The spread of COVID-19 in a landlocked country the case of Luxembourg

A Preprint

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Abstract

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***K*eywords** blah · blee · bloo · these are optional and can be removed

1 Introduction

The Grand-Duchy of Luxembourg is a country that is unique in many ways. As its official name quite clearly indicates, it is a grand duchy, the last of its kind on earth. It is a relatively young country, as it became a grand duchy once it gained independence from Napoleonic France in 1815 (but was pretty much still a puppet state of the Kingdom of the Netherlands until the end of the 19th century), is one of the founding members of the European Coal and Steel Community, which evolved to become the European Union and has three official languages: French, German, and Luxembourguish. Luxembourg is also a landlocked country, sandwiched between France, Germany and Belgium. This geographic position has given Luxembourg many advantages. One such advantage is that its labour force, which amounts to 400000 workers and is composed of 50% of French, German and Belgian commuters. This is also the reason why Luxembourg has one of the highest GDPs per capita in the world: half of its riches are produced by foreigners which are not taken into account in the computation of GDP per capita.

Half of Luxembourg's population is also composed of foreigners, the largest community being the Portuguese, followed by the French.

In this article, I posit the following hypothesis: due to its quite unique characteristics, the spread of COVID-19 in a landlocked country like Luxembourg is the exact opposite of the spread of COVID-19 that can be observed on an island country such as New Zealand, or Madagascar. A landlocked country like Luxembourg, which is furthermore highly dependent on foreign workers, has many more difficulties to control the spread of COVID-19 within its borders. Unlike an island country, a landlocked country that is highly tied to its neighbours cannot simply close its borders and put a very hard lockdown in place to control the pandemic. Or if the landlocked country does that, as soon as it opens its borders, the disease will start spreading again. To illustrate this idea, I will discuss how COVID-19 starting spreading, but not only within the borders of Luxembourg, but rather within the so-called Greater Region. The Greater Region *a space for cross-border cooperation in the heart of Europe* and is composed of the Grand-Duchy of Luxembourg, two Belgian Provinces, two French Départements and two German Bundesländer.

*This preprint was written during my free time as a private citizen, and reflects in no manner the views of the Ministry of Higher Education and Research, nor the Government of the Grand-Duchy of Luxembourg.

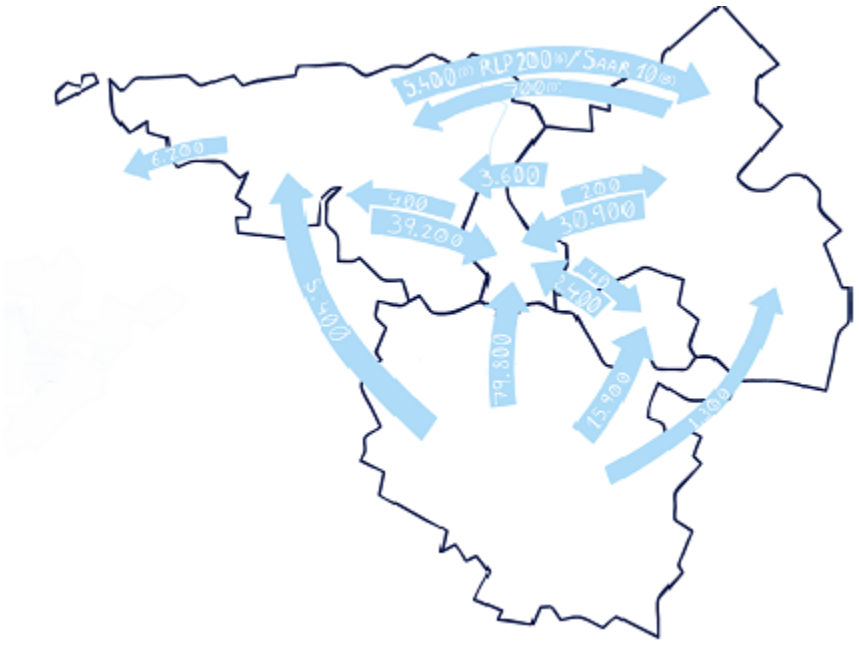


Figure 1: The daily commuters in the Greater Region. Luxembourg absorbs the vast majority. (Source: Bienvenue dans la Grande Région, 2018)

