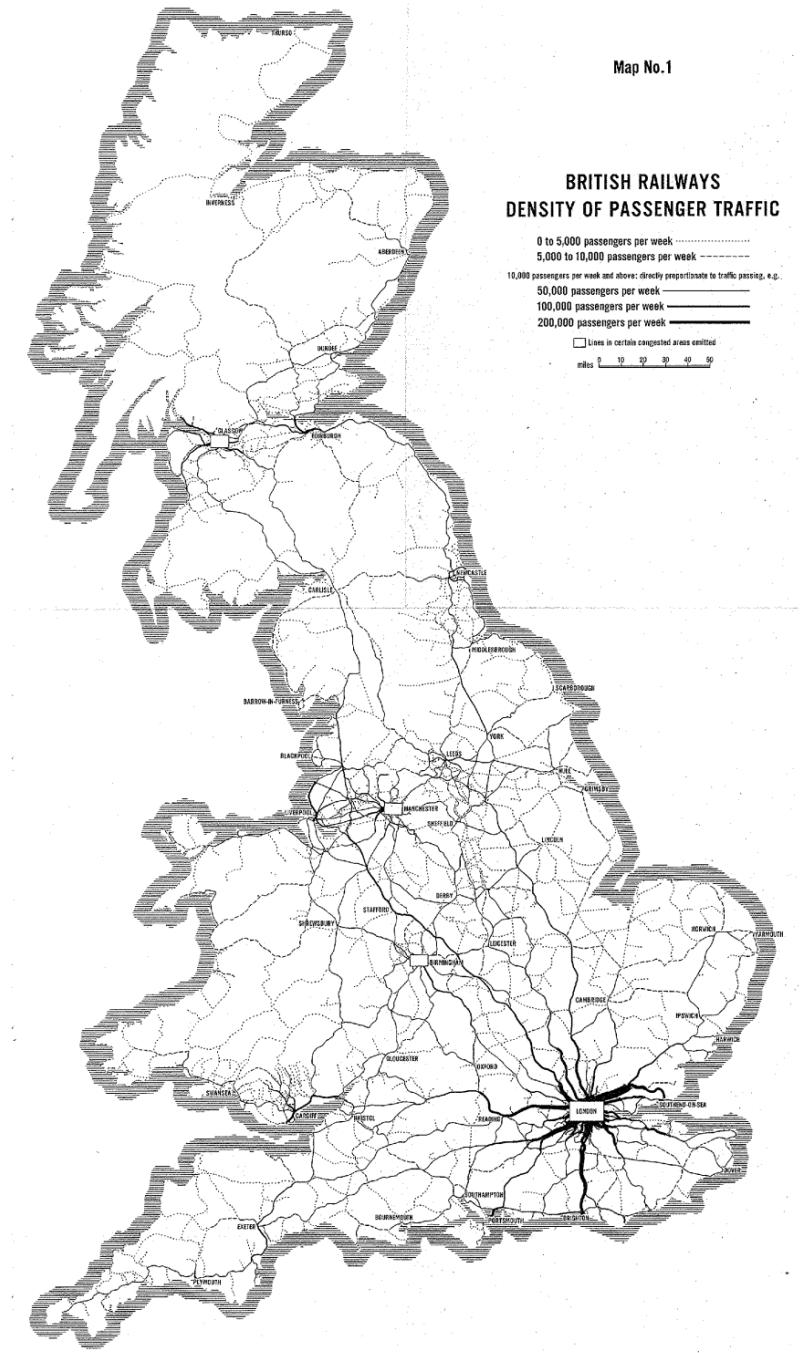


The Railway



Map No. 1

**BRITISH RAILWAY
DENSITY OF PASSENGER TRAFFIC**

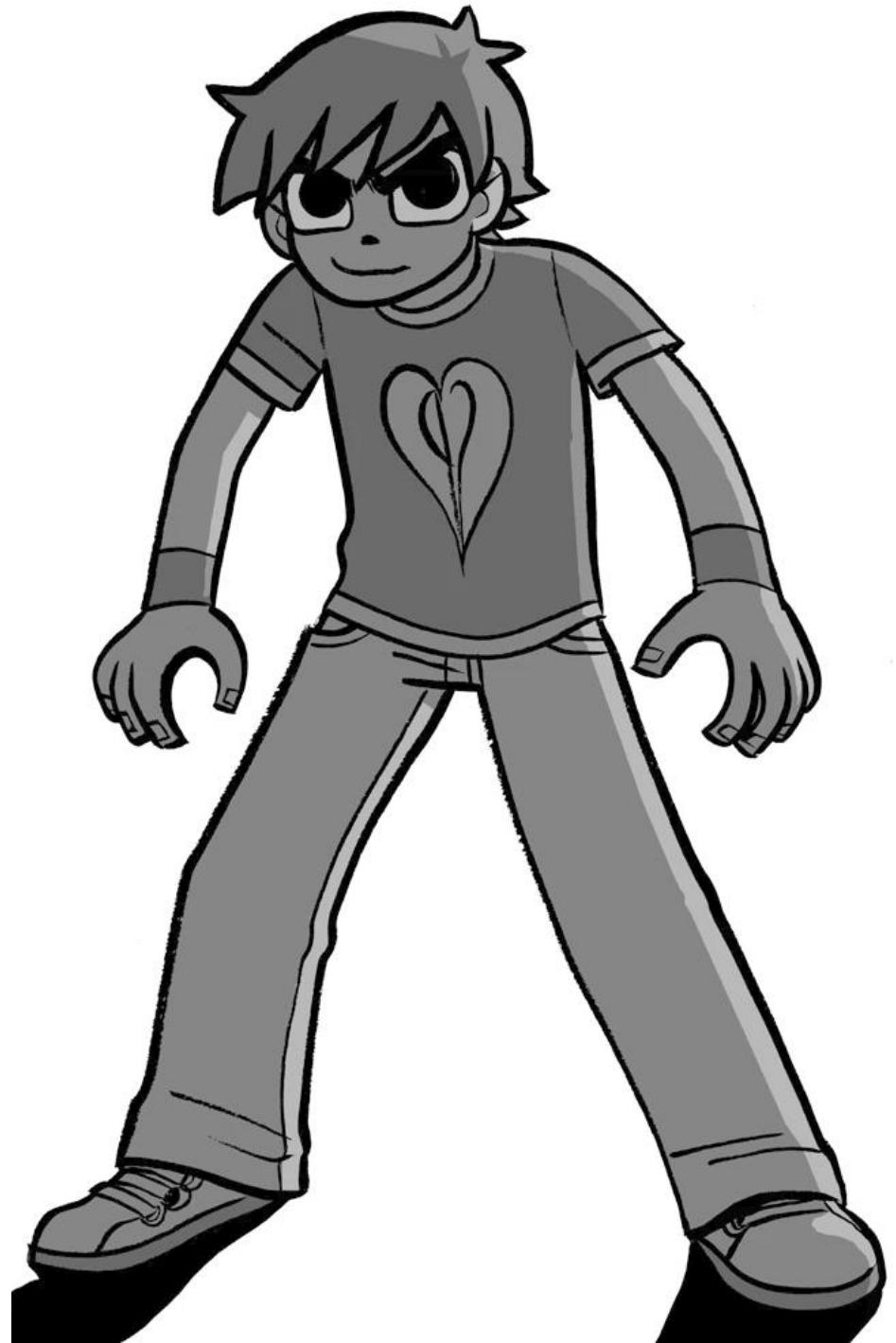


Map No.1

The actual



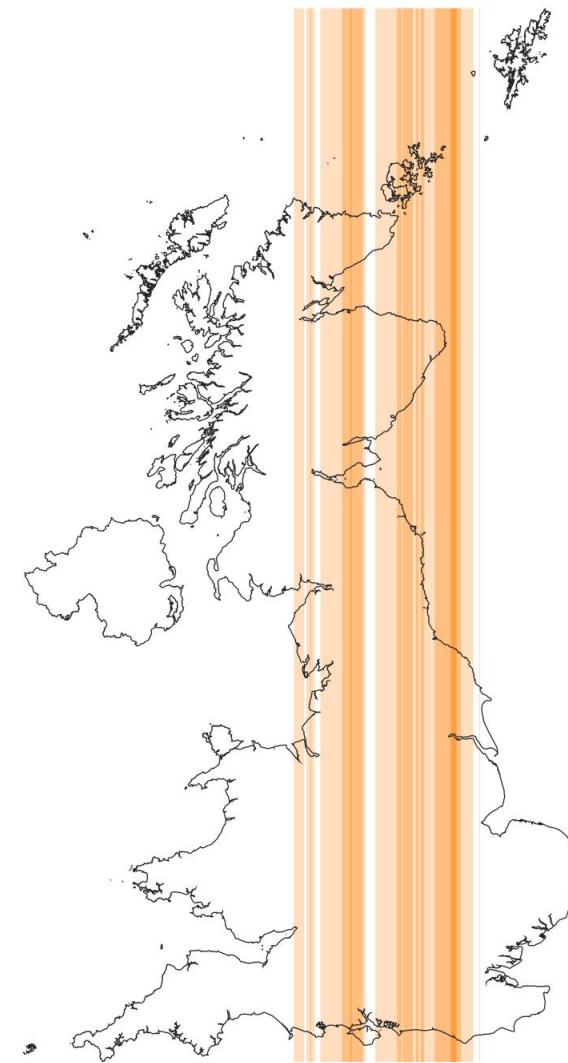
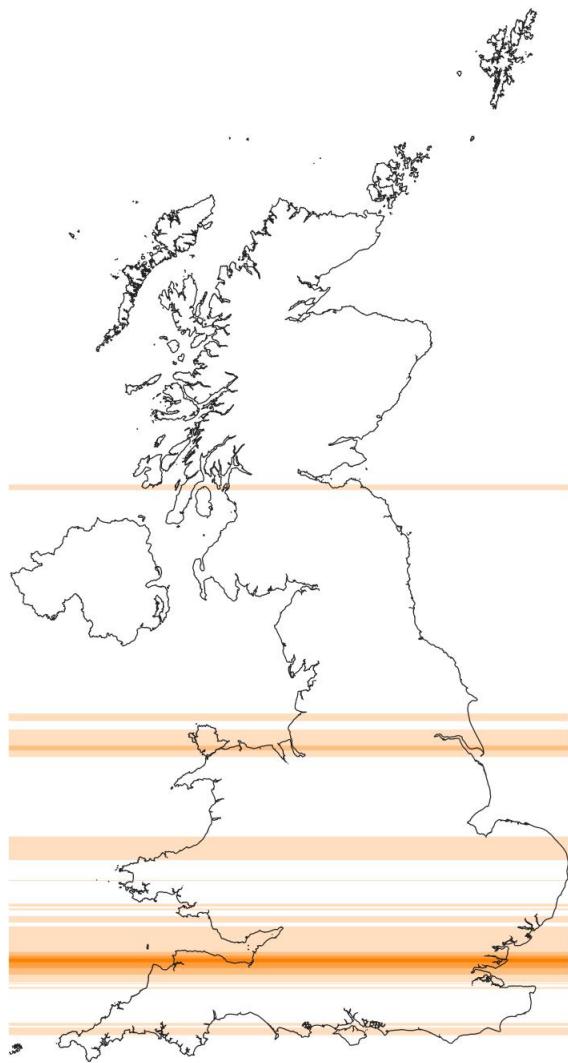
Gen X (Slacker Mode)



