Measuring Accessibility using R

As measuring accessibility required significant data processing, we will use a pre-prepared set of data and code (R language) in the form of a tutorial.

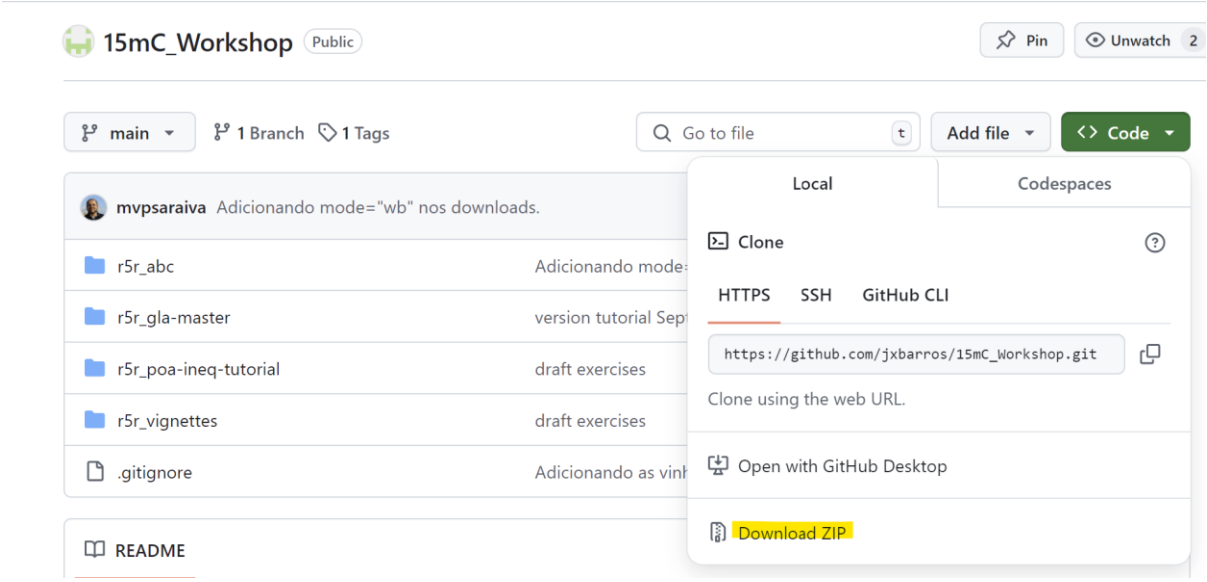
This tutorial will take you through the various stages of computing an accessibility metric without requiring programming knowledge or technical skills on data management.

There tutorials are available to download from GitHub.

If you are using your own computer, you will need to install the required software before starting.

To download the tutorial materials, go to https://github.com/jxbarros/15mC_Workshop/

The click on Code download, then select Download the Zip file.



Extract all files into your computer. Open the folder.

Before we start, **we need to install the 5r5 package and the JAVA Development Kit 21**.

We will do that via RStudio, by following the instructions at https://github.com/ipeaGIT/r5r /

Copy each of the lines below, and paste it in the RStudio console, then click ENTER.

