Get your dataset ready!

Using R and GIS

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1 Introduction

This course aims to provide tools to deal with exploring and treating transportation datasets using R programming, an open-source and widely used tool for data analytics in urban mobility.

Additionally, this course provides guidance towards the use of reproducible methods to deal with large datasets that require manipulation and/or spatial analysis.

The course has a **hands-on** approach, where participants will learn the basics of **coding**, **data manipulation**, and **spatial analysis** for urban mobility and transportation.

1.1 Mobility data

There is an emerging increase in mobility data, through new forms of technology, which result in very large and diverse datasets.

Figure 1.1: E-Scooter trip data in Lisbon. How to deal with it?
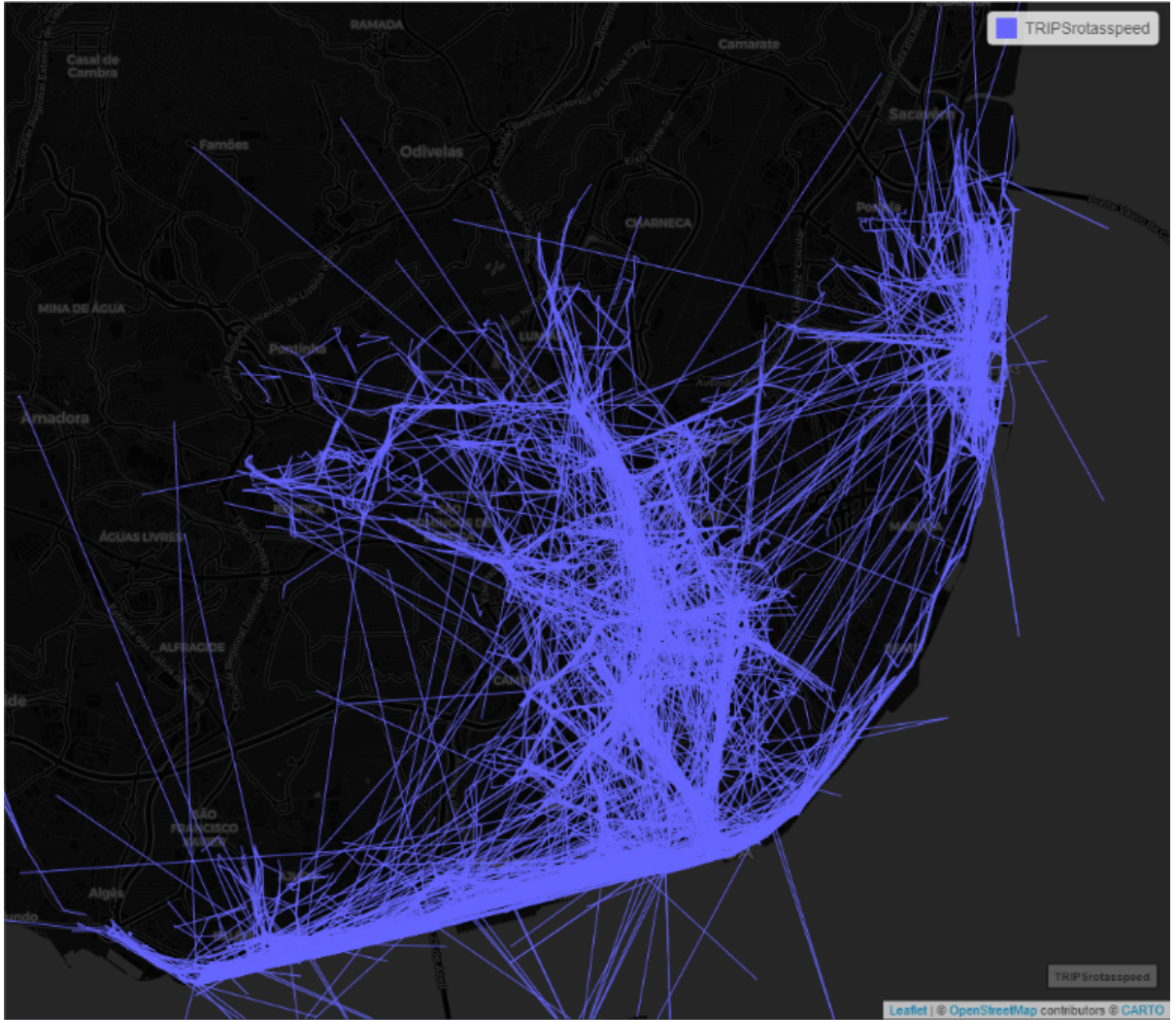
Knowing how to get, treat and analyze complex datasets with the up-to-date technologies is extremely relevant for academia, policy makers and start-ups, since it allows them to:

1. acquire critical view on urban mobility based on data;

2. spatially identify locations in the city that require policy priorities;

3. and improve the efficiency of data analysis processes.

Why R and GIS

Most academic programs focus on teaching modelling and deep analysis of data. However, there is a need to learn how to explore and prepare a dataset for modelling. The use of **programming and GIS** techniques have enormous advantages, including their flexibility; reproducibility; and transparency and understanding the step-by-step process.

The use of GIS techniques in transportation is, traditionally, not considered in transportation learning programs, despite being of enormous relevance when doing accessibility analysis or reeling with georreferenced transportation data, such as bike sharing route trips' datasets, origin-destination flows datasets, home/work locations, GTFS public transit data, and so on. There is a need to learn how to locate these open datasets, how to explore them and how to integrate them into transportation and urban analysis. Additionally, the use of open source software and datasets allows researchers to perform methods that are reproducible and transparent.

TLDR

- Open-source tools widely used in data analytics and spatial analysis
- Flexibility and reproducibility in data manipulation and visualization
- Critical for urban mobility and transportation research, with spatial relevance
- Large transportation datasets are becoming increasingly common

1.2 Course objectives

Introduce R Programming Basics

- Equip participants with foundational skills in R programming
- Emphasize reproducible research practices to ensure transparency and replicability in analyses

Teach Data Manipulation Techniques

- Use key R packages for data cleaning, manipulation, and summarization of datasets
- Enable participants to efficiently handle large and complex transportation datasets

Spatial Data Visualization

- Introduce methods for quick and effective spatial data visualization using R and GIS tools
- Provide hands-on experience with creating interactive maps and visualizations

Perform Basic Spatial Analysis

- Teach participants how to perform spatial analysis of transportation datasets using GIS techniques with R
- Cover practical applications such as georeferencing data, accessibility analysis, and routing ODs
- Utilize real-world transportation data for practical, hands-on learning

1.3 Target audience

- Ph.D. candidates from DTN and other researchers
- Policy makers and practitioners in urban mobility
- Beginners to intermediate R users, no prior experience needed

2 Course Structure

The course consists of an in-person 2-day course, taking place during the EIT DTN Annual Meeting on the **19th and 20th September 2024**.

The first day will focus on learning the basics of R programming and how to treat and explore datasets. The second day will focus on analyzing spatial datasets, and routing origins to destinations.

2.1 Day 1

Morning

- Introduction to **programming** techniques and **data structures**
- Introduction to R, and RStudio: **software installation** and main packages
- **R base and basics**: examples and exercises

Afternoon

- **Data manipulation**: using the dplyr package to select, filter, left-join, group and summarize
- Introduction to **GIS** and **spatial data**: import and visualize vector data
- R markdown and **interactive maps**

2.2 Day 2

Morning

- **Desire lines** from OD and transport zones
- **Georeference** coordinates: examples from surveys
- **Accessibility analysis**: from buffers to road networks

Afternoon

- **Open Transportation data**: where to find it
- **Routing with R**: multimodal and intermodal (*r5r demo* - Rafael Pereira)
- Group **exercise**