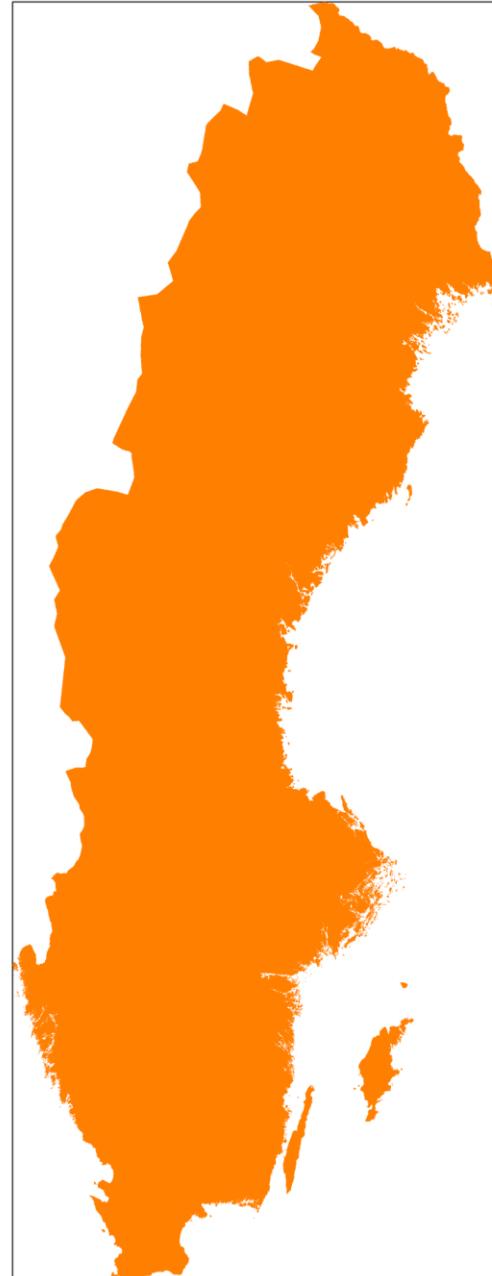
Post-Apocalypse



More Social Media



More Social Media



Here Endth
the
Second Lesson



Waving
not
drowning



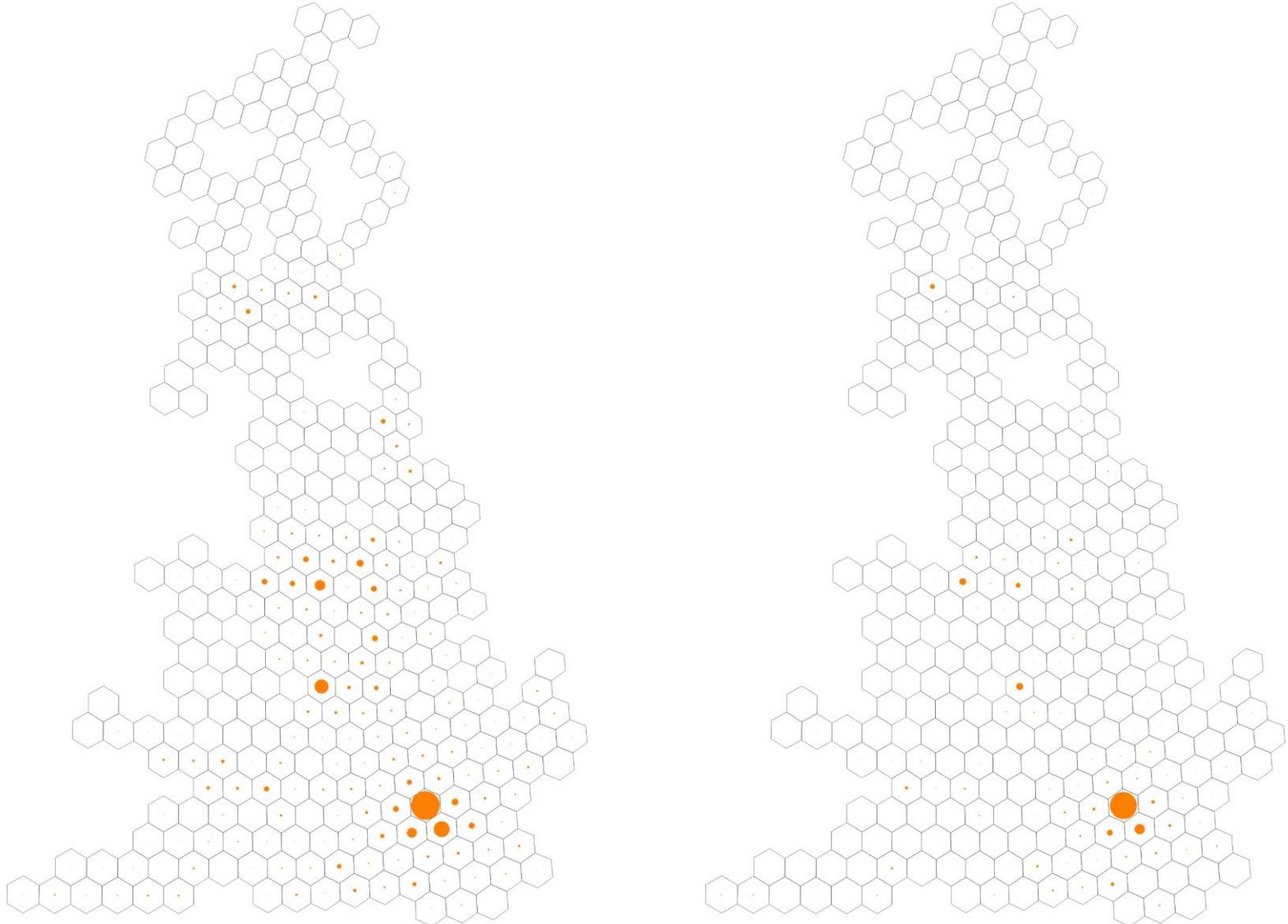
Work in progress



ODM Machine Learning

H3 Grid 03 Scale 400

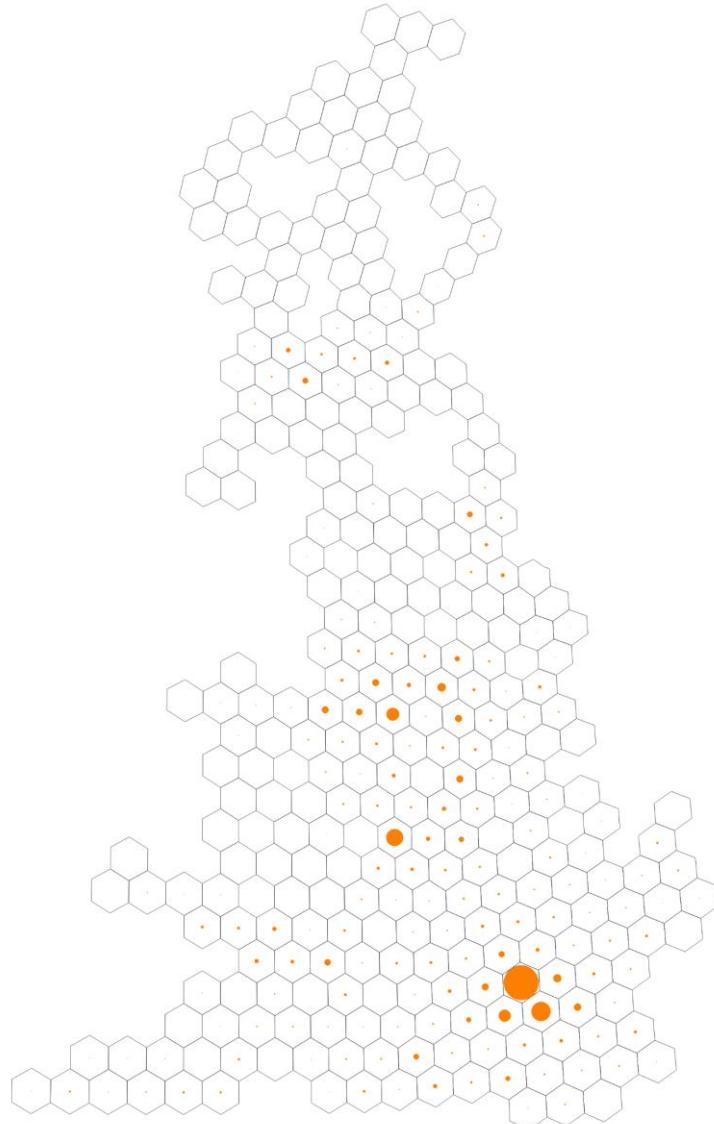
Population distribution Rail passenger travel