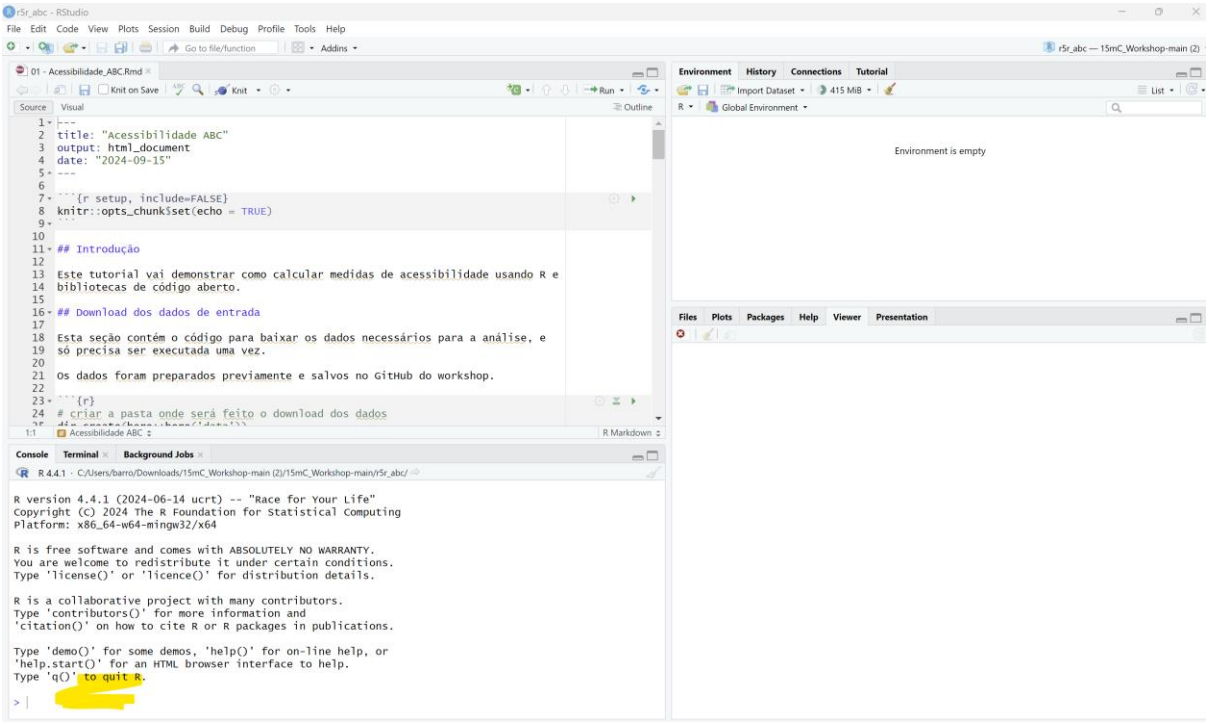
Once the code runs, you can copy the next line and do the same thing.

```
install.packages("r5r")

utils::remove.packages('r5r')

devtools::install_github("ipeaGIT/r5r", subdir = "r-package")

install.packages('rJavaEnv')

# check version of Java currently installed (if any)
```

rJavaEnv::java_check_version_rjava()

install Java 21

rJavaEnv::java_quick_install(version = 21)



We are now ready to start the tutorial.

1. London Tutorial

The tutorial will use data a reduced dataset that only covers part of the GLA: called inner-London (see map below). This will allow you to compute the metric using the workstation room computers.

