Introduction & overview

Applied Data Science using R, Session 1

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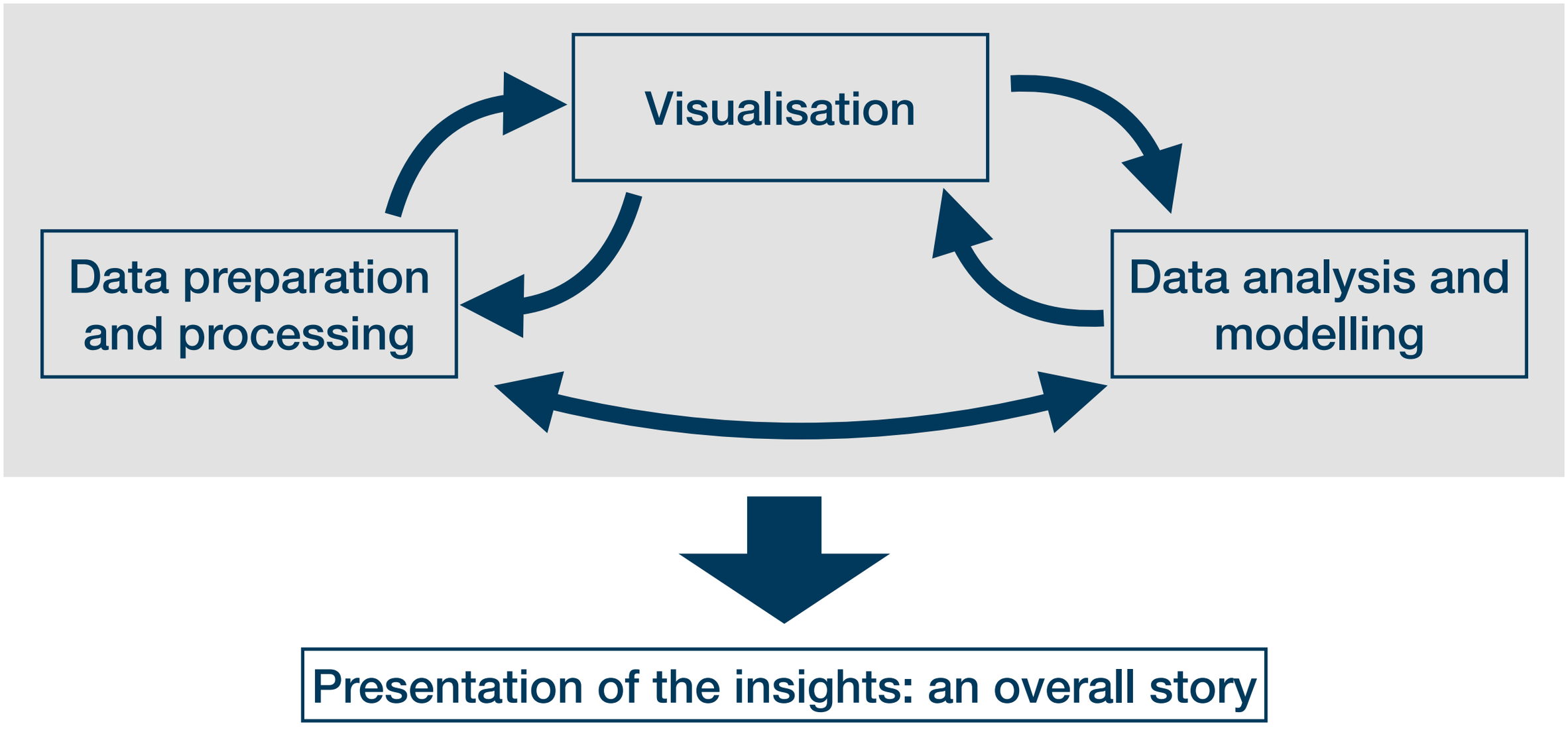
Part I:

Organization & outlook

Note: my slides for this course are meant as a “script on slides”

Goal of the course

- In this course you will learn how to prepare, analyse, and present quantitative data using the software **R** → four key areas



Why R?