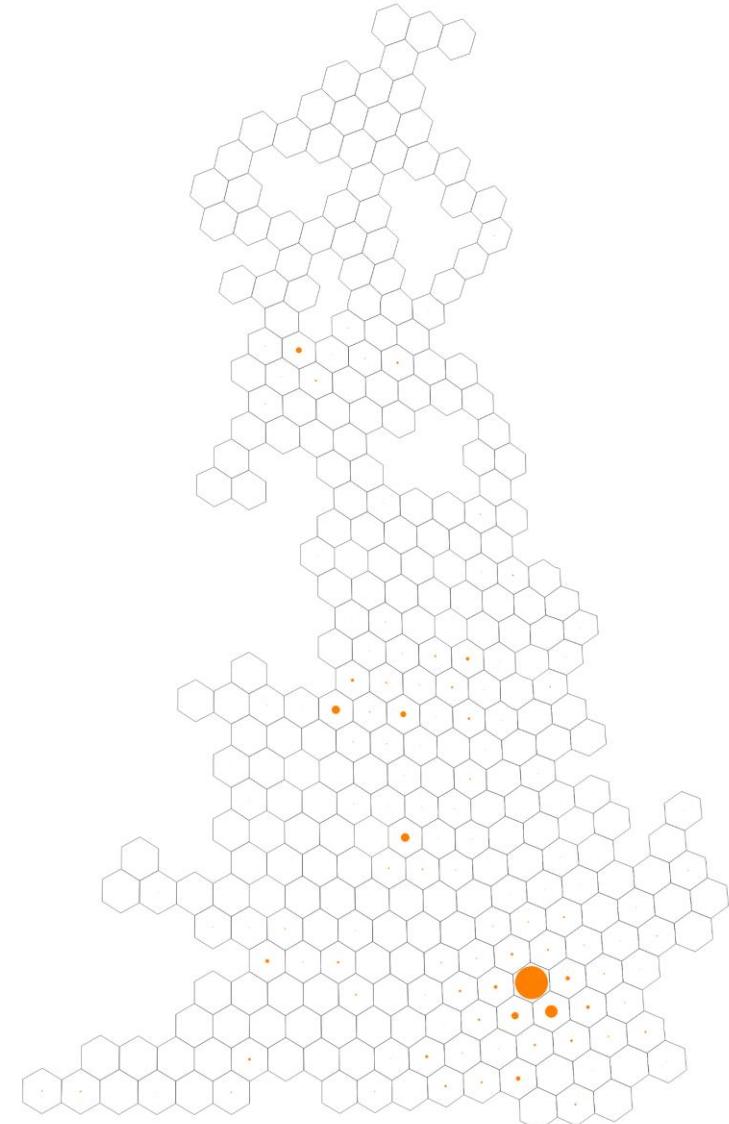
ODM Machine Learning

H3 Grid 03 Scale 400
R2 0.794

Linear Regression



Rail passenger travel

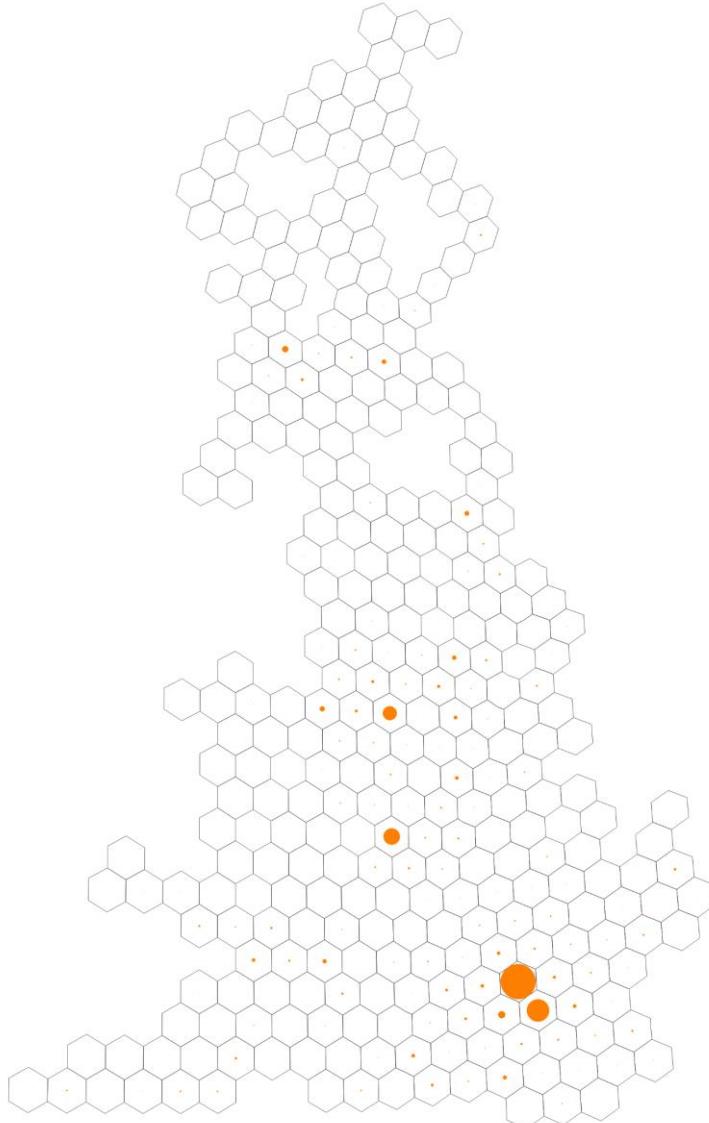


ODM Machine Learning

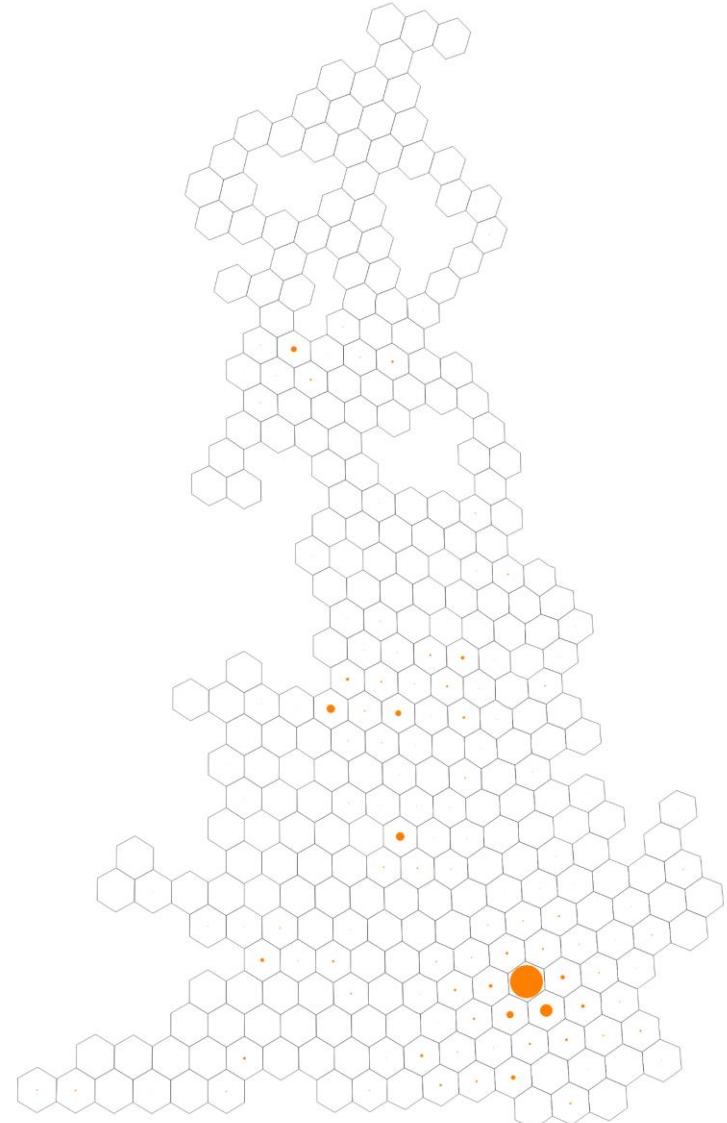
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R2 0.761