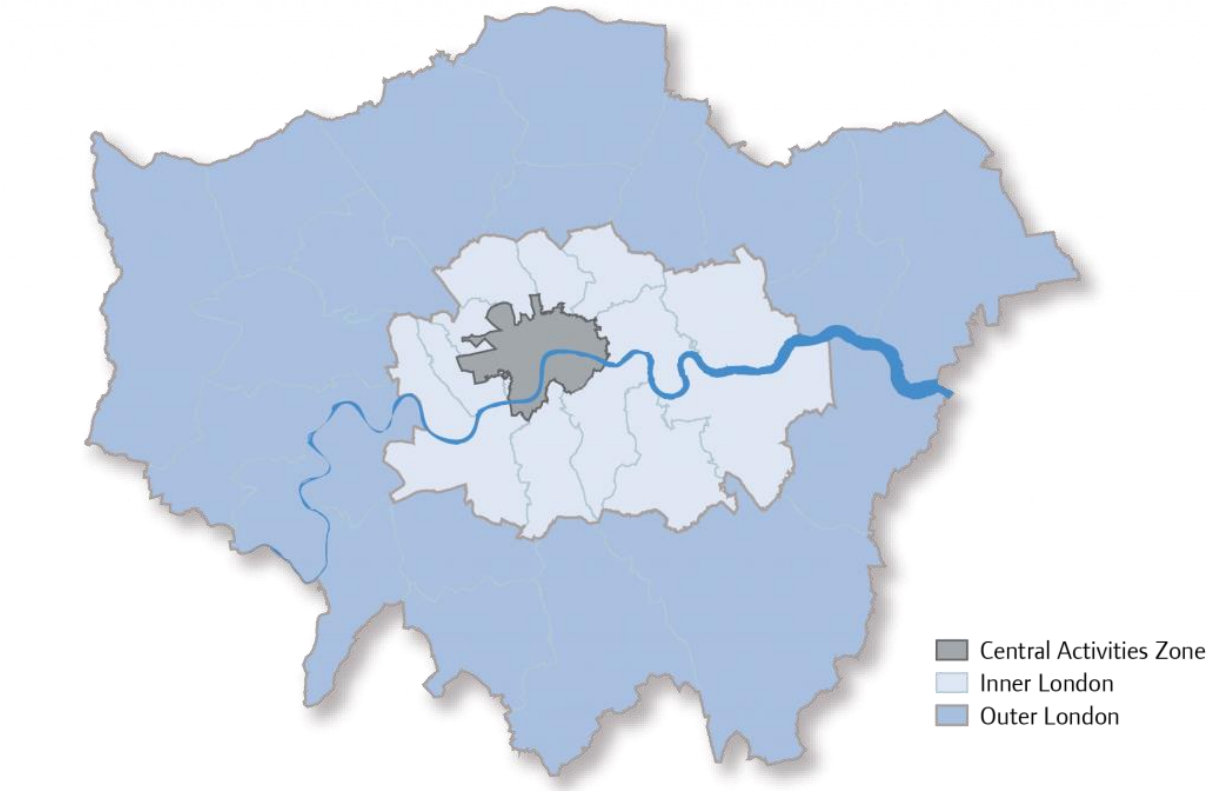


Image showing inner and outer London. Source: https://www.london.gov.uk/file/3971128

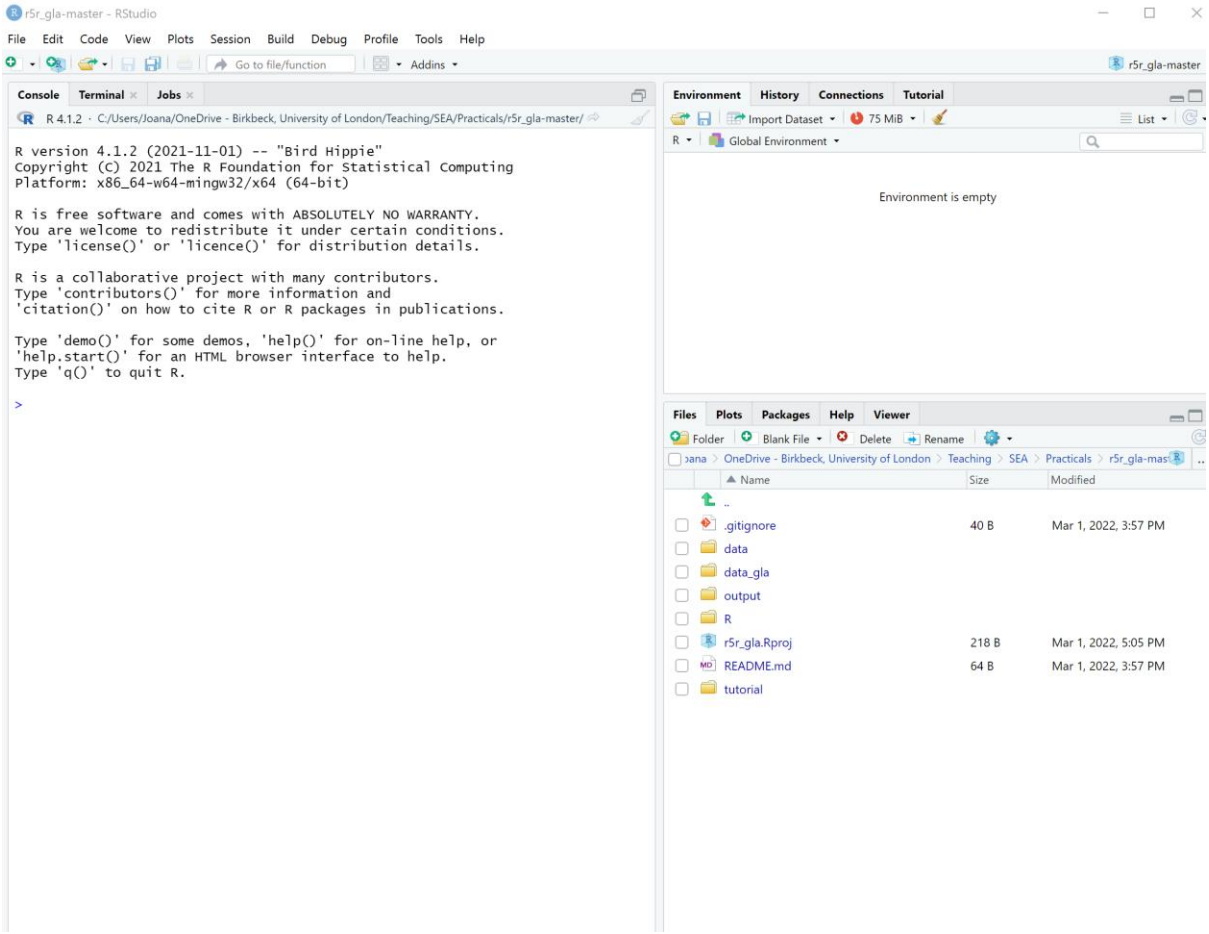
As you will need the results for the entire GLA for your assessment, a set of results is available and have been saved in the 'output' folder that you will download together with the tutorial (see below).

