R Markdown

04.05.2022, Data Science (SpSe 2022): T9

Prof. Dr. Claudius Gräbner-Radkowitsch
Europa-University Flensburg, Department of Pluralist Economics
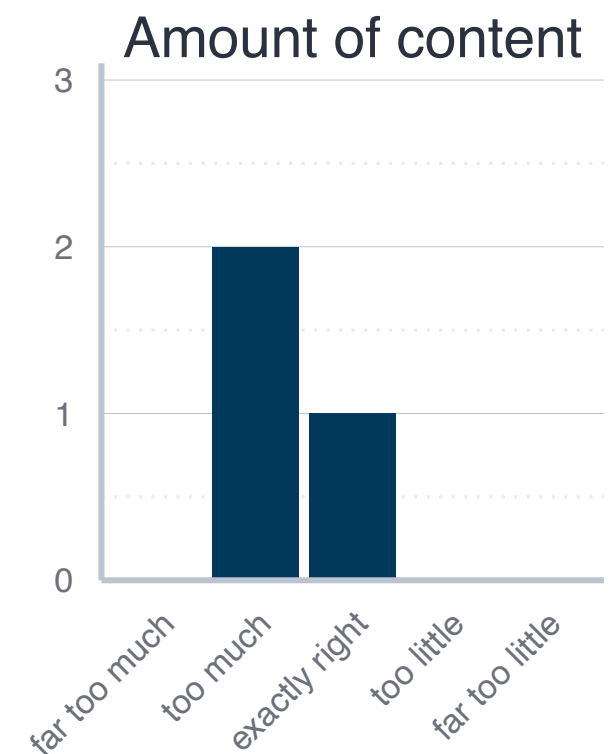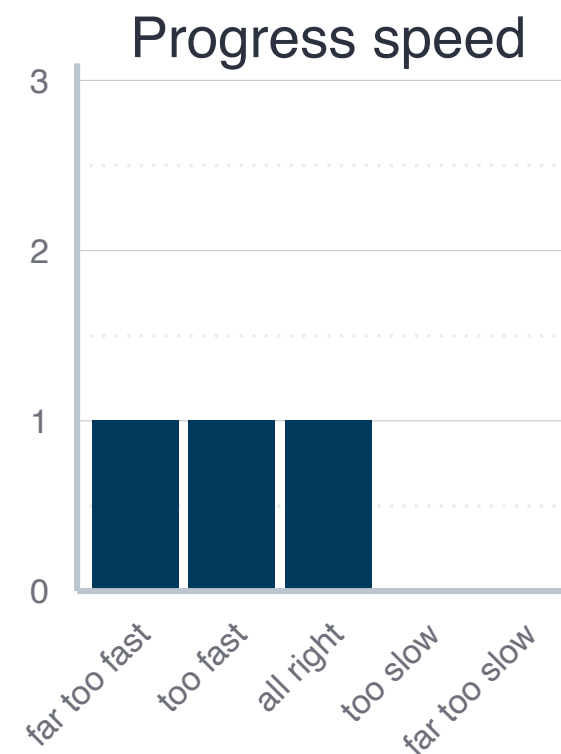www.claudius-graebner.com | @ClaudiusGraebner | claudius@claudius-graebner.com

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and Economic Education
Department of Pluralist Economics

Prologue:

Prologue
Feedback and exercises

- Three of you filled out the feedback survey. Main take-aways:

  - Some of you are starting to experience problems with following the lectures

  - Reading the mandatory readings and lecture notes, as well as doing the exercises is really essential

  - I also added some hints on Moodle

- What were the main problems with the exercises?

Progress speed

far too fast	too fast	all right	too slow	far too slow
1	1	1		

Amount of content

far too much	too much	exactly right	too little	far too little
	2	1		

Goals for today

I. Understand what R Markdown is about

II. Write your first R Markdown document

III. Render R Markdown documents into html and PDF format

IV. Become aware of specific challenges for project management when using R Markdown

What is R Markdown?

What is R Markdown?