Histogram Gradient Boosting
Trees Regression

HGBR Regression



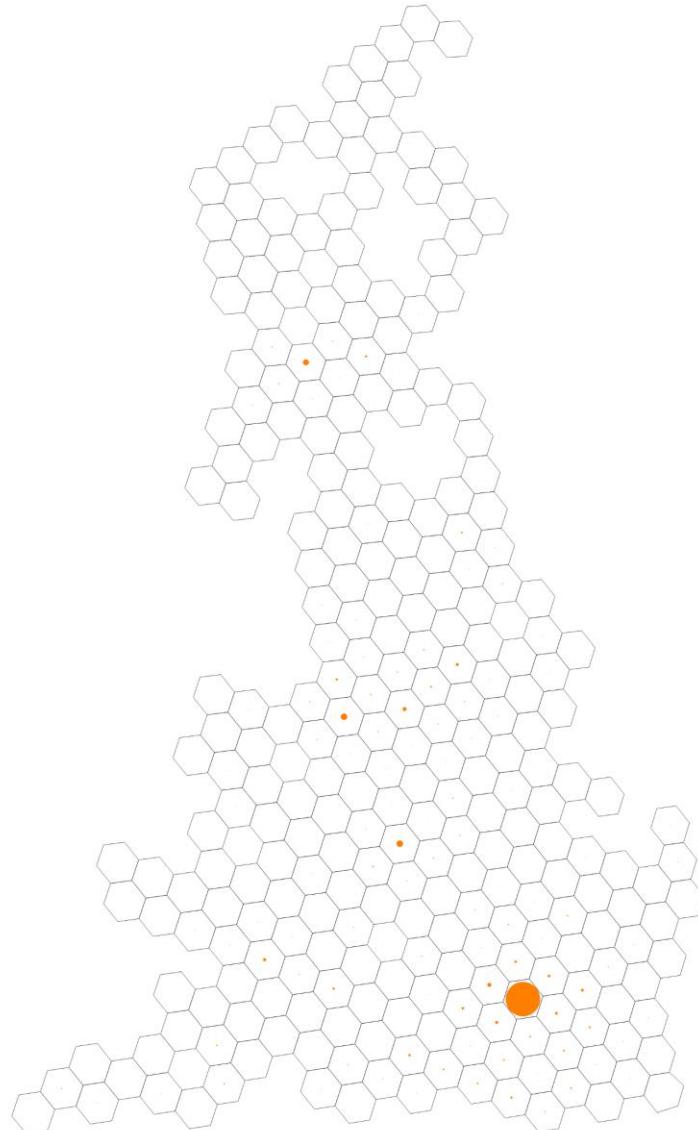
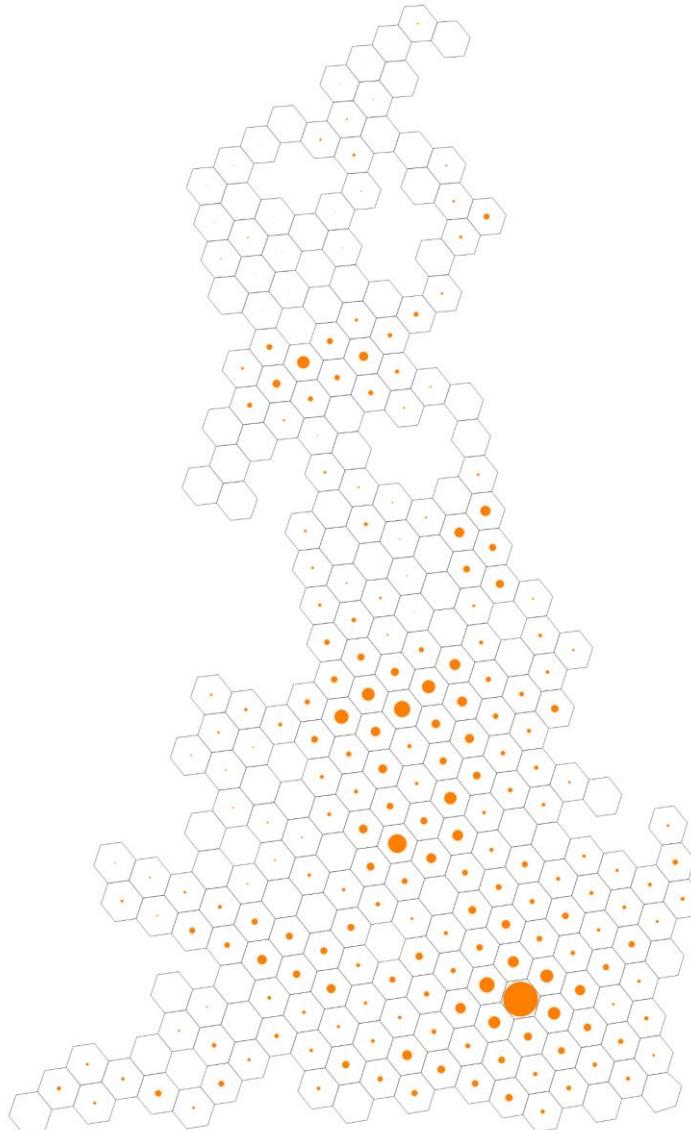
Rail passenger travel



ODM Machine Learning

H3 Grid 04 Scale 141

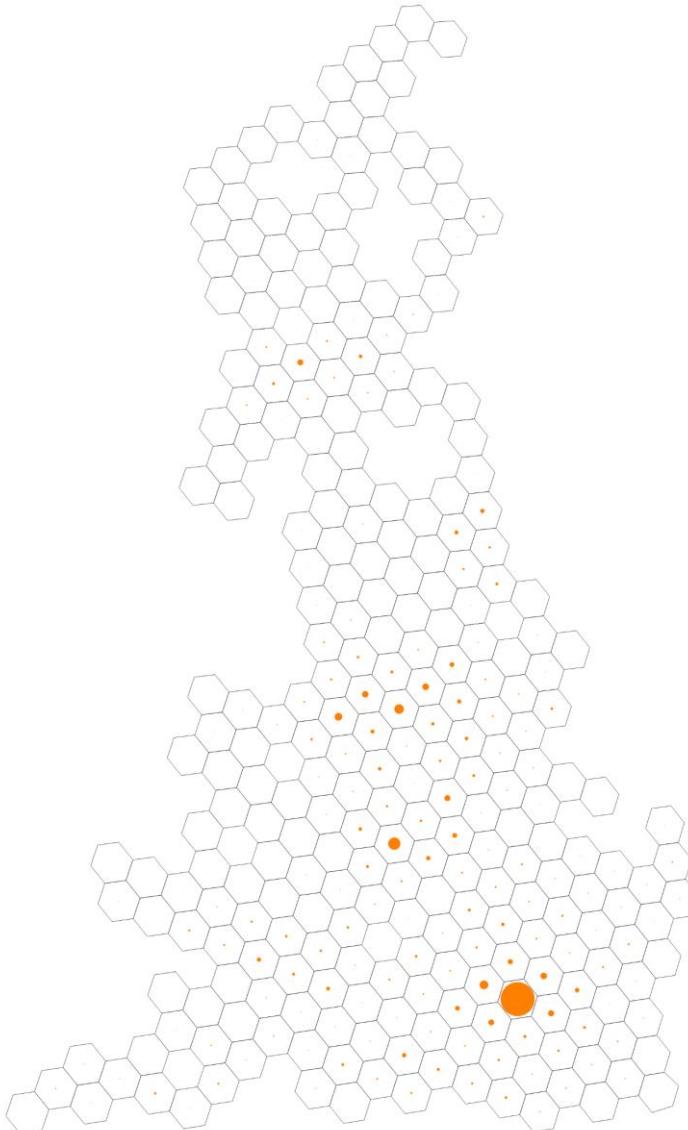
Population distribution Rail passenger travel