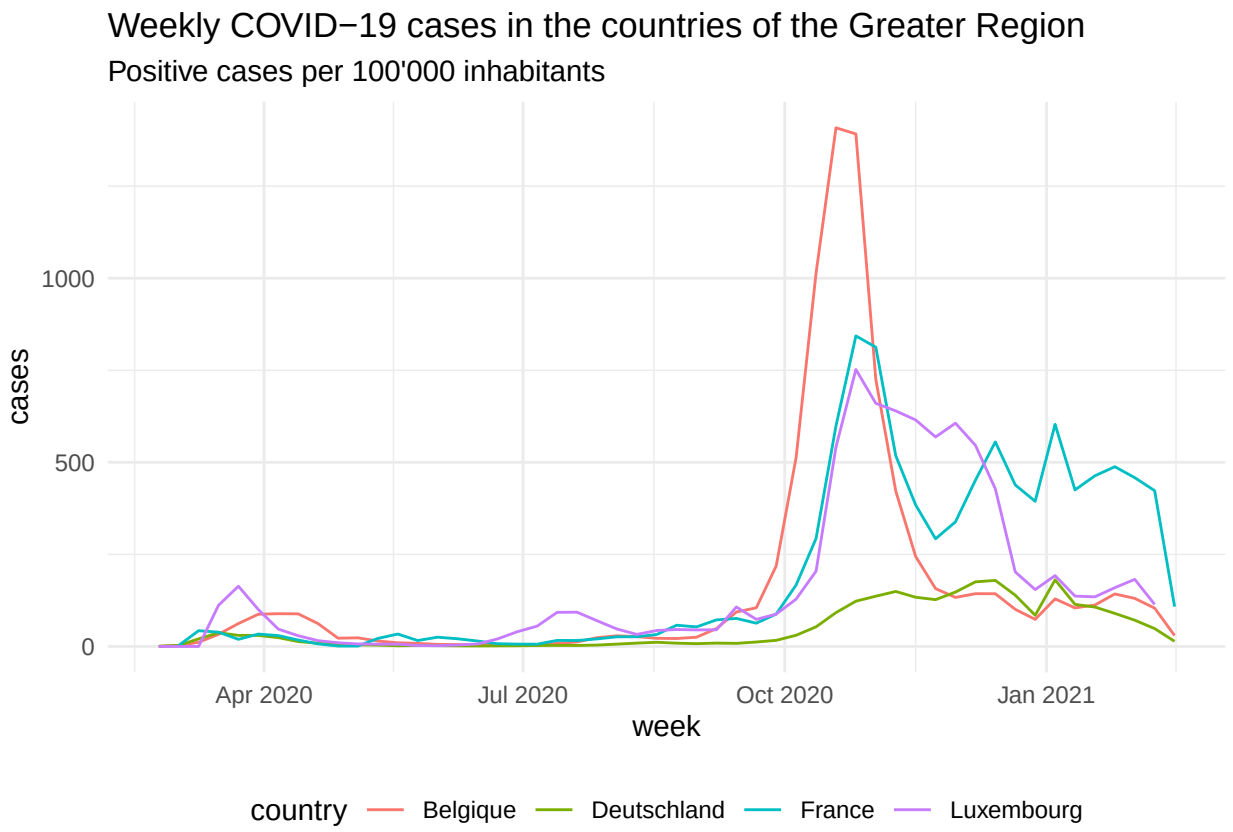
Figure 1 show a map of the Greater Region with the flows of daily commuters between its constituent regions. Every day, according to this map from 2018, more than 150000 commuters go to Luxembourg to work. In 2019, it was reported that this number reached 200000.[2]

The goal of this work is thus as follows: I will train machine learning models to predict the spread of COVID-19 in Luxembourg using openly available data on the weekly positive cases of COVID-19. However, because of the very tight economic and social integration of Luxembourg to its neighbours I will use as features weekly positive cases in the border regions as well as Google Mobility data[3] for Luxembourg to proxy for hard, and soft, lockdowns. I will show that weekly, and most importantly lags of weekly cases in the neighbouring regions predict cases for Luxembourg.