- R Markdown is a document format that allows you to write documents containing code of two languages:

  - R code to perform statistical analysis → we know this (almost 😉)

  - Markdown code to create formatted text using a plain text editor

- Markdown is readable in its source and, if rendered, allows for formatting, such as **bold** or *italic* fonts, tables, headings…
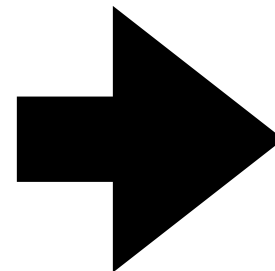
```
# Formatting in markdown
This is the source code. It is ugly,
but it is readable.

> **Note:** You can edit it on every editor,
and still can format your text.

You can have *italics*, you can have **bold**
texts, and much more!

## Tables

| Column 1 | Column 2  |
|:--------:|:---------:|
| Cell 1   | Cell 2    |
| Cell 3   | Cell 4    |
```

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Tables

Column 1	Column 2
Cell 1	Cell 2
Cell 3	Cell 4

What is R Markdown?

- R Markdown is a document format that allows you to write document comprising two languages:

  - R code to perform statistical analysis → we know this (almost 😉)

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- Markdown is readable in its source and, if rendered, allows for formatting, such as **bold** or *italic* fonts, tables, headings…

- We will not cover the basics of markdown → quite boring in a group

  - Please do the **interactive Markdown tutorial** on the course webpage

- Together, R and Markdown allows you to write formatted texts and conducts statistical analysis within one file

  - Perfect to make research accessible and reproducible

What is R Markdown

The header - contains meta information

Markdown

Chunk options

R Chunks

```
---
title: 'GDP and development'
author: Claudius
date: '2022-04-06'
output:
  html_document:
    theme: readable
    highlight: tango
    toc: true
    toc_depth: 2
    number_sections: true
---

# Packages used

```{r}
library(DataScienceExercises)
library(ggplot2)
```

GDP and development indicators

While there are convincing critiques of GDP as a measure of well-being, there
is also a clear relationship between GDP and socio-economic wellbeing indicators,
such as life expectancy:

```{r, include=FALSE}
gdp_data <- DataScienceExercises::gdplifexp2007
head(gdp_data, 3)
```

```{r, echo=FALSE, warning=FALSE}
plot_preview <- ggplot2::ggplot(
  data = gdp_data,
  mapping = ggplot2::aes(
    x = gdpPercap,
    y = lifeExp,
    size = pop,
    fill = continent
  )
) +
  ggplot2::geom_point(
    shape=21, color="black", alpha=0.5) +
  labs(
    title = "Life expectancy and income per capita",
    caption = "Note: size of bubbles represents population. Data: Gapminder",
    x = "GDP per capita (int. Dollar)",
    y = "Life expectancy in years"
  ) +
  ggplot2::scale_x_continuous(
    labels = scales::number_format(scale = 0.001, suffix = "k")
  ) +
  ggplot2::scale_size_continuous(
    guide = "none",
    range = c(0.1, 24)
  ) +
  scale_fill_brewer(
    palette = "Dark2"
  ) +
  ggplot2::theme_bw() +
  theme(
    legend.position = "bottom",
    legend.title = ggplot2::element_blank(),
    panel.border = ggplot2::element_blank(),
    axis.line = ggplot2::element_line(colour = "grey"),
    axis.ticks = ggplot2::element_line(colour = "grey")
  )
plot_preview
```

This relationship seems to be, however, heterogeneous across countries.
```
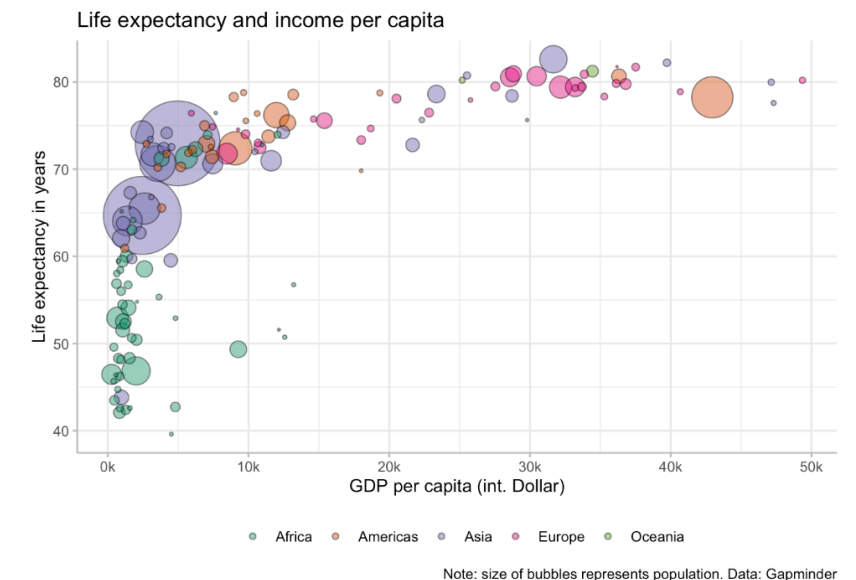
## GDP and development