- R allows you to conduct **all steps of this data science pipeline** within one consistent framework in a transparent and reproducible manner

- R is free, OS-independent and **open source**
  → inclusive, transparent, and vibrant tool

> “The days of commercial statistical languages and packages such as SAS, Stata and SPSS are over”
>
> Paul Jansen, CEO of Tiobe Software

- For statistical analysis, R is among the **most widely used** and demanded programming languages

- R is demanded in almost **every industry**

- Learning R makes it **easier to learn other** widely used programming languages

- There is a great and friendly R **Community**

#	RedMonk	TIOBE	PYPL
1	JavaScript	Python	Python
2	Python	C	Java
3	Java	Java	JavaScript
4	PHP	C++	C/C++
5	C#	C#	C#
6	C++	Visual Basic	PHP
7	CSS	JavaScript	R
8	TypeScript	PHP	Objective C
9	Ruby	Assembly	Swift
10	C	SQL	TypeScript
11	Swift	Go	Matlab
12	R	Swift	Kotlin
13	Objective C	R	Go
14	Shell	Matlab	Ruby
15	Scala	Delphi	VBA

What you will be able to do

- **Read** in data sets from various sources
- **Prepare** ‘messy’ data and produce ‘tidy’ data
- Create illustrative **visualisations** on a publication-ready level