2 The COVID-19 pandemic in the Greater Region

```
tar_read(epid_curves)
```

[2] https://paperjam.lu/article/plus-200-000-frontaliers-sur-m
[3] https://www.google.com/covid19/mobility/

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tar_read(epidem_map)$map_first_wave
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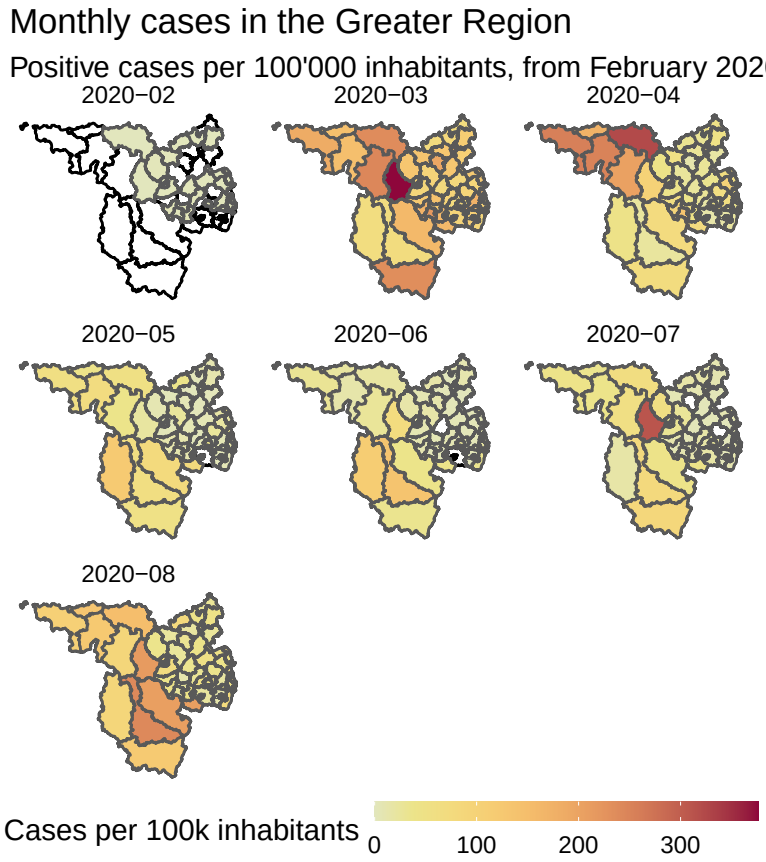


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tar_read(epidem_map)$map_second_wave
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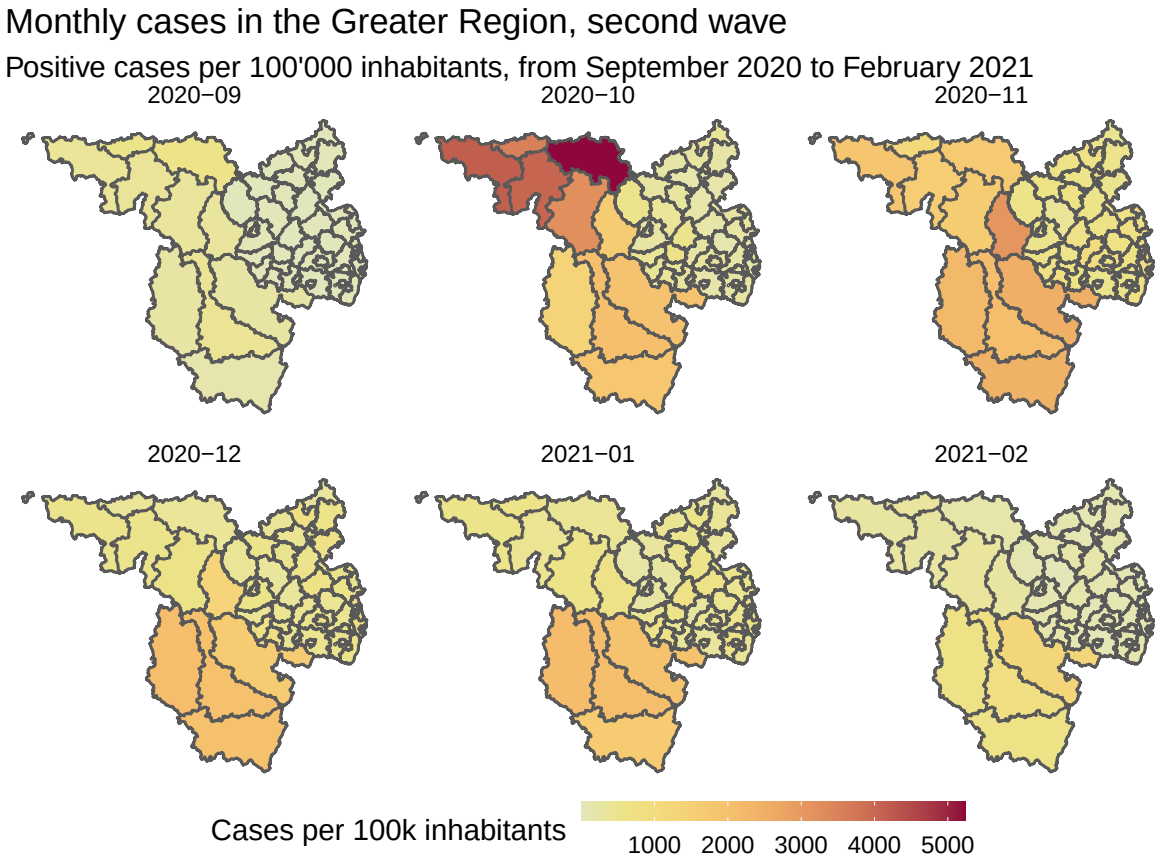