These include the cumulative accessibility using cut-off times (30, 60 and 90 min) for the following transport modes: walk, bike, bus, and transit.

To open the London tutorial, click on r5r.gla (R project):

Name	Status	Date modified	Type	Size
data	✓	01/03/2022 15:57	File folder	
data_gla	✓	01/03/2022 15:57	File folder	
output	✓	01/03/2022 15:57	File folder	
R	✓	01/03/2022 15:57	File folder	
tutorial	✓	01/03/2022 15:57	File folder	
.gitignore	✓	01/03/2022 15:57	GITIGNORE File	1 KB
r5r_gla	✓	01/03/2022 15:57	R Project	1 KB
README.md	✓	01/03/2022 15:57	MD File	1 KB

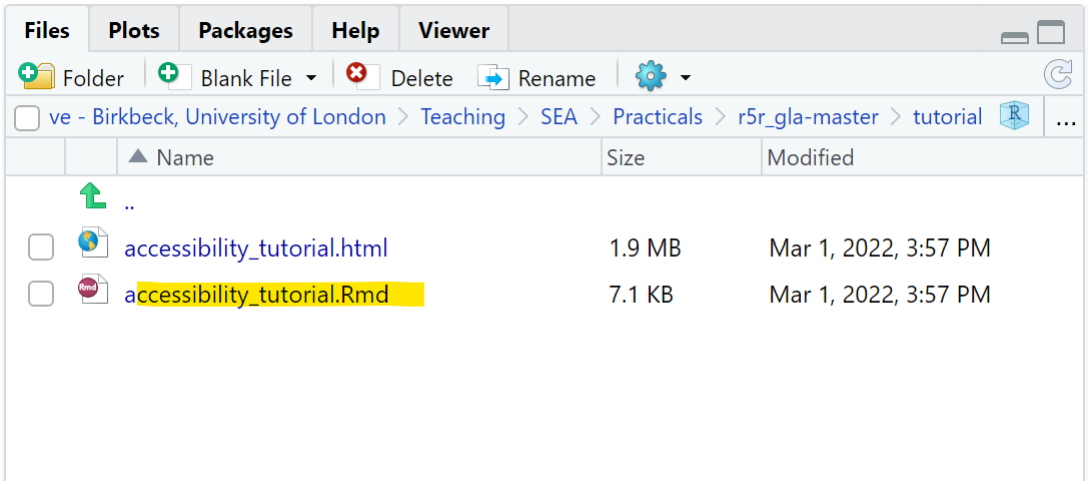
The R project will open in RStudio:

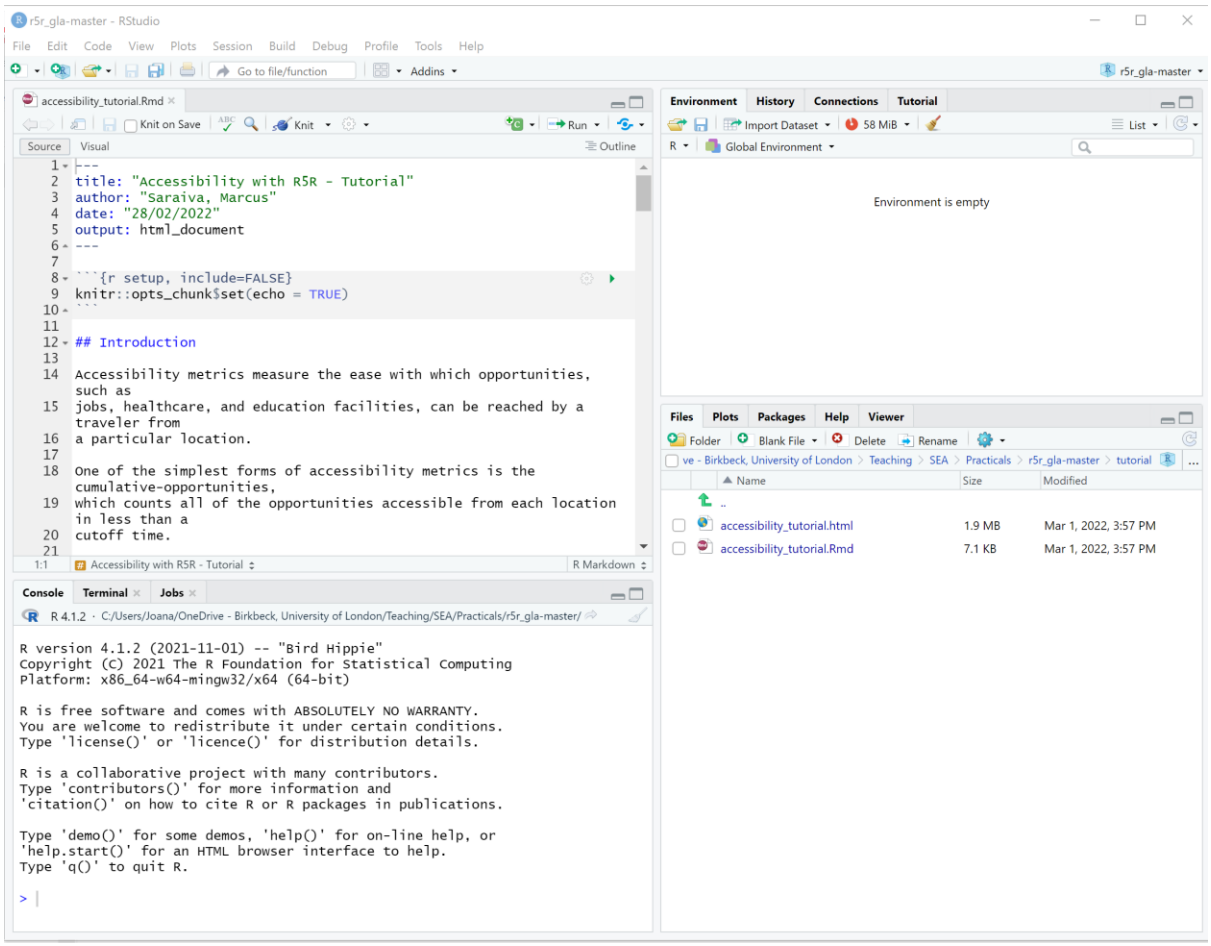


Before starting, make sure you have installed the required packages. If you are unsure, copy the following lines into the console part of RStudio and press enter:

```
install.packages("r5r")
install.packages("tidyverse")
install.packages("data.table")
install.packages("rgdal")
install.packages("rgeos")
install.packages("sf")
install.packages("mapview")
install.packages("leaflet")
install.packages("piggyback")
install.packages("devtools")
install.packages("oapdata")
install.packages("quantreg")
install.packages('geobr')
```

Now open the tutorial folder and click on the accessibility_tutorial.Rmd file:





If you get a message saying an additional library is required, **accept** the suggested installation.

The accessibility_tutorial. Rmd file contains information, instructions (text) as well as pieces of code you will run to calculate accessibility for Inner London.

You are not required to understand the programming language. The text will provide you with the information you need to know. If you are not familiar with R language, you will not understand the code, but this is not a problem as the focus here is accessibility!

Scroll down and read the text. Stop when you get to the parts that contain code. You will see a green arrow on the right-hand side of the code.

You must click on the green arrows to run each piece of code. Read the text and try to make sense of what the code is doing.

If you are doing this alone at home, make note of your questions so you can ask Joana later.

If you are in class with the group, we will be going through the tutorial together and you can raise your questions to the tutor immediately.