EUROPEAN COMMISSION

OECD

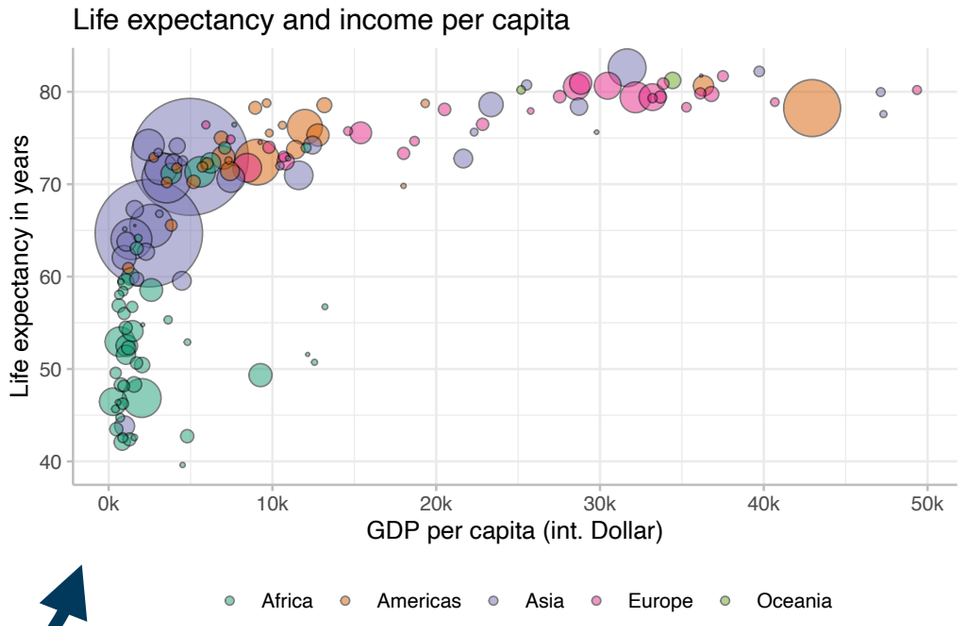
THE WORLD BANK

INTERNATIONAL MONETARY FUND

DESTATIS
Statistisches Bundesamt

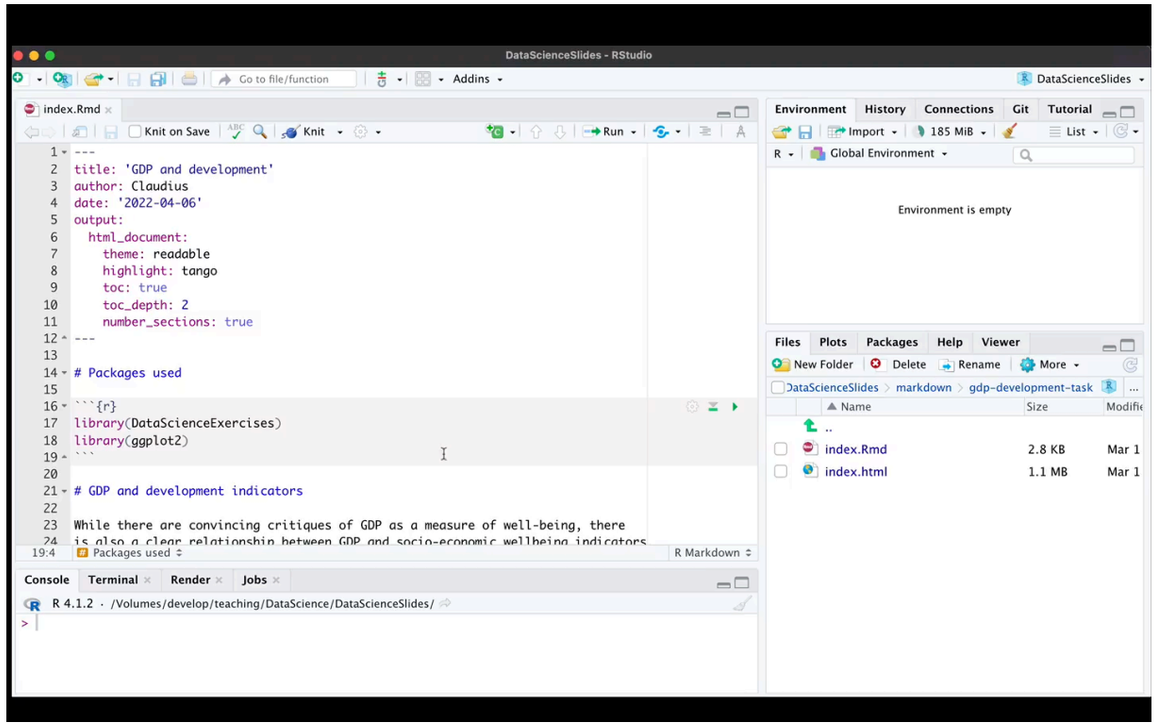
```
country,1952,1957,1962,1967,1972,1977,1982,1987,1992,1997,2002,2007
Afghanistan,Asia|28.801|8425333|779.4453145,Asia|30.332|9240934|820
.8530296,Asia|31.997|10267083|853.10071,Asia|34.02|11537966|836
.1971382,Asia|36.088|13079460|739.9811058,Asia|38.438|14880372|786
.11336,Asia|39.854|12881816|978.0114388,Asia|40.822|13867957|852
.3959448,Asia|41.674|16317921|649.3413952,Asia|41.763|22227415|635
.341351,Asia|42.129|25268405|726.7340548,Asia|43.828|31889923|974
.5803384
Albania,Europe|55.23|1282697|1601.056136,Europe|59.28|1476505|1942
.284244,Europe|64.82|1728137|2312.888958,Europe|66.22|1984060|2760
.196931,Europe|67.69|2263554|3313.422188,Europe|68.93|2509048|3533
.00391,Europe|70.42|2780097|3630.880722,Europe|72|3075321|3738
.932735,Europe|71.581|3326498|2497.437901,Europe|72.95|3428038|3193
.054604,Europe|75.651|3508512|4604.211737,Europe|76.423|3600523|5937
```