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tar_read(cv_plan)
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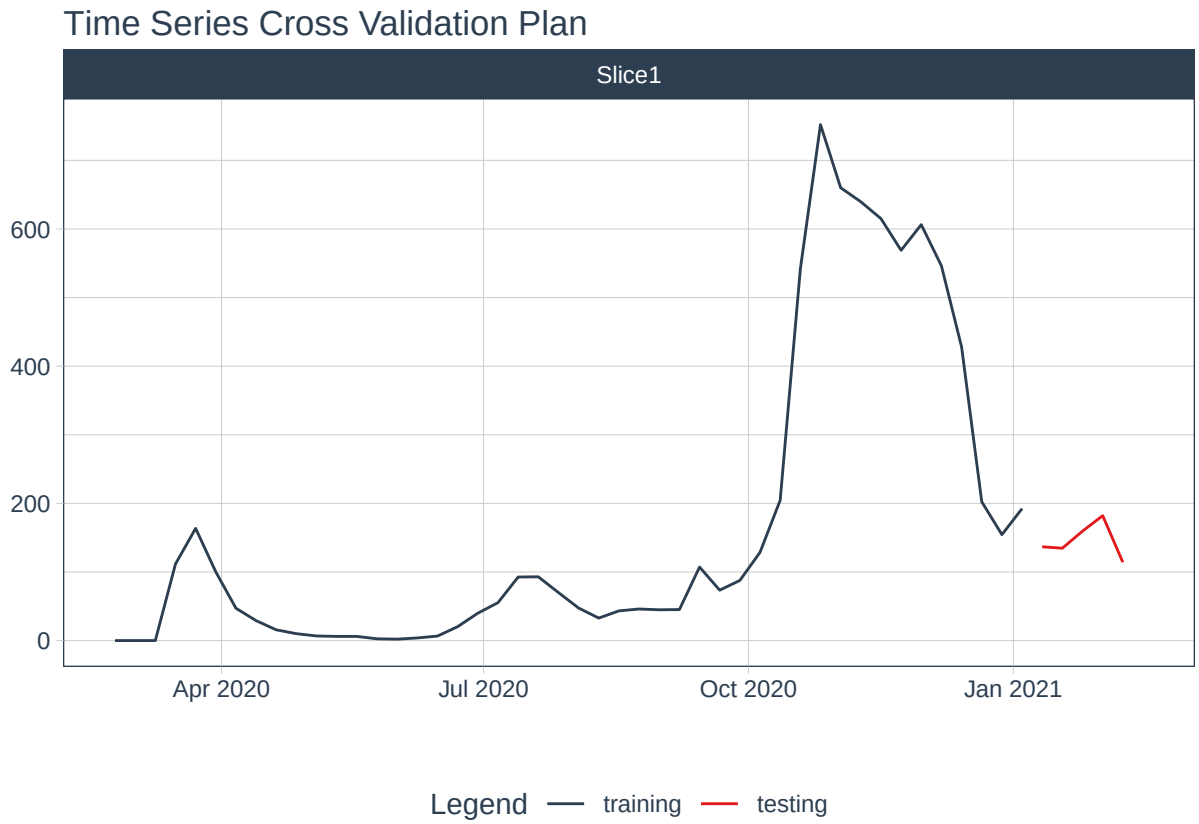