3 Detailed schedule

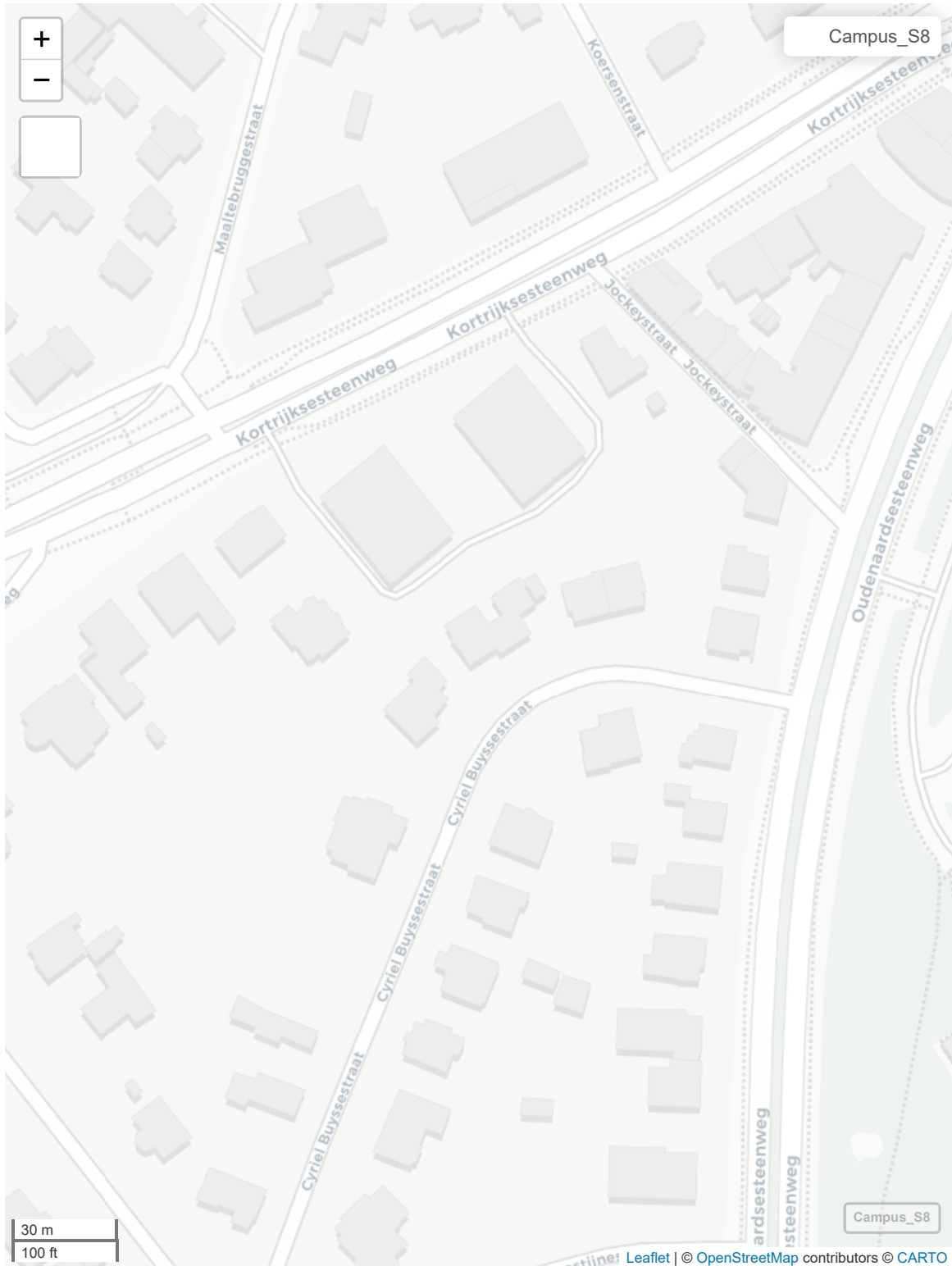| Day 1	
9.00	Introductions and Presentation of the course contents

Day 2	
9.00	Getting ready

4 Location

The course will take place at Campus Sterre, Building S8, room 2.4.

```r
Campus_S8_coord = c(3.7105372, 51.0241258)
Campus_S8 = sf::st_sfc(sf::st_point(Campus_S8_coord))
Campus_S8 = sf::st_as_sf(Campus_S8, crs = 4326) # assing crs

mapview::mapview(Campus_S8) # quick map view
```

5 Resources

- Laptop, with any OS Internet connection
- Github repository with all the materials (data, code and guidelines)
- Survey datasets, school locations and public transport operator datasets

Part I

Day 1

6 Software

In this chapter we will guide you through the installation of R and QGIS.