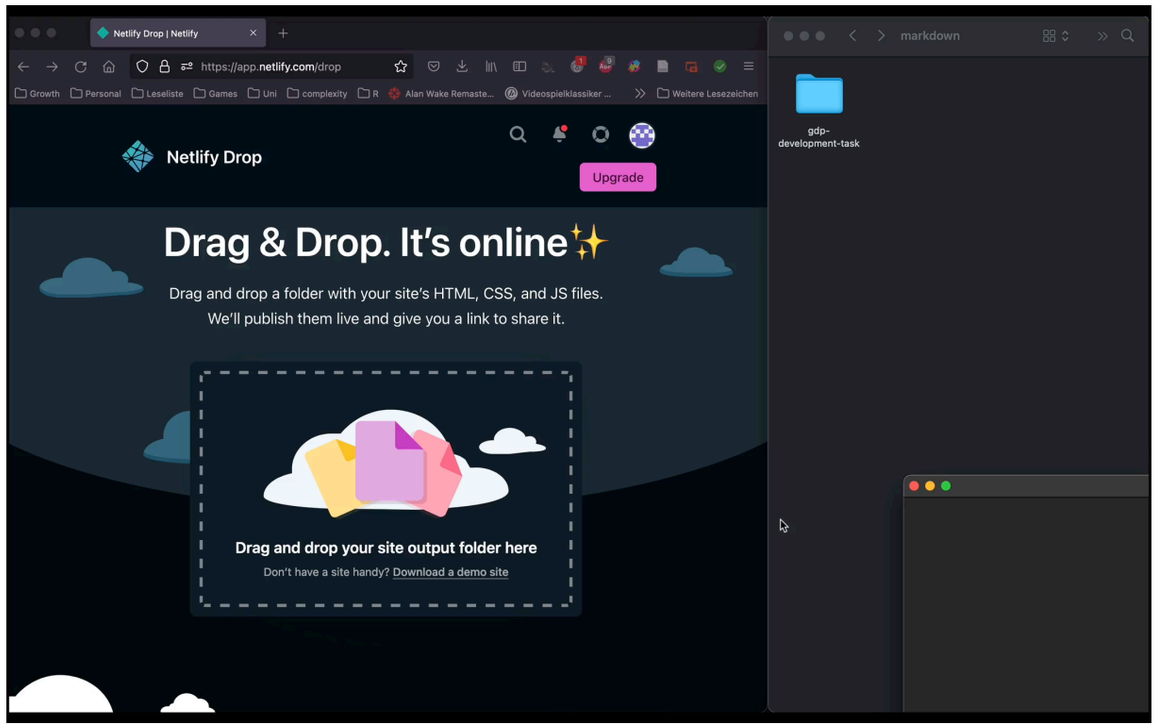
```
# A tibble: 142 × 5
   country       continent lifeExp       pop gdpPercap
   <fct>         <fct>       <dbl>     <int>     <dbl>
 1 China         Asia         73.0 1318683096     4959.
 2 India         Asia         64.7 1110396331     2452.
 3 United States Americas     78.2  301139947    42952.
 4 Indonesia     Asia         70.6  223547000     3541.
 5 Brazil        Americas     72.4  190010647     9066.
 6 Pakistan      Asia         65.5  169270617     2606.
 7 Bangladesh    Asia         64.1  150448339     1391.
 8 Nigeria       Africa       46.9  135031164     2014.
 9 Japan         Asia         82.6  127467972    31656.
10 Mexico        Americas     76.2  108700891    11978.
# … with 132 more rows
```



What you will be able to do

- **Identify hidden patterns** in data and **make predictions** using models
- Write reproducible research **reports** in Quarto
- **Publish** visually appealing reports on the web via Netlify





The road to our goal

- This is the third time I am teaching this particular course at the EUF → our outline is tentative and subject to change
- There will be **lecture videos** for most sessions, sometimes we will experiment with a **blended learning** approach
- We will regularly consult three open source and **free textbooks**, I have written **lecture summaries and tutorials**
- I provide you with **practical exercises**
  - Work together, find study groups
  - Use the Moodle forum for questions
  - Try to follow the course constantly

moodle

- Ask questions and **provide feedback**
  - There will be *very short* feedback forms for each session, the results will be presented at the beginning of the next week