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tar_read(forecast_plot)
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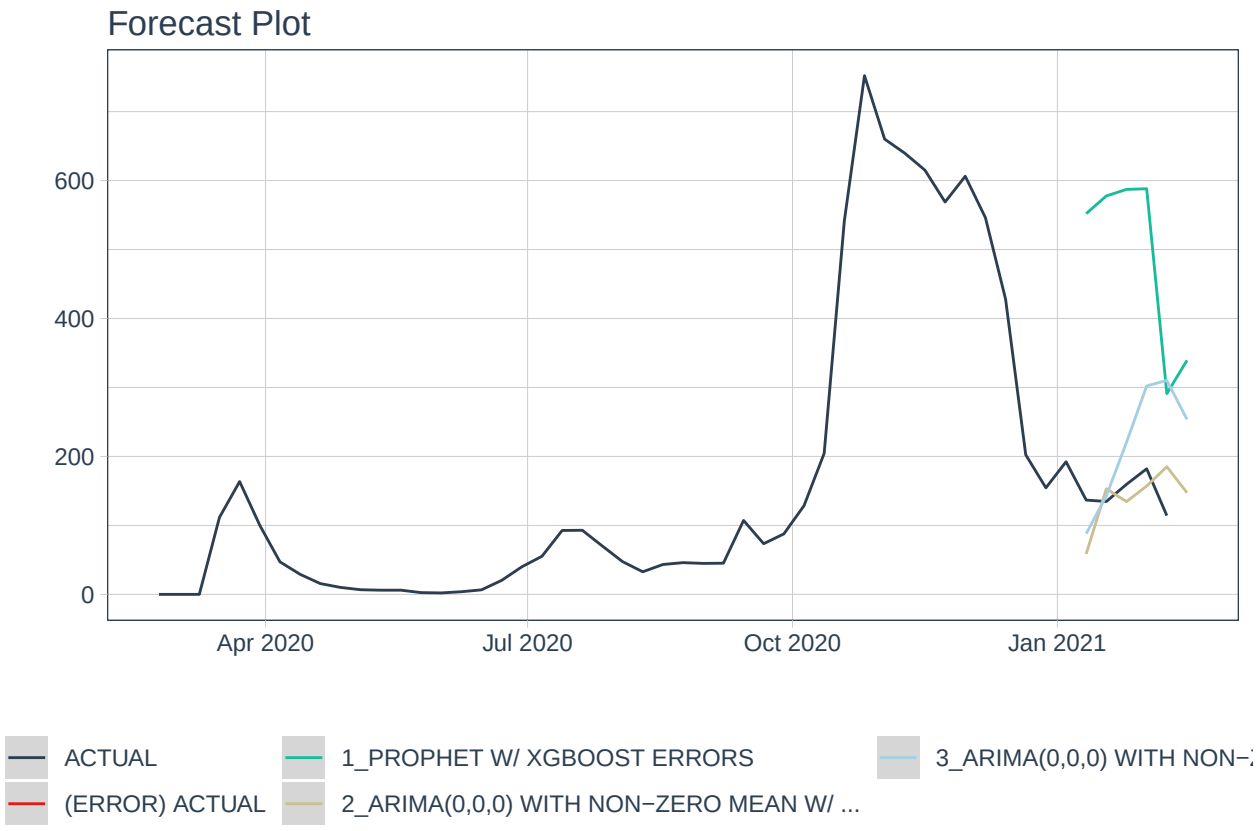

3 Headings: first level

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3.1 Headings: second level

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3.1.1 Headings: third level

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4 Examples of citations, figures, tables, references

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The documentation for `natbib` may be found at