**Claudius**

**2022-04-06**

- 1 Packages used
- 2 GDP and development indicators
- 3 Trends of divergence

## 1 Packages used

```
library(DataScienceExercises)
library(ggplot2)
```

2 GDP and development indicators

While there are convincing critiques of GDP as a measure of well-being, there is also a clear relationship between GDP and socio-economic wellbeing indicators, such as life expectancy:
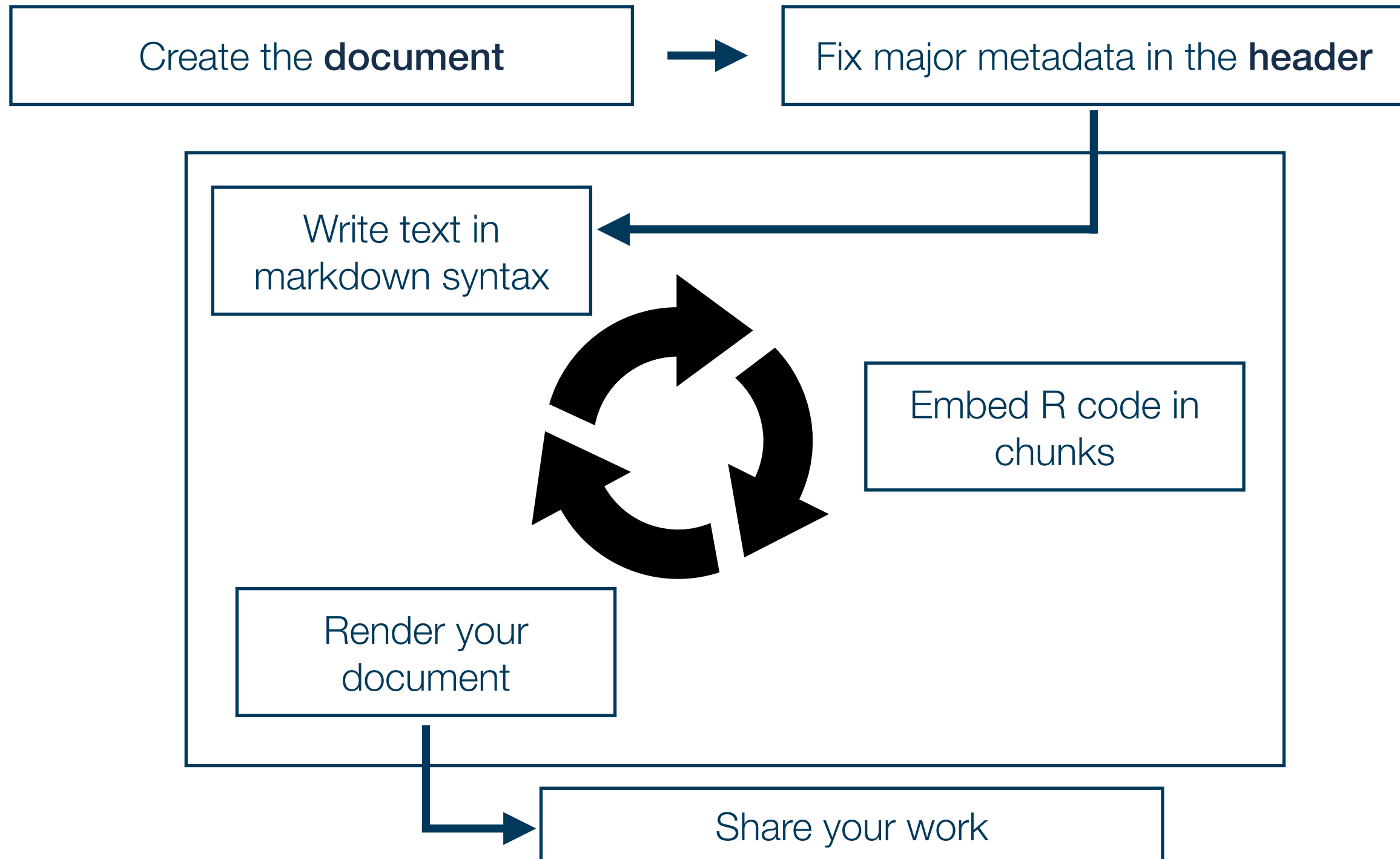