Organization of the lectures

- Each session comprises theory and practice → always bring **laptops**👩‍💻👩🏾‍💻
  - Sometimes also **blended learning sessions**: watch video at home, do group practice on-site
- Questions should always be posted online in the **Moodle forum**
- Questions should most of all be **answered by other students** → solving each others' problems helps tremendously for understanding
- The forum ensures that answers to questions are (i) recorded and (ii) available to everybody
- Particularly intriguing questions can be discussed in the beginning of a session

Logistics

- There is one weekly and one bi-weekly on-site session
  - But not 100% regular → regularly check the outline
- The course material as such will be made available via a course webpage
  - Written in R → easier for me to maintain + makes material publicly available
- Discussion and announcements are organised via Moodle
  - Moodle room: `11973` | Moodle password: `DataAnalysis23`
  - Most important: the forum for our questions and the announcements

Examination

- Upon successful completion, this course is worth **5 CP**
  - Corresponds to **150 working hours**, about 25 being lecture time
- You decide whether your overall grade comprises of…
  - A mid-term exam during the middle of the semester (50%) and a final exam at the end of the semester (50%)
  - Or only a final exam at the end of the semester (100%)
- You will need to analyse artificial data sets, write reproducible reports, and answer content questions:
  - Includes data preparation, visualisation and analysis
  - Open book character is meant to mimic the practical application of the tools
  - But: no access to the internet during the exam

Summary: our ‘learning agreement’

The goal

You learn to be confident in using R when turning raw data into a comprehensible story. This includes **importing**, **transforming**, **modelling**, and **visualising** data, and to **communicate** the overall results.

What I offer

I provide **slides, example codes, tutorials, and exercises**, which are tailored to your learning needs. I will give my best to facilitate an **amicable working environment**, and answer questions in class and via Moodle.
I seek your **feedback** and implement it, when feasible.

What I expect

I expect you to **attend** classes regularly, to be **honest** about what you did not understand, to **support each other** through Moodle and in class, that you do the **homework** and **exercises regularly** such that you keep up with the course, and that you make use of the **feedback** tools.

Summary: our ‘learning agreement’

- Why do I expect these activities from you?
  - Learning a programming language is a **consecutive activity**: you miss basics in the beginning → you’ll quickly become frustrated and get lost
  - This is a demanding course: catching up later on what you missed earlier will be difficult
  - Learning a programming language works mainly through practice and **doing** → practical exercises have a *huge* benefit
  - Learning a programming language is *difficult* and at times *frustrating* → we need an amicable environment and must support each other
  - Few things have a bigger learning effect than helping others with their problems

Learning a programming language can be a lot of fun and really brings you forward – if we do this together as a team💪🏽

Open questions?

Short introduction round:

- What's your **name** and study **background**?
- What was your **motivation** to come today and register for the course?
- What's your biggest **wish** and biggest **concern** for this **course**?
- What do you associate with the term "**Data Science**"?

Part II:

Installing R and R Studio

R and R-Studio

- R is a programming language
  - It is a language that allows you to issue commands to your computer:

```
> fib_n(4)
```