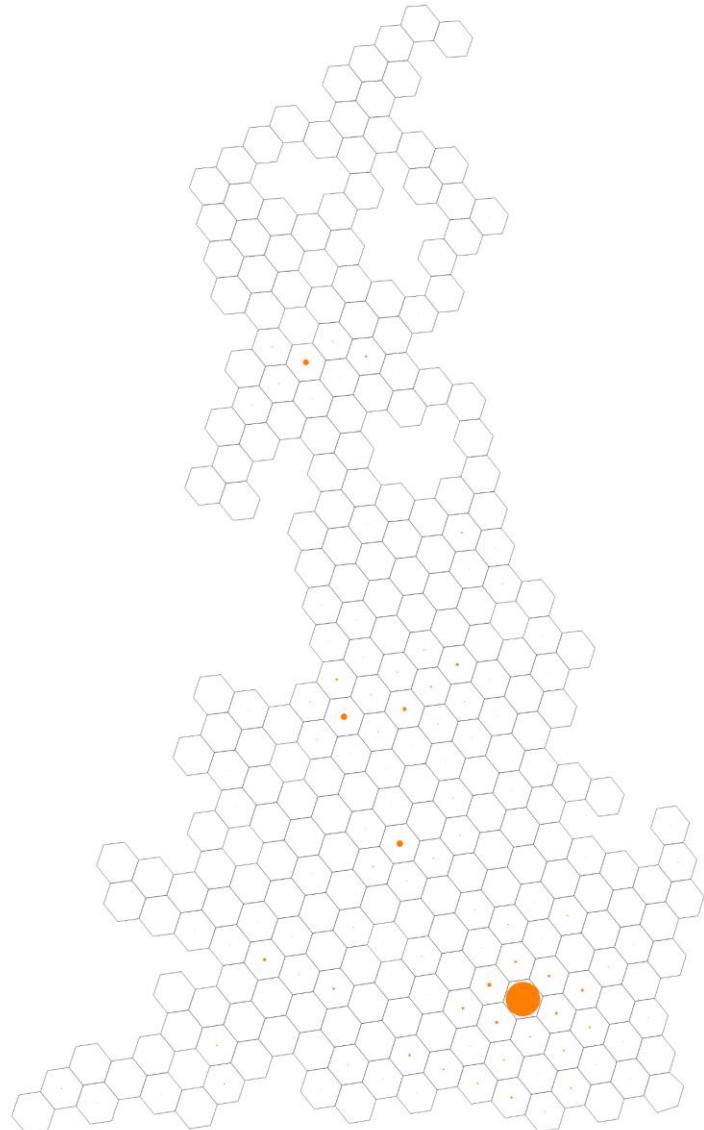
ODM Machine Learning

H3 Grid 04 Scale 141
R2 0.827

Linear Regression



Rail passenger travel

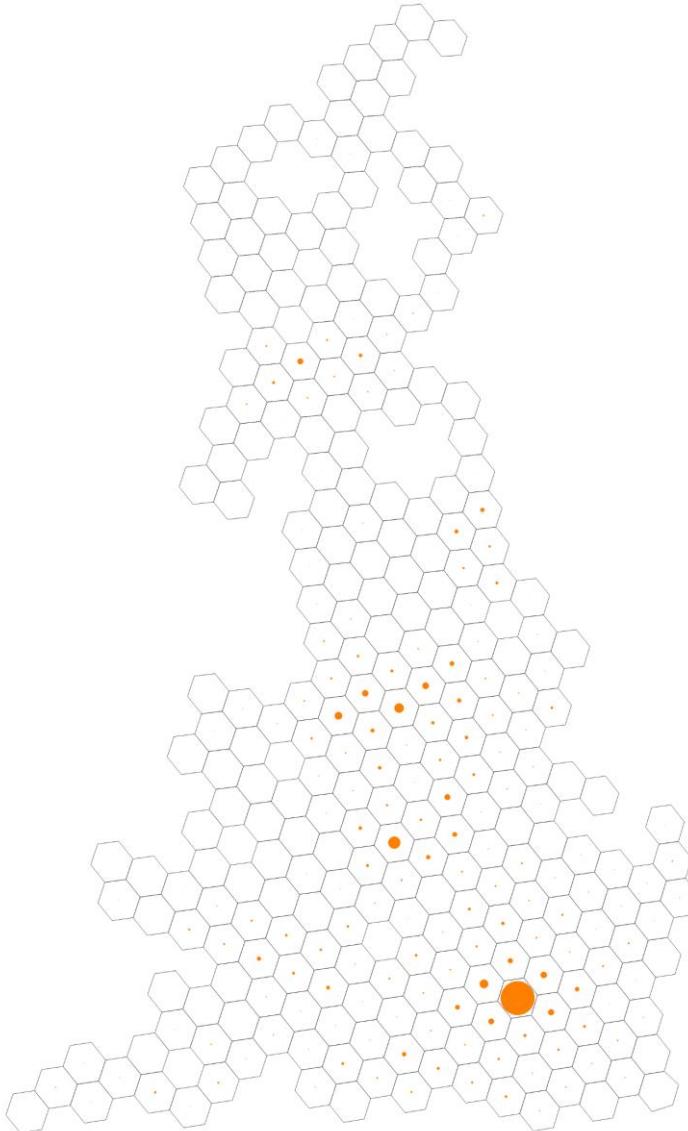


ODM Machine Learning

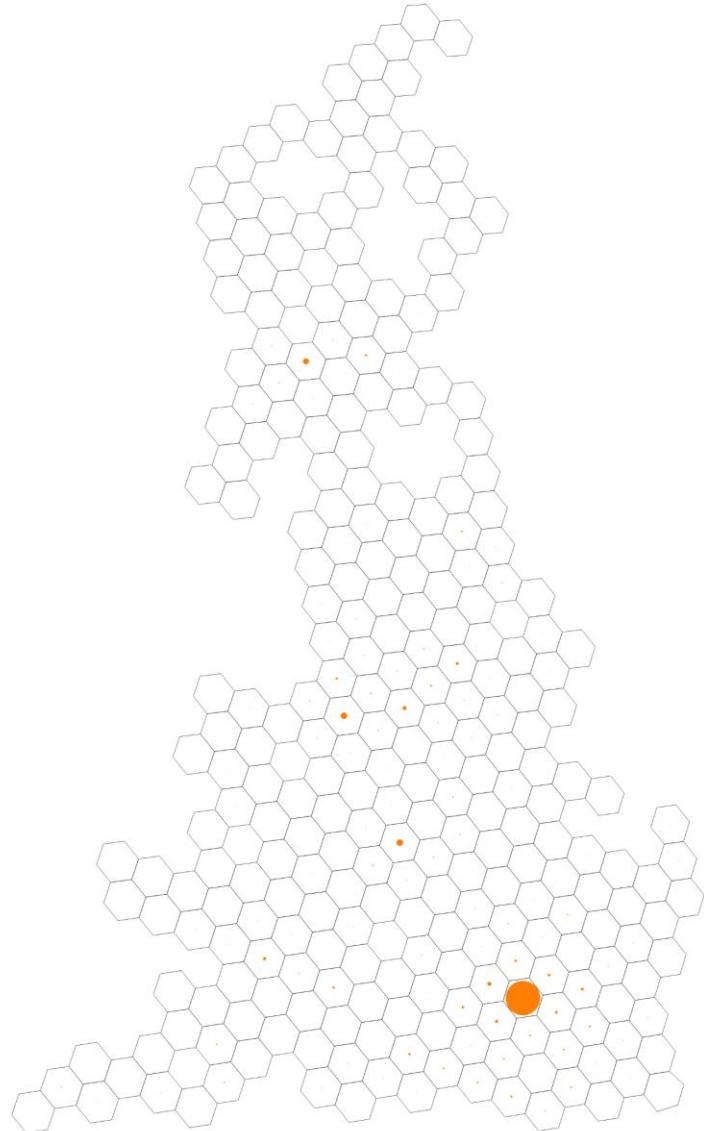
H3 Grid 03 Scale 400
R2 0.547

Histogram Gradient Boosting
Trees Regression

HGBR Regression



Rail passenger travel





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Origin and destination matrix (ODM) 2019-20

[Office of Rail and Road \(ORR admin\)](#)[FILE](#)

Versions

1.0 (Active)

Licence type

OGL3

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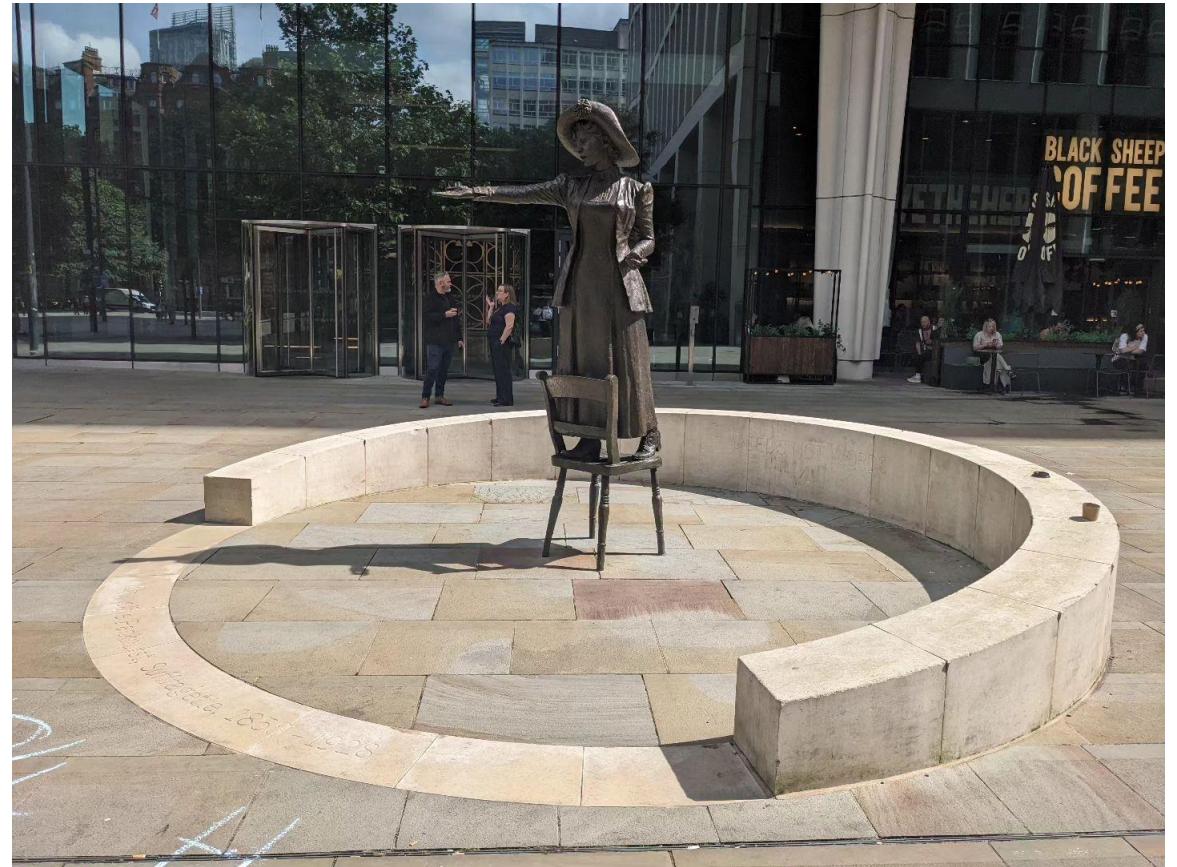
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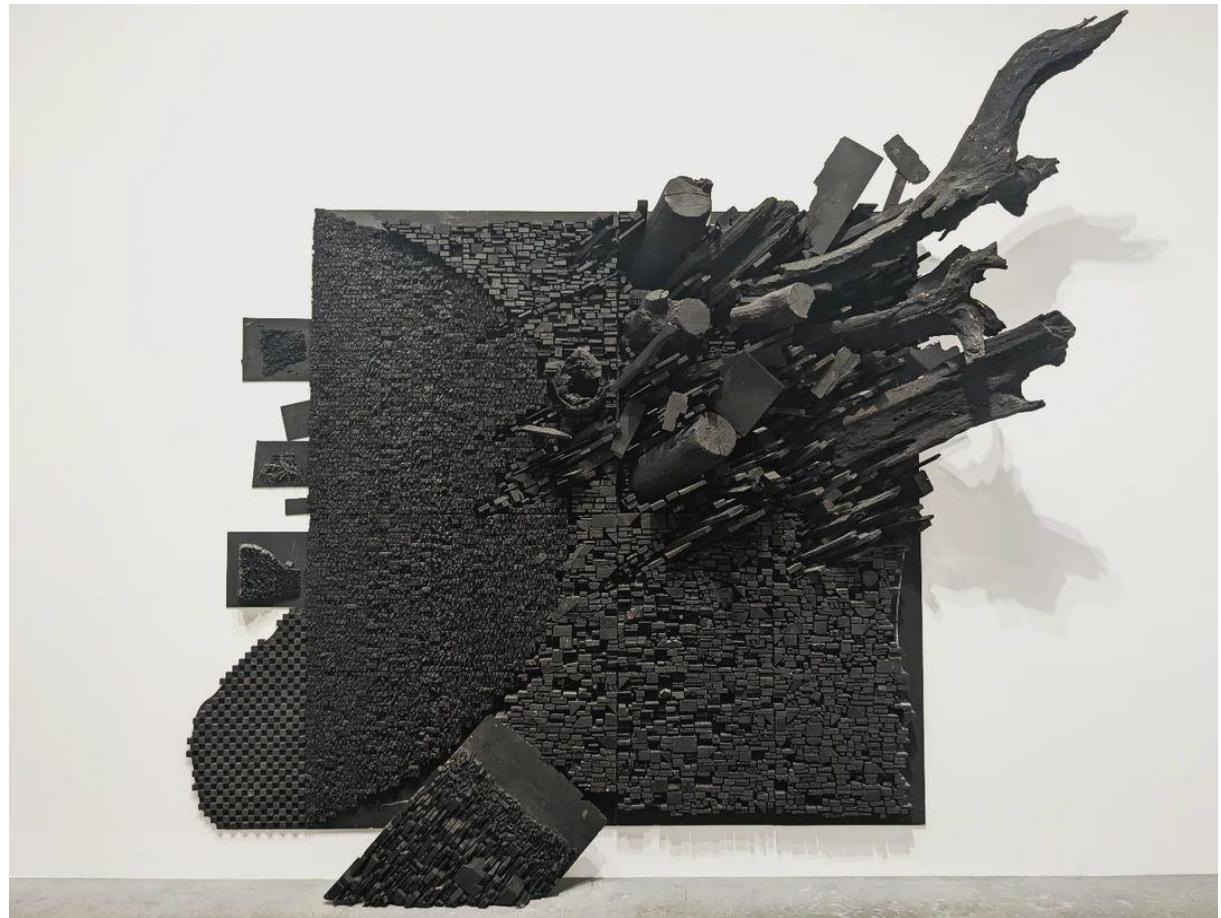
Origin and destination matrix (ODM) - journeys between all pairs of mainline stations in Great Britain in financial year 2019-20