6.1 R and RStudio

You will need **R** installed on your computer (version 4.4.1 or higher) and also **RStudio**[1].

6.1.1 R

6.1.2 RStudio

6.2 QGIS

QGIS is a geographic information system software that is free and open-source. QGIS supports Windows, macOS, and Linux. It supports viewing, editing, printing, and analysis of geospatial data in a range of data formats[2].

In this course QGIS will be used to geocode coordinates, make accessibility analysis using the street network, and visualize OD flows.

QGIS allows the visualization of data with a graphical user interface (GUI), which can be preferable for basic usage. For advanced computation with geo data, programming software such as Python or R can be more adequate.

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[1]We will use RStudio, although if you already use other studio such as VScod, that's also fine.
[2]https://en.wikipedia.org/wiki/QGIS

6.2.1 Download

You should go for the Long-Term Version provided by QGIS. If you have installed the most up-to-date version, that's also fine.

https://qgis.org/download/

This download will be about 1.2-1.6 GB.

You should also have Python installed. Otherwise QGIS will install it for you [?].

6.2.1.1 Windows

Download and open the executable file.

6.2.1.2 Mac

Download and open the executable file.

6.2.1.3 Ubuntu

You can look for QGIS in the Ubuntu **Software Center** or install it via the terminal.

```
sudo apt install gnupg software-properties-common
sudo mkdir -m755 -p /etc/apt/keyrings  # not needed since apt version 2.4.0 like Debian 12 an
sudo wget -O /etc/apt/keyrings/qgis-archive-keyring.gpg https://download.qgis.org/downloads/
```

Add the QGIS repo for the latest stable QGIS (3.38.x Grenoble) to `/etc/apt/sources.list.d/qgis.sources`:

```
Types: deb deb-src
URIs: https://qgis.org/ubuntugis-ltr
Suites: jammy
Architectures: amd64
Components: main
Signed-By: /etc/apt/keyrings/qgis-archive-keyring.gpg
```

```
sudo apt update
sudo apt install qgis qgis-plugin-grass saga
sudo apt install python3-qgis
```

Consider change the language to English in the global options (easier to follow tutorials).

6.2.2 Plugins

For this course we will use the Open Route Service plugin.

6.2.2.1 Basemaps

Install the useful free basemaps.

> Copy-past into the python console: [https://raw.githubusercontent.com/klakar/](https://raw.githubusercontent.com/klakar/QGIS_resources/master/collections/Geosupportsystem/python/qgis_basemaps.py) [QGIS_resources/master/collections/Geosupportsystem/python/qgis_basemaps.](https://raw.githubusercontent.com/klakar/QGIS_resources/master/collections/Geosupportsystem/python/qgis_basemaps.py) [py](https://raw.githubusercontent.com/klakar/QGIS_resources/master/collections/Geosupportsystem/python/qgis_basemaps.py)

6.2.2.2 Open Route Service

[Sign up for an account](#) and create a token. Copy your API.

> In QGIS Plugins → Manage and install plugins → Search for **ORS Tools** → Install Open ORS Tools, provider, settings, and paste API key.

6.2.2.3 qgis2web

This is an useful pluggin to create interactive HTML maps.

> In QGIS Plugins → Manage and install plugins → Search for **qgis2web** → Install qgis2web.

Tutorial here: https://www.qgistutorials.com/en/docs/leaflet_maps_with_qgis2leaf.html

7 Software

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7.1 R and RStudio

```
1 + 1
```

```
[1] 2
```

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https://qgis.org/download/

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[1]https://en.wikipedia.org/wiki/QGIS

7.2.1.1 Windows

7.2.1.2 Mac

7.2.1.3 Ubuntu

7.2.2 Plugins

Part II

Day 2

8 Introduction

This is a book created from markdown and executable code.

See Knuth (1984) for additional discussion of literate programming.

8.1

References

Knuth, Donald E. 1984. "Literate Programming." *Comput. J.* 27 (2): 97–111. https://doi.org/10.1093/comjnl/27.2.97.