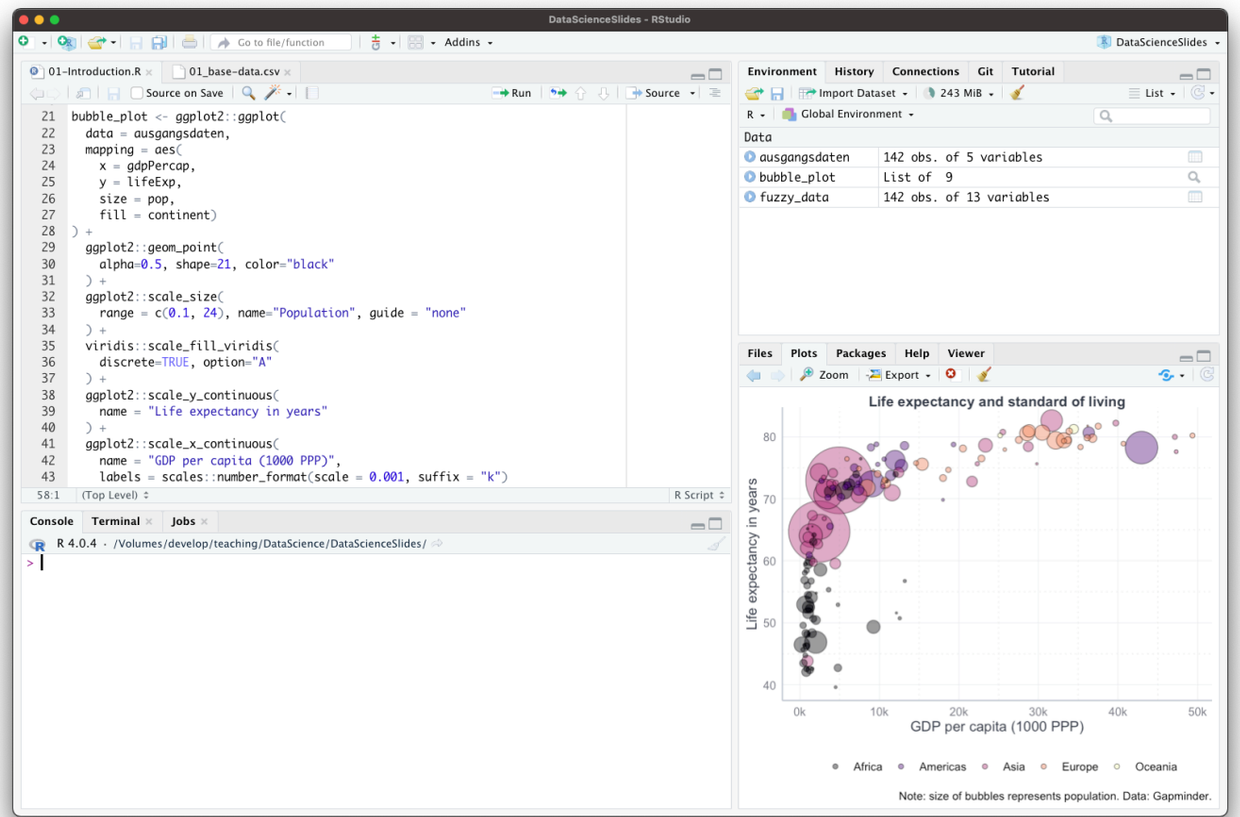


```
8B542408 83FA0077 06B80000 0000C383
FA027706 B8010000 00C353BB 01000000
B9010000 008D0419 83FA0376 078BD989
C14AEBF1 5BC3
```



```
[1] 3
```

- R-Studio is an integrated development environment
  - Basically a fancy text editor with additional features that make programming easy



R and R-Studio

- R is a programming language
- R-Studio is an integrated development environment