Have a question?

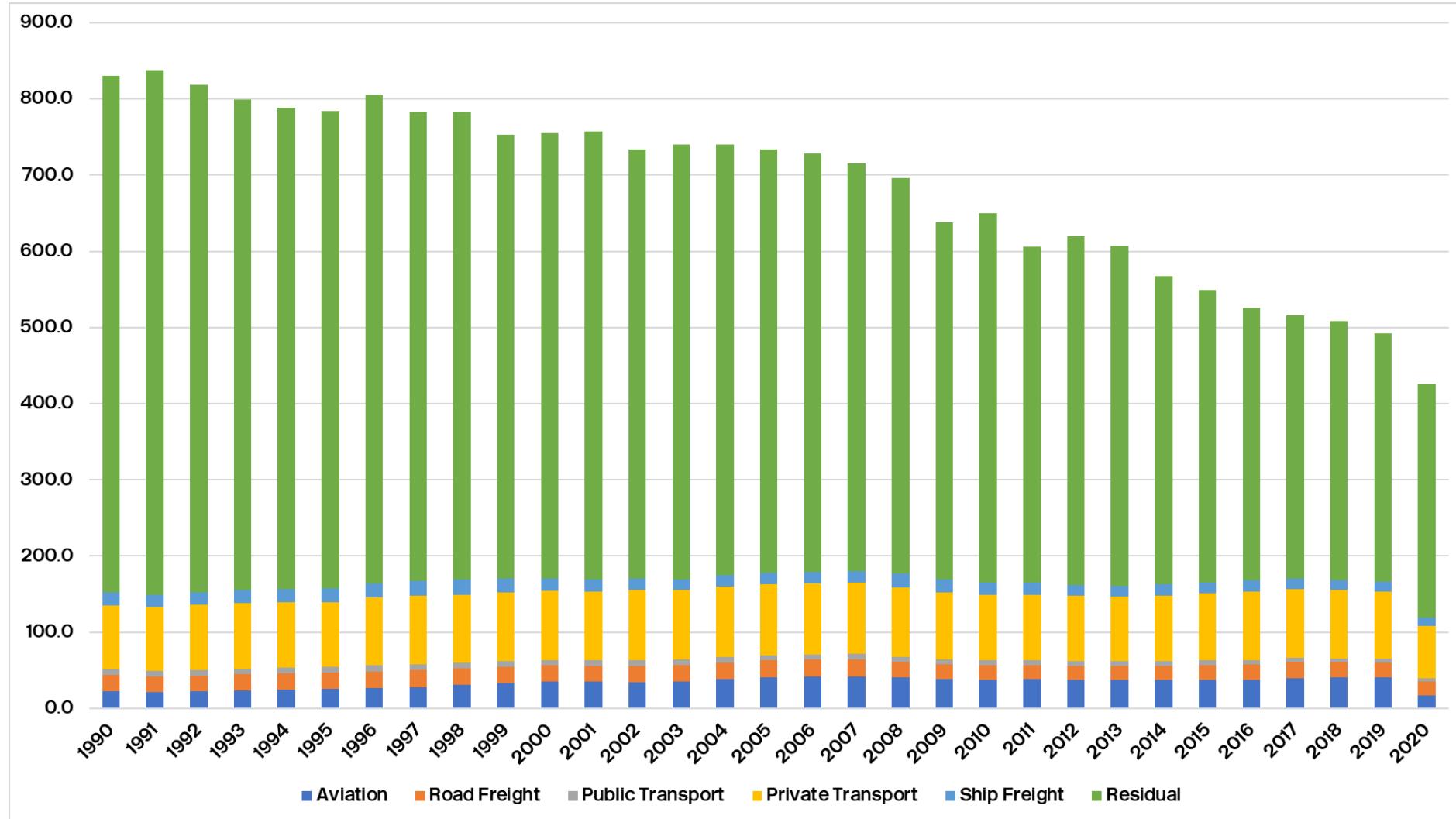
The then so what?