At the end of the tutorial, there are suggestions on changes to try, so you can measure accessibility using different travel modes, cut-off times, or at different times of the day.

This is done by changing the parameters of the accessibility function in the code. In order to find out the possible parameters for the accessibility function, **put the cursor on the accessibility function and click F1**. All options will appear on the help window. Note that those are the parameters that can be calculated using this code, but this depends on the information available on the GTSF dataset used.

These are not mandatory but will allow you to explore different aspects of accessibility and gain confidence with using the code.

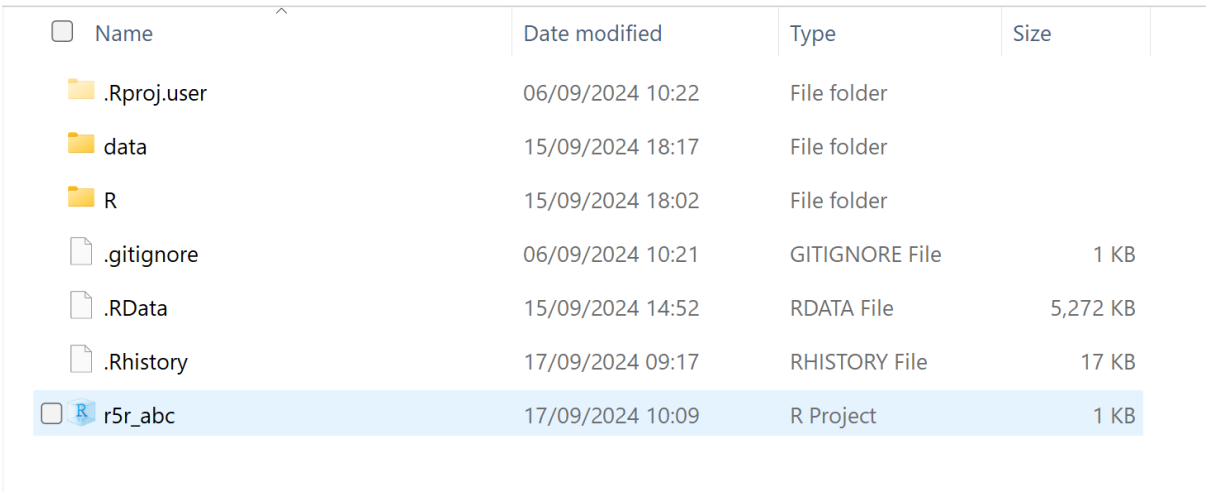
Don't worry if something goes wrong. You can use *control+z* to go back on changes. In the worst-case scenario, you will need to download the folder from GitHub again, but this is not a big deal!

Also, don't worry if you get a lot of warning (red) messages – these should not be a problem. See examples of error/warning messages at the end of this document.

2. ABC Tutorial

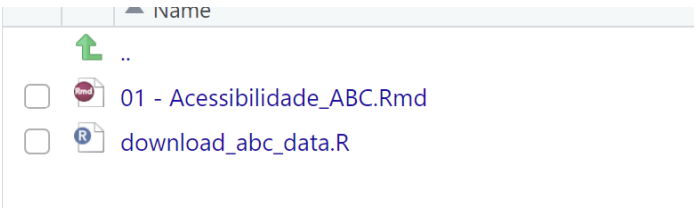
We will now look at a similar exercise using the ABC (Santo André, São Bernardo do Campo and Sao Caetano do Sul) as case study.

Go to the r5r_abc folder and open the project of the same name.



Name	Date modified	Type	Size
.Rproj.user	06/09/2024 10:22	File folder	
data	15/09/2024 18:17	File folder	
R	15/09/2024 18:02	File folder	
.gitignore	06/09/2024 10:21	GITIGNORE File	1 KB
.RData	15/09/2024 14:52	RDATA File	5,272 KB
.Rhistory	17/09/2024 09:17	RHISTORY File	17 KB
r5r_abc	17/09/2024 10:09	R Project	1 KB

Once the project opens in RStudio, click into R and open the tutorial by clicking on the Accessibility_ABC.Rmd file:



Possible errors messages and warnings:

It is likely you will see various error and warning messages (see examples below). As long as the task is completed, you can ignore those messages.

```
}
13:30:51.202 [main] ERROR com.conveyal.r5.streets.StreetLayer - Continuing to load but ignoring generalized costs due to exce
ption: java.lang.RuntimeException: All ways are expected to have generalized cost tags. Missing: slope_1:forward
Mar 04, 2023 1:31:03 PM org.hsqldb.persist.Logger logInfoEvent
INFO: dataFileCache open start
13:31:04.118 [main] ERROR com.conveyal.r5.streets.StreetLayer - Invalid turn restriction 149905, does not have from, to and v
ia, skipping
13:31:04.142 [main] ERROR com.conveyal.r5.streets.StreetLayer - Invalid turn restriction 1829708, does not have from, to and
 via, skipping
13:31:04.143 [main] ERROR com.conveyal.r5.streets.StreetLayer - Invalid turn restriction 1829709, does not have from, to and
 via, skipping
13:31:04.151 [main] ERROR com.conveyal.r5.streets.StreetLayer - Invalid turn restriction 2441789, no way from from to to via
 via, skipping
13:31:04.201 [main] ERROR com.conveyal.r5.streets.StreetLayer - Invalid turn restriction 3845561, does not have from, to and
 via, skipping
13:31:04.227 [main] ERROR com.conveyal.r5.streets.StreetLayer - Invalid turn restriction 5615179, does not have from, to and
 via, skipping
13:31:04.239 [main] ERROR com.conveyal.r5.streets.StreetLayer - Invalid turn restriction 6415295, no way from from to to via
```

```
13:31:04.493 [main] ERROR com.conveyal.r5.streets.StreetLayer - Invalid turn restriction 13325973, does not have from, to a
 via, skipping
13:31:04.502 [main] ERROR com.conveyal.r5.streets.StreetLayer - Did not find from/to edges for restriction 13569989, skippi
WARNING: An illegal reflective access operation has occurred
WARNING: Illegal reflective access by com.esotericsoftware.kryo.util.UnsafeUtil (file:/C:/Users/Joana/AppData/Local/Temp/Rt
A5pUeN/r5-v6.4-all.jar) to constructor java.nio.DirectByteBuffer(long,int,java.lang.Object)
WARNING: Please consider reporting this to the maintainers of com.esotericsoftware.kryo.util.UnsafeUtil
WARNING: Use --illegal-access=warn to enable warnings of further illegal reflective access operations
WARNING: All illegal access operations will be denied in a future release

Finished building network.dat at C:/Users/Joana/Desktop/Restructuring and VSER/AB paper 19 Jan 23/SEA TUTORIAL/r5r_gla-mast
r/data_inner/network.dat
```

The error below is a common one, and it is due to an issue with the downloaded file (inner-london-latest.osm.pbf) which is very large and often gets corrupted due to issues in the download process.

```
144
145 ```{r include=FALSE}
146 r5r_core <- setup_r5(here::here("data_inner"), verbose = FALSE, temp_dir = TRUE)
147 ```
```

```
Error in setup_r5(here::here("data_inner"), verbose = FALSE, temp_dir = TRUE) :
 java.lang.RuntimeException: Error occurred while parsing OSM file
 C:\Users\Joana\Desktop\Restructuring and VSER\AB paper 19 Jan 23\SEA TUTORIAL\r5r_gla-master\data_inner\inner-
 london-latest.osm.pbf
```