This relationship seems to be, however, heterogeneous across countries.
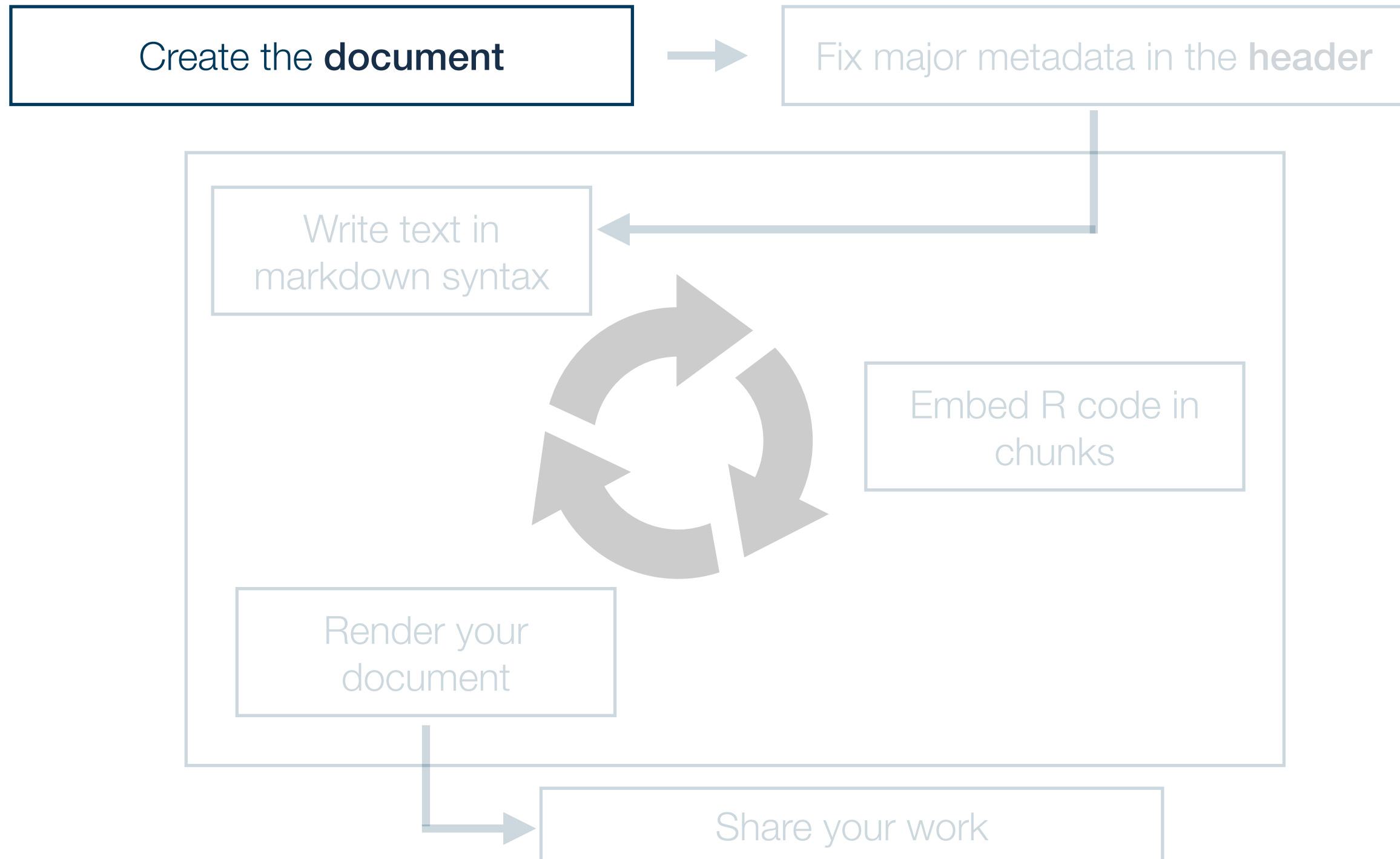
What is R Markdown?