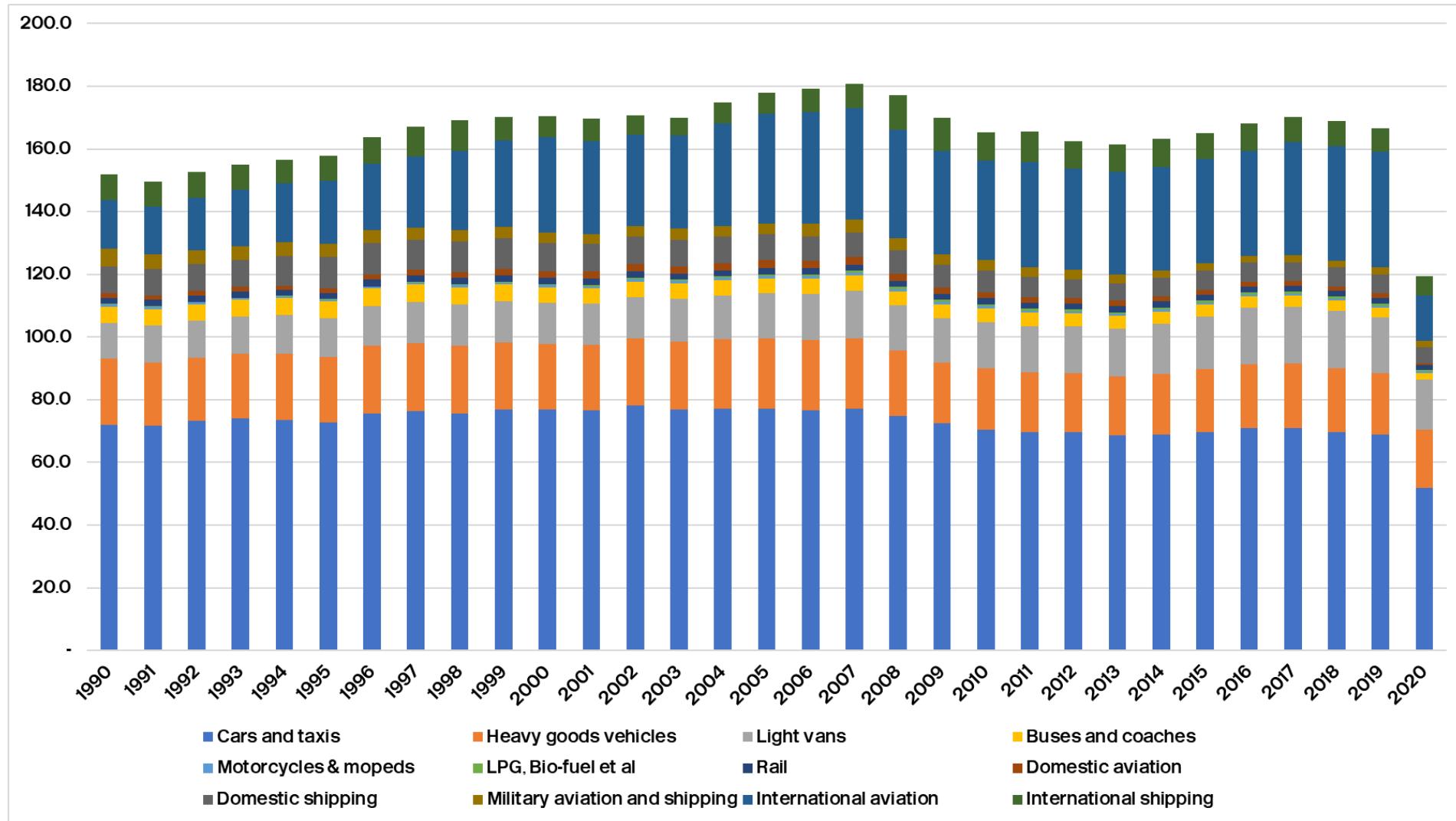
Emissions



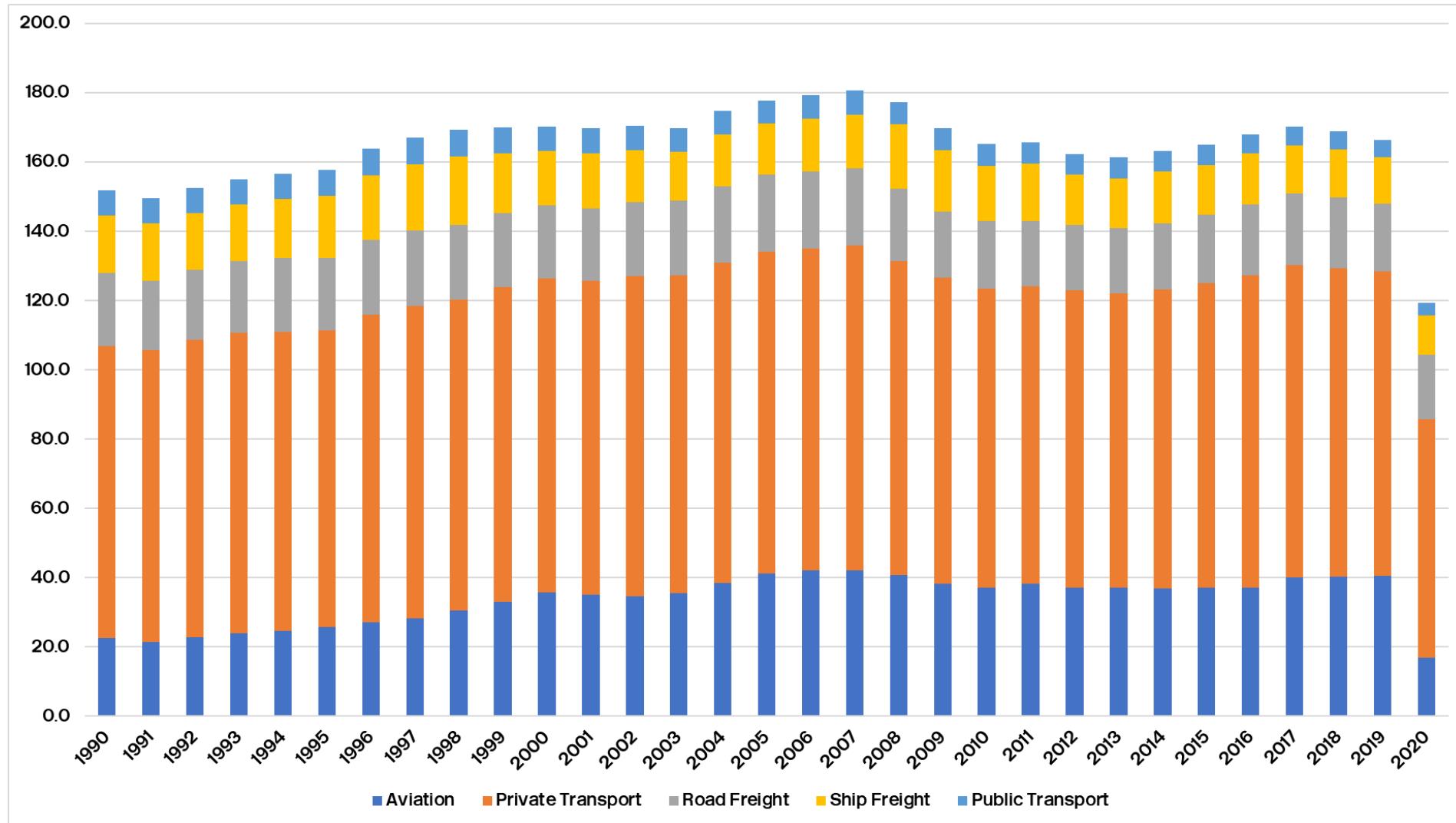
UK CO₂ Emissions 1990-2020



UK CO₂ Emissions 1990-2020



UK CO₂ Emissions 1990-2020



An Integrated Public Transport Strategy

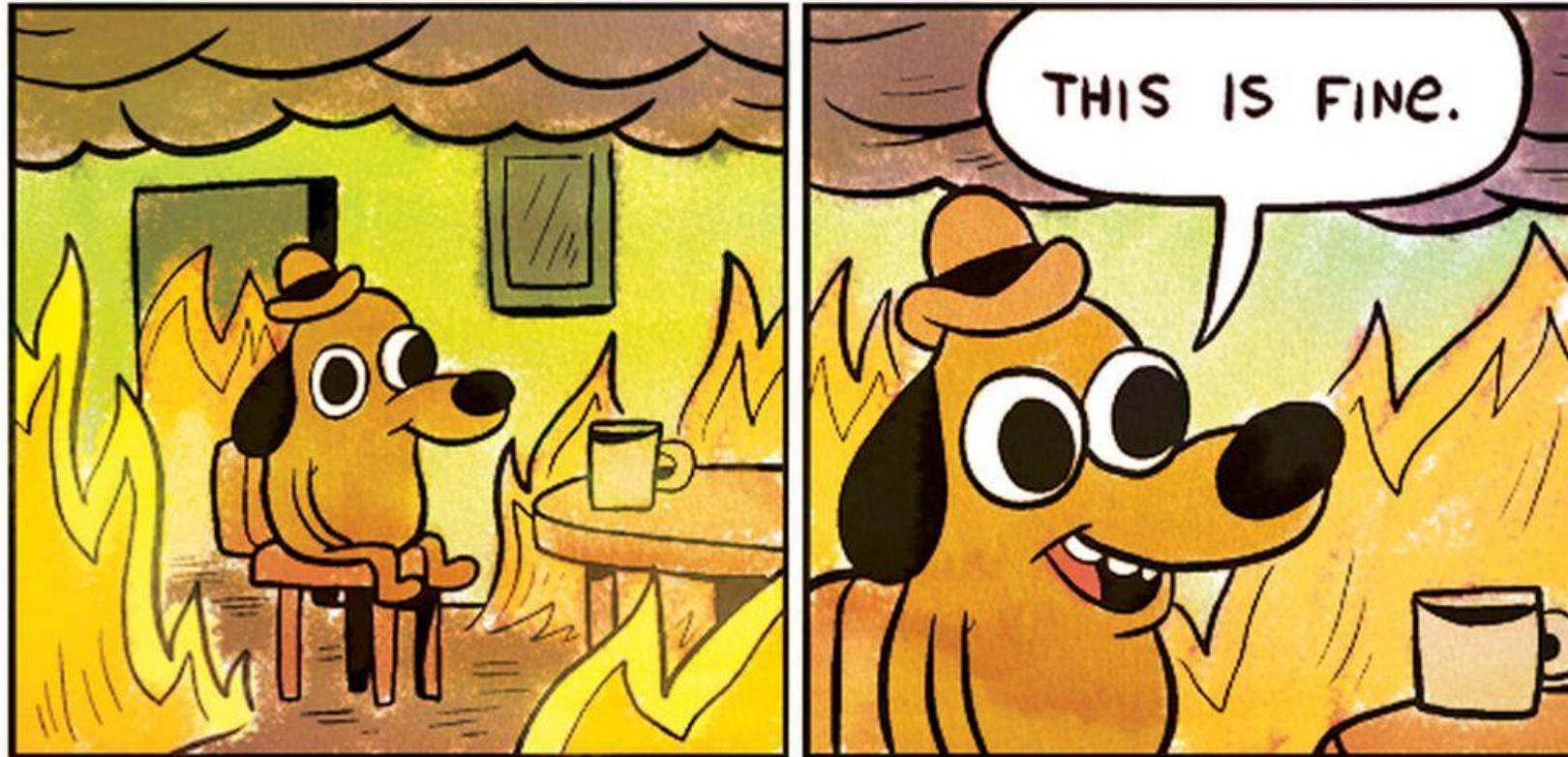


What about some High-Speed Rail?

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FULLY AUTOMATED LUXURY HIGH SPEED RAILWAY

Is it enough?