`http://mirrors.ctan.org/macros/latex/contrib/natbib/natnotes.pdf`

Of note is the command `\citet`, which produces citations appropriate for use in inline text. For example,

```
\citet{hasselmo} investigated\dots
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produces

> Hasselmo, et al. (1995) investigated…

`https://www.ctan.org/pkg/booktabs`

4.1 Figures

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plot(mtcars$mpg)
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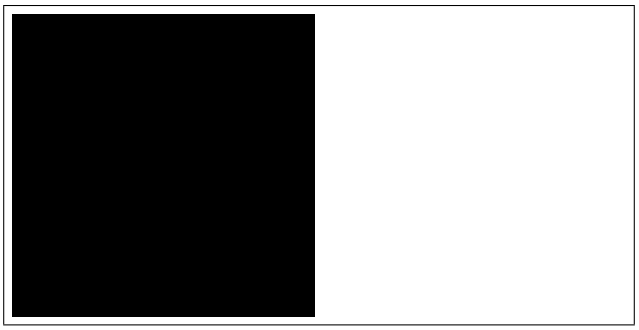
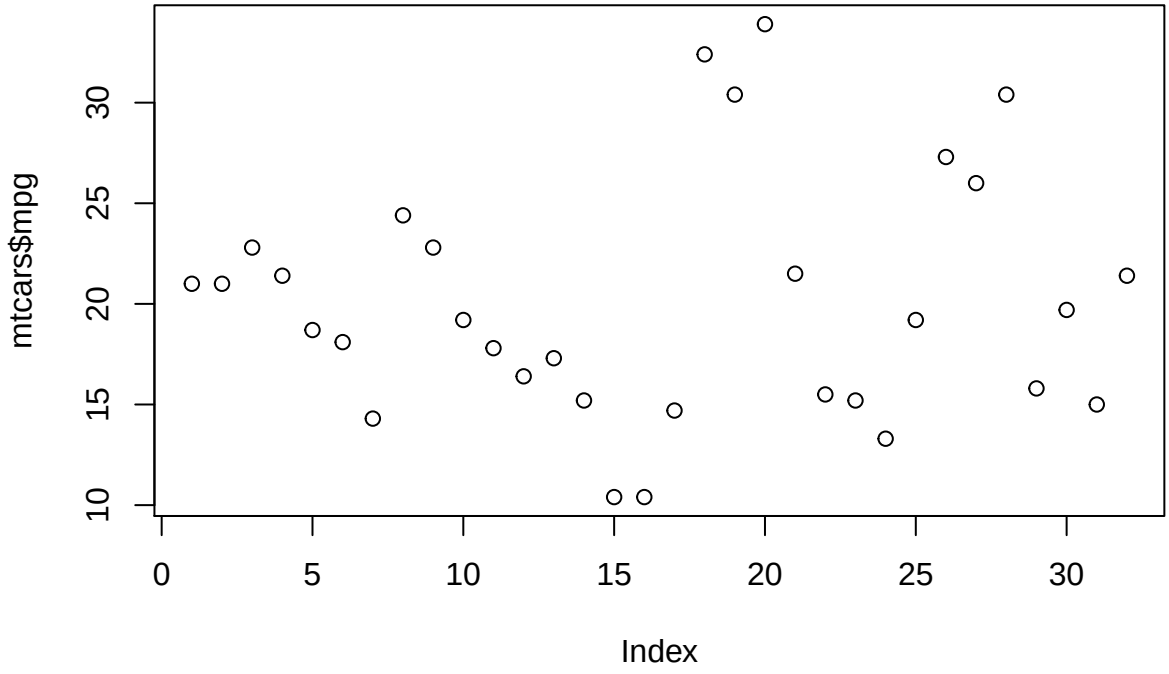


Figure 2: Sample figure caption.



4.2 Tables

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4.3 Lists

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Table 1: Sample table title

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Name	Description	Size (μm)
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Axon	Output terminal	$\sim$10
Soma	Cell body	up to 10^6

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- Aliquam dignissim blandit est, in dictum tortor gravida eget. In ac rutrum magna.

Hadash, Guy, Einat Kermany, Boaz Carmeli, Ofer Lavi, George Kour, and Alon Jacovi. 2018. "Estimate and Replace: A Novel Approach to Integrating Deep Neural Networks with Existing Applications." *arXiv Preprint arXiv:1804.09028*.

Kour, George, and Raid Saabne. 2014a. "Fast Classification of Handwritten on-Line Arabic Characters." In *Soft Computing and Pattern Recognition (SoCPaR), 2014 6th International Conference of*, 312–18. IEEE.

———. 2014b. "Real-Time Segmentation of on-Line Handwritten Arabic Script." In *Frontiers in Handwriting Recognition (ICFHR), 2014 14th International Conference on*, 417–22. IEEE.