- R Markdown documents can be rendered to very different formats

  - HTML, PDF, Word, …

- There are also many extensions available…

  - `bookdown` to write books

  - `blogdown` to create websites

  - `learnr` to create exercises

  - And many more…

- Basic **syntax the same** for all applications → this will be the focus here

  - Now go through the single steps required to get a R Markdown working
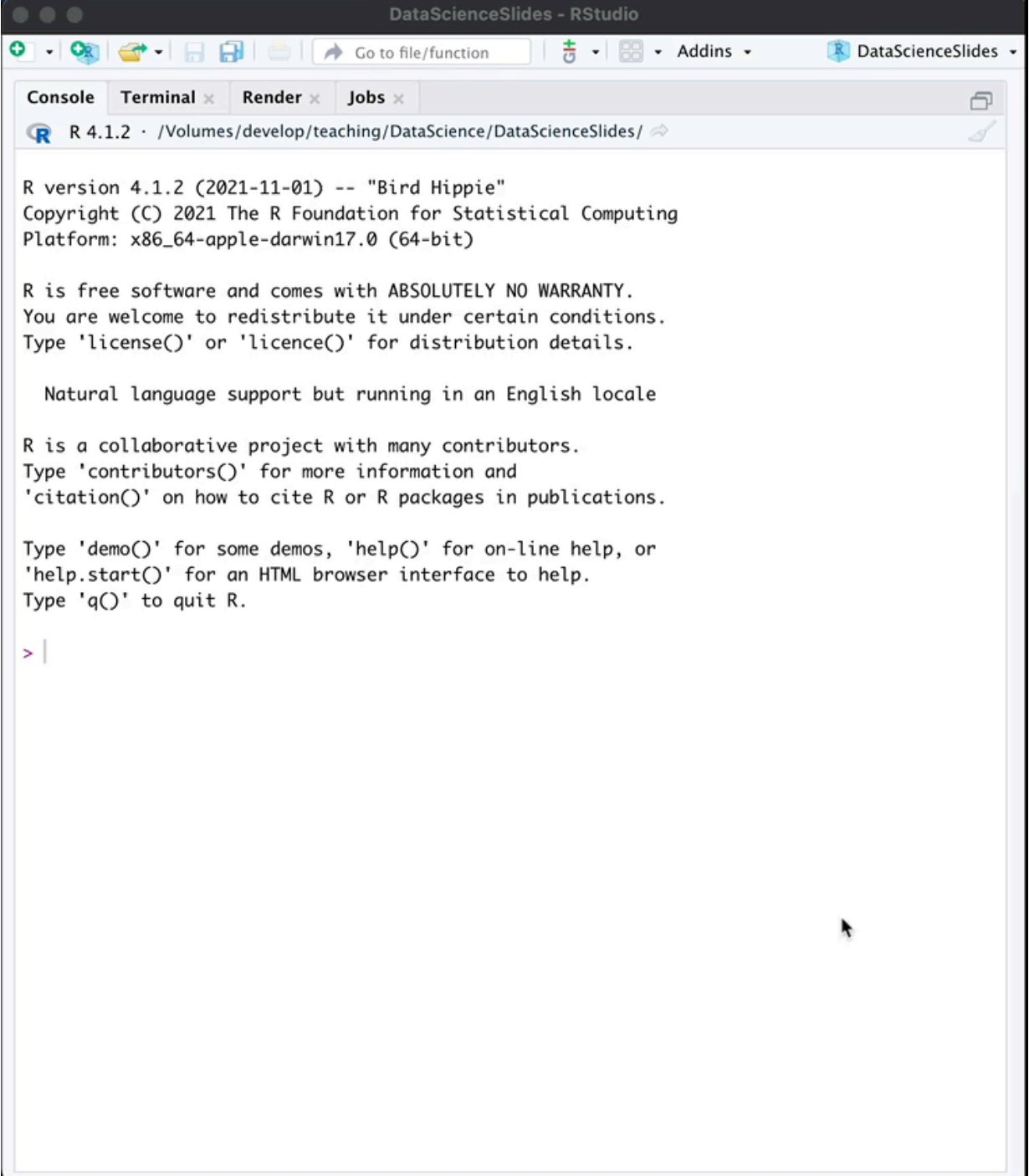
R Markdown Step by Step