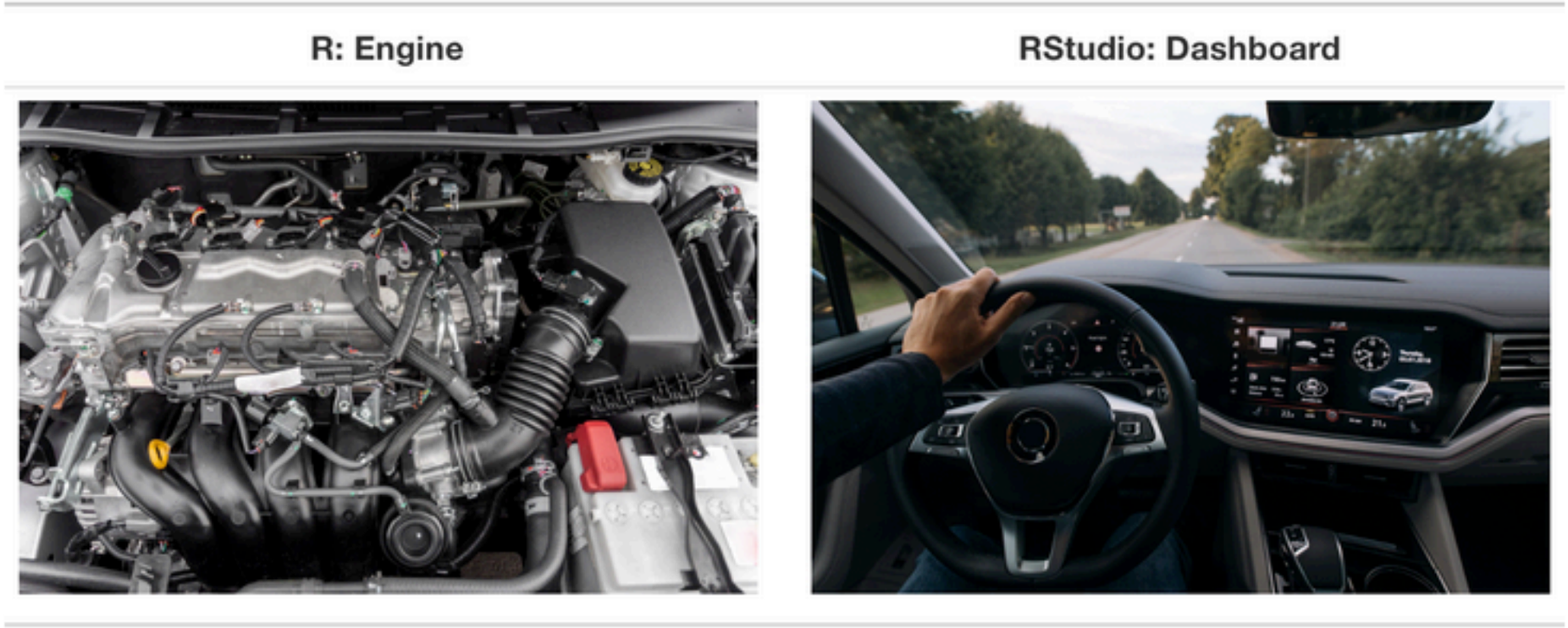


Figure: Ismay & Kim (2022)

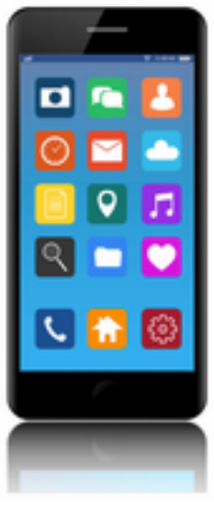
- You need to install R first, then you can install R Studio
- After that, you basically only use R Studio → it calls R whenever necessary

R and R packages

- If you install R, you can issue a lot of commands that your computer immediately understands
- However, there might be some routines that R “doesn’t understand”
- You might “teach” R this by defining, for instance, certain functions that perform these operations
- You might then even “save” these functions and pass it on to others, so that they can use them as well
- This is the idea of **R packages**: a collection of variables and functions written by others that you can install on your computer and use them
- Once an R package is installed, you can use all functions and variables defined by the creator of the package

R and R packages

- Again, Ismay & Kim (2022) have a nice analogy:

R: A new phone	R Packages: Apps you can download
	

- I wrote a small script that installs all packages that we will use throughout the semester, so we can already resolve all installation issues now