Questions and Answers



Parting Words

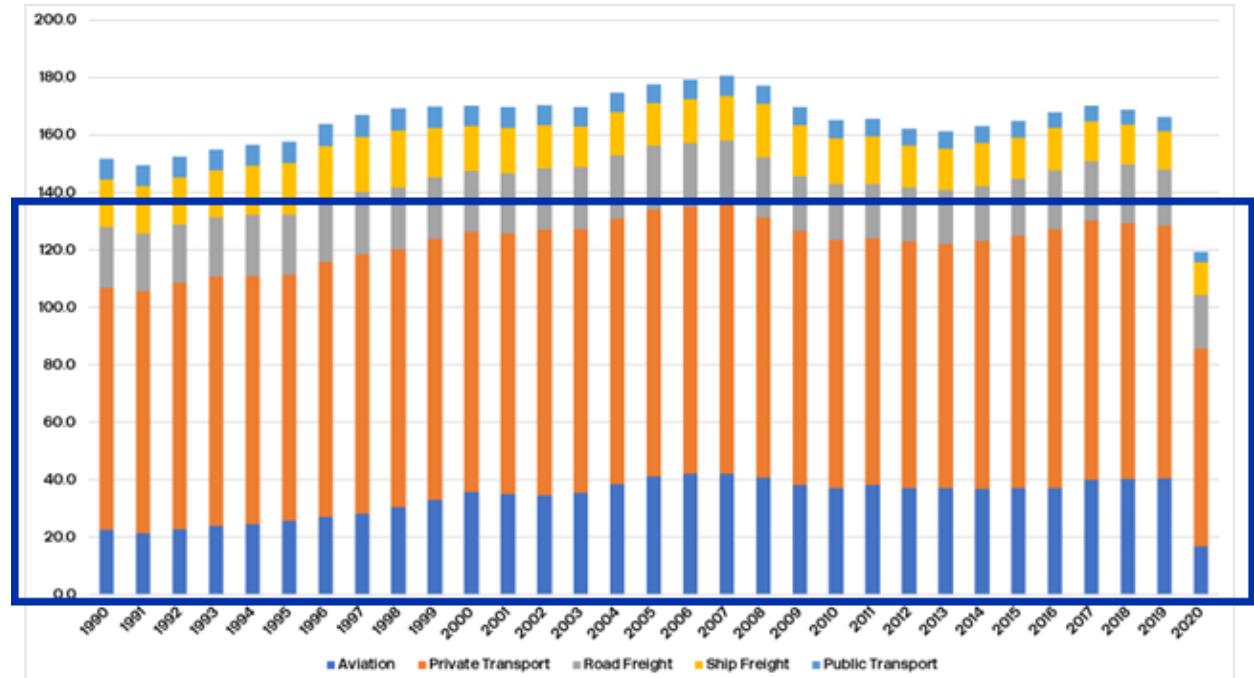




**Build it and
they will
come!**

Incremental Change

Significant investment in rail
will make a difference



The data is awesome...

'Madame Helena, the timetable is the most perfect product of the human mind'

R.U.R.
Karel Capek



...but it's all Greek to me

μῆνιν ἄειδε θεὰ Πηληϊάδεω Ἀχιλῆος
ούλομένην, ἡ μυρί' Ἀχαιοῖς ἄλγε' ἔθηκε,
πολλὰς δ' ἵφθιμους ψυχὰς Ἀϊδι προΐαψεν
ἡρώων, αύτοὺς δὲ ἐλώρια τεῦχε κύνεσσιν
οίωνοῖσί τε πᾶσι, Διὸς δ' ἐτελείετο βουλή, ἐξ
οὗ δὴ τὰ πρῶτα διαστήτην ἐρίσαντε
Ἀτρεΐδης τε ἄναξ ἀνδρῶν καὶ δῖος Ἀχιλλεύς

The Iliad book 1 - Homer



What about some High-Speed Rail?

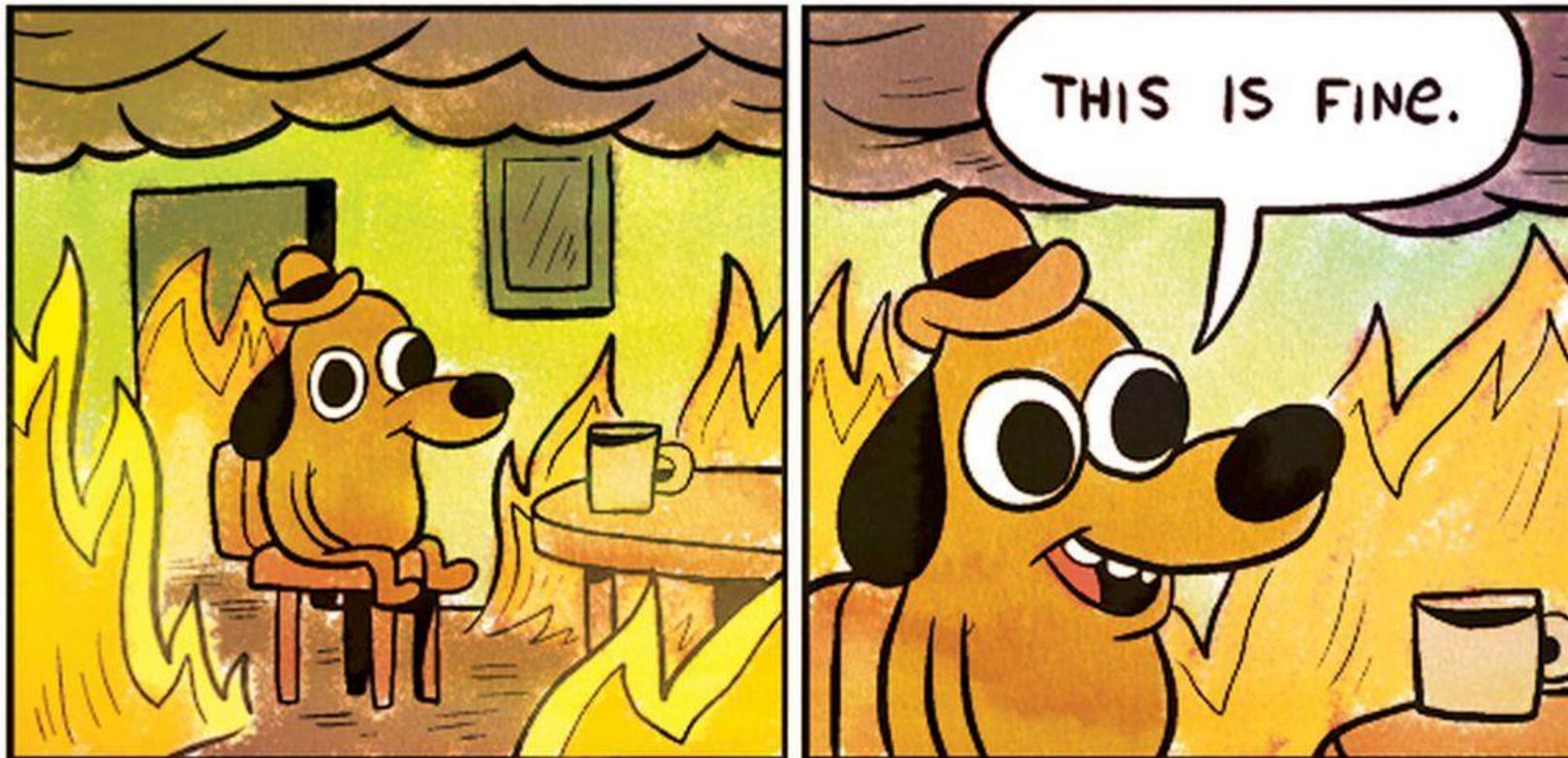
will deakin

FULLY AUTOMATED LUXURY HIGH SPEED RAILWAY

The big
BUT



Is it enough?



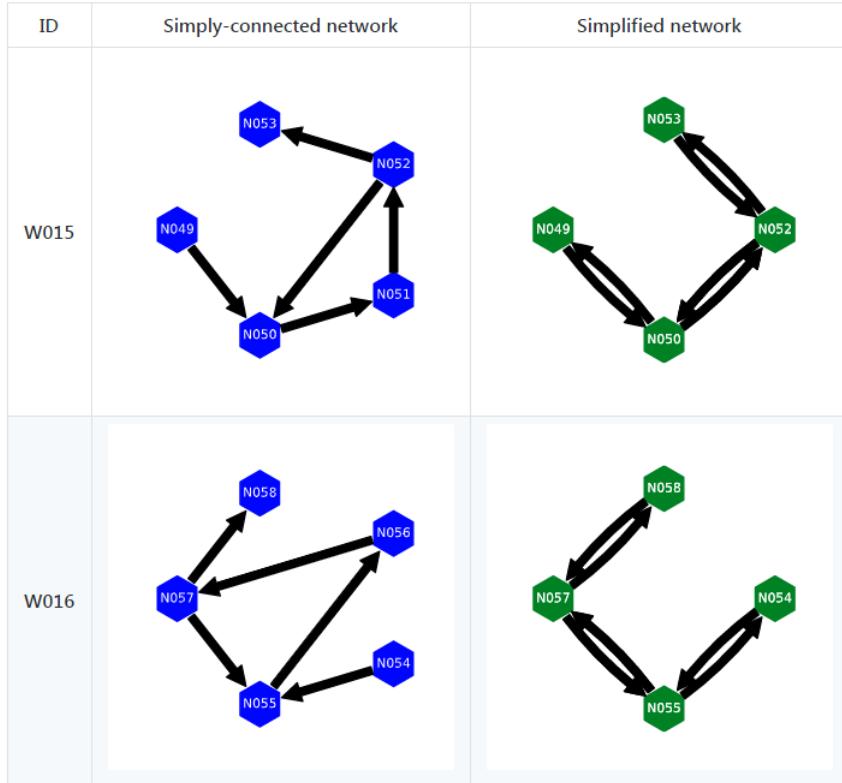
Thank You



Will Deakin
@wnd@fosstodon.org
X/Twitter @WillDeakin1



Technology



Tools

- github.com
- gist.github.com
- bl.ocks.org
- d3js.org
- python.org
- gdal.org
- leaflet.js
- [./jq](#)
- nodejs.org
- Tesseract-OCR
- [MapBox tippecanoe](https://MapBox/tippecanoe)
- arangodb.com
- postgresql.org
- tabula.technology
- tesseract-OCR
- solr.apache.org
- qgis.org
- gdal.org
- python Pandas
- python GeoPandas
- python osmnx

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6. Department for Business, Energy & Industry Strategy, [here](#)
7. Open Rail Data wiki, [here](#)
8. Rail Development Group “Concept of Operations - Stock and Crew System” (RDG-CONOPS/NTI/002 Issue 1.1) January 2021 [here](#)
9. National Electronic Sectional Appendix (NESA) [here](#)
10. NESA table extract [here](#)

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Postscript

'It is better to ask some of the questions than to know all of the answers'

- James Thurber

My thanks go to Alisdair Rae, Peter Hicks, Stuart Lowe, Gareth Dennis, Xander Veitch, Garry Keenor, and my ever and long-suffering family, all friends, colleagues and contributors to all the projects I have wilfully used for their help, support and advice

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