Show Traceback

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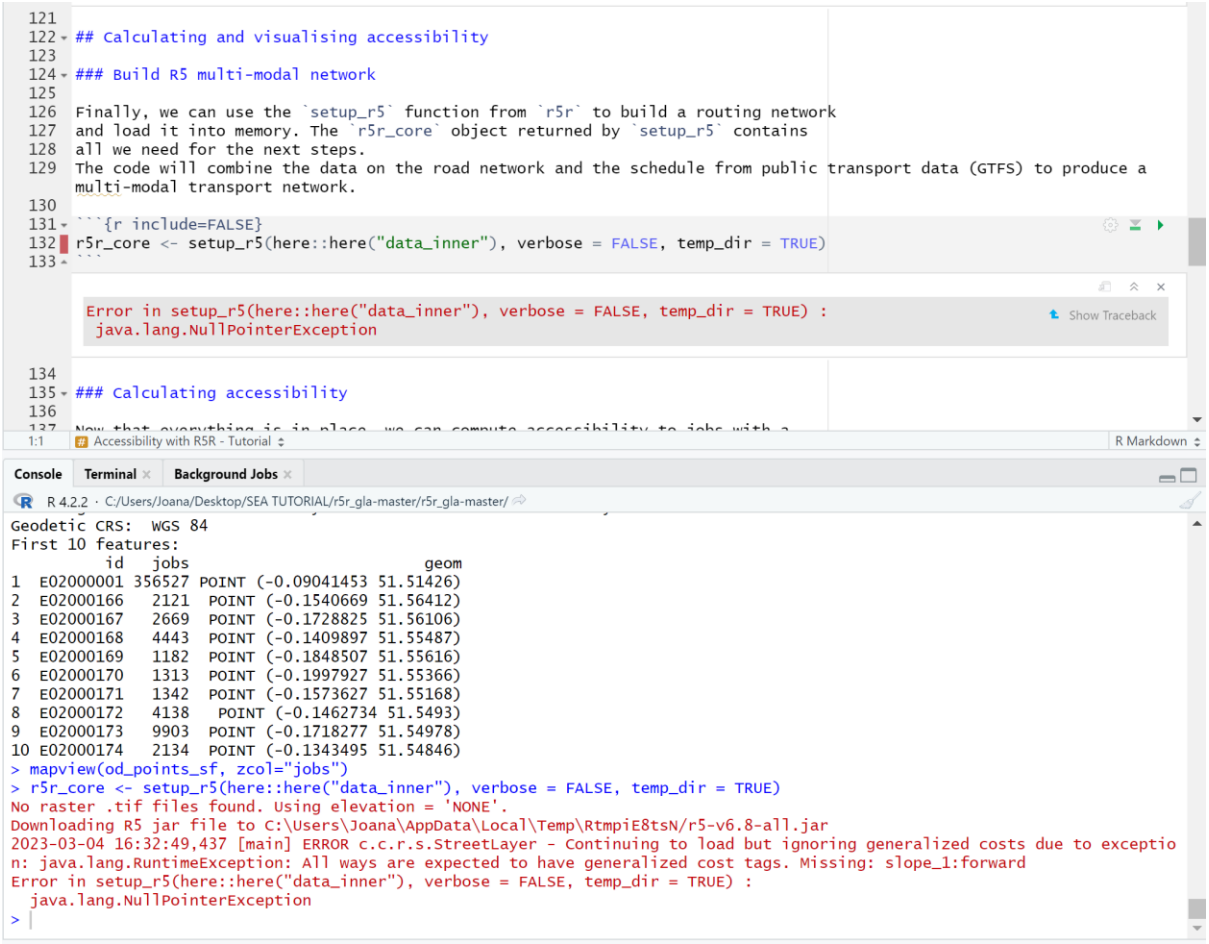
The solution is to download the file again from:

https://drive.google.com/file/d/1zuQOPL21U5ueicW4Rr3ApNUWTH0FRoH-/view?usp=sharing

Check the file has the correct size, like in the picture below:

Another possible error is due to a bug on the r5r package, which has been fixed this week. If you get the following error when running the code in the lines 131-132 of the code, it is likely you need to reinstall the package and restart the tutorial.



If the error persists, you can install the development version of r5r by using the following command:

devtools::install_github("ipeaGIT/r5r", subdir = "r-package")

Further tasks:

Open the accessibility results for the entire GLA in QGIS (shapefile available in the Output folder you downloaded from GitHub and also available in the SEA Moodle page).

Open the attribute table and look at the results.

Select at least 2 different travel modes and 2 cut-off times and create maps of the results.

Based on the instructions on how to create choropleth maps you used for the segregation indices, create maps using 'natural breaks' and 10 classes. Collate your maps in a word document and bring them to the class next week for discussion.

Links for manual download of key datasets:

https://drive.google.com/file/d/1zuQOPL21U5ueicW4Rr3ApNUWTH0FRoH-/view?usp=sharing

The file 'inner-london-latest.osm.pbf' will be downloaded

https://data.bus-data.dft.gov.uk/timetable/download/gtfs-file/london

The file itm_london_gtfs.zip will be downloaded.

Save both files in your data_inner folder. These will replace the versions of the files automatically downloaded.