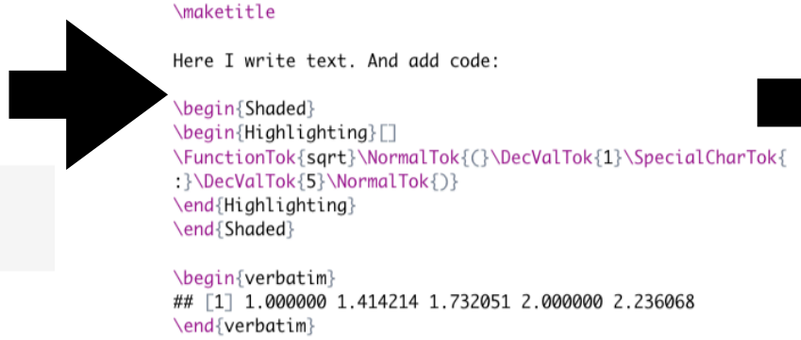
And what about LaTeX?

- In this course we learn how to write nice reports in Quarto / R Markdown
  - You put R code and text into one file, and you get a webpage in HTML or a nice PDF file
- Creating HTML code is easy, but creating a PDF is nothing trivial
- To do this, we need a software called LaTeX → a typesetting system
- It turns plain text into nice text within a PDF document

```
---
title: "R Markdown and PDF"
author: "Claudius"
output: pdf_document
---

Here I write text. And add code:

```{r}
sqrt(1:5)
```
```



```
\ifLuaTeX
  \usepackage{selnolig}  % disable illegal ligatures
\fi

\title{R Markdown and PDF}
\author{Claudius}
\date{}

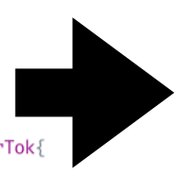
\begin{document}
\maketitle

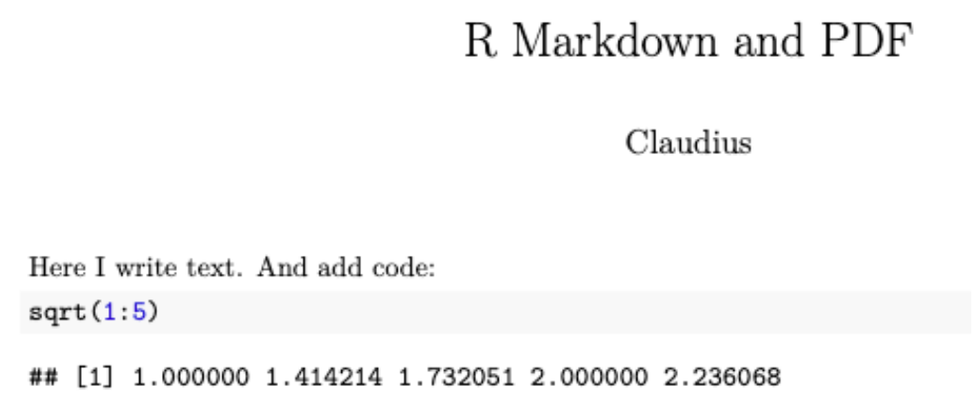
Here I write text. And add code:

\begin{Shaded}
\begin{Highlighting}[]
\FunctionTok{sqrt}\NormalTok{(}\DecValTok{1}\SpecialCharTok{
:}\DecValTok{5}\NormalTok{)}
\end{Highlighting}
\end{Shaded}

\begin{verbatim}
## [1] 1.000000 1.414214 1.732051 2.000000 2.236068
\end{verbatim}
```

This is LaTeX





R Markdown and PDF

Claudius

Here I write text. And add code:

```
sqrt(1:5)
```

```
## [1] 1.000000 1.414214 1.732051 2.000000 2.236068
```

Installation procedure

- It is absolutely essential that you install all the necessary software as soon as possible → installation guidelines on the course homepage
- Until next session you should have…
  - …tried to install R, R Studio and Git → follow my tutorials
  - …posted all problems with a screenshot in the Moodle forum

- Be prepared tomorrow, trying to install R just before the session is 🤬
- We need to solve all installation problems until the end of next week
  - Post problems on Moodle, help each other out

Problems with the installation?

1. Check again in the tutorials
2. Post your problems in Moodle
3. Accompany them with screenshots