R Markdown step-by-step

Create the **document** → Fix major metadata in the **header**

Write text in markdown syntax

Embed R code in chunks

Render your document

Share your work

R Markdown step-by-step

Create the **document** → Fix major metadata in the **header**

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R Markdown step-by-step
1. Creating the document

- First create a new Rmd document, and choose, if adequate, a template

- There are plenty of templates distributed as packages

  - For learning purposes its always best to start with a blank document

- After creating the document its best to save it immediately

  - Either in the subdirectory `R`, or in a separate top-level directory `markdown`

R Markdown step-by-step

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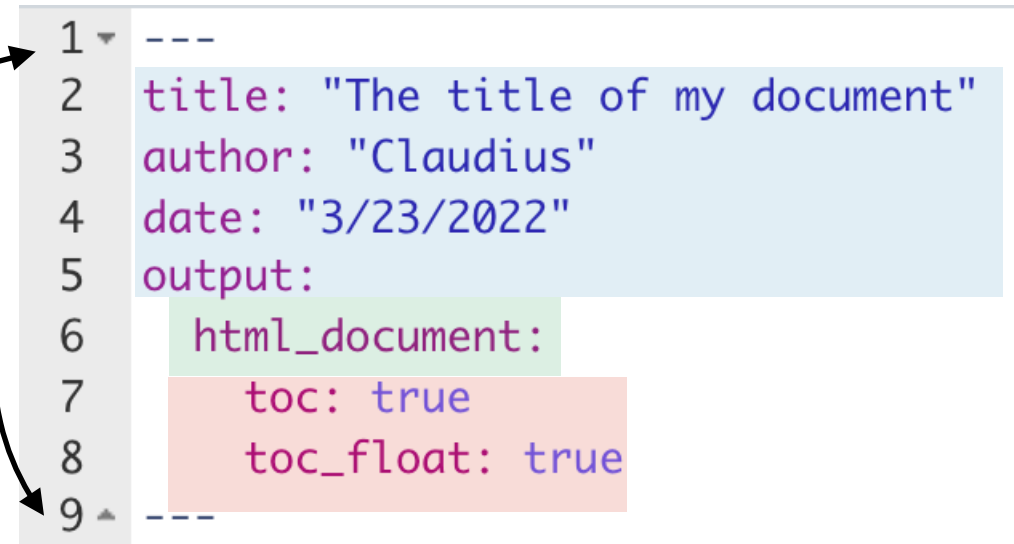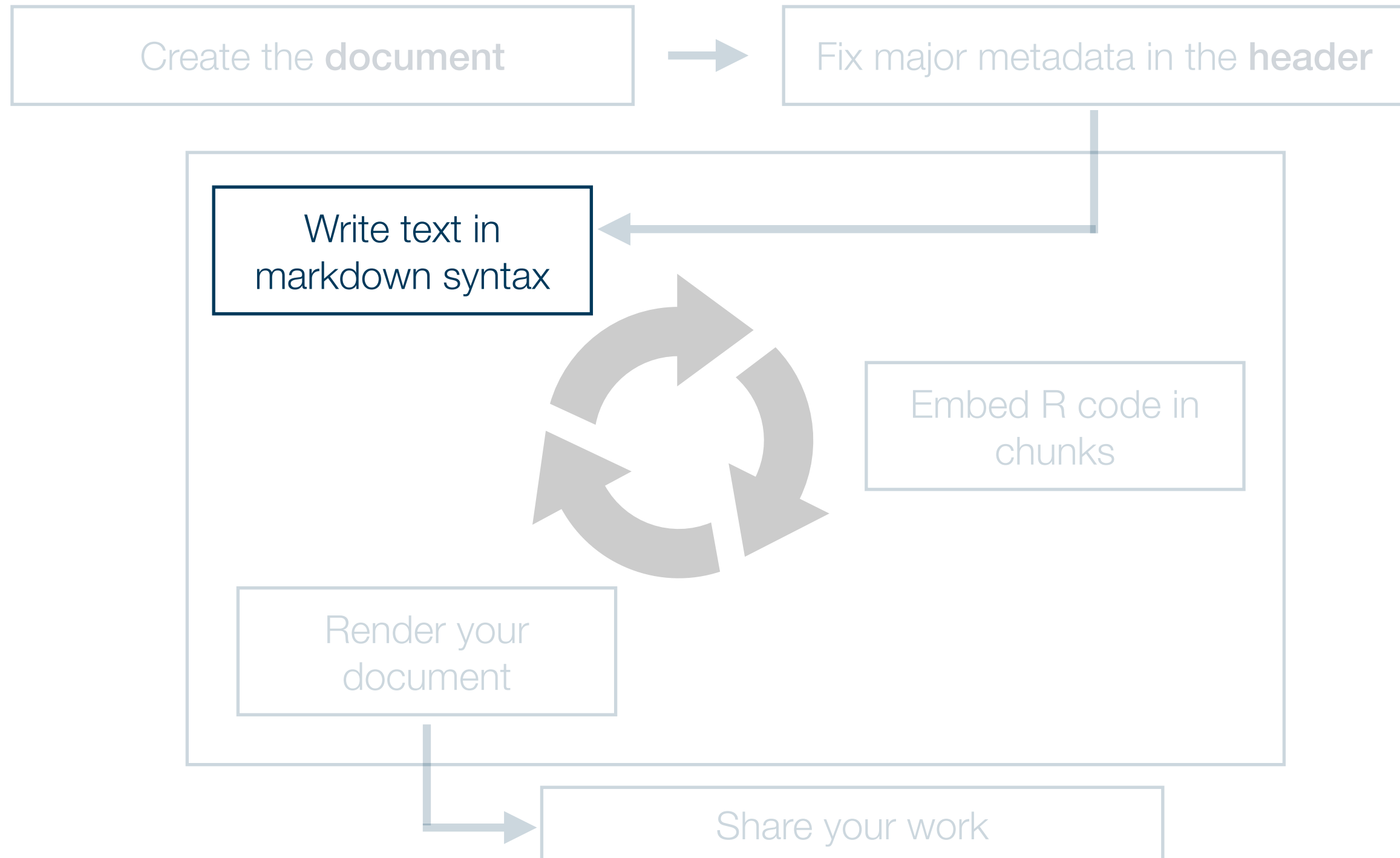
R Markdown step-by-step
2. Specify the header

- The header contains meta data

    - It starts and ends with `---`

    - Usually you should set at least `title`, `author`, and `date`

```
1  ---
2  title: "The title of my document"
3  author: "Claudius"
4  date: "3/23/2022"
5  output:
6    html_document:
7      toc: true
8      toc_float: true
9  ---
```

- The output arguments are usually set later

    - Determines the function used by the markdown package to render output (`rmarkdown::html_document()`, `rmarkdown::pdf_document()`,...)

    - The more specific comments translate into arguments of `rmarkdown::*_document()`

- The headers is written in YAML

    - There is a nice overview over the major keywords in the Markdown Coodbook (see further readings)

R Markdown step-by-step

Create the **document** → Fix major metadata in the **header**

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R Markdown step-by-step
3. Write the main text

- Just write the text as you would do in any normal text editor

  - To format the text, follow the Markdown syntax

  - This syntax is best learned by example → do the interactive Markdown tutorial on the course homepage

R Markdown step-by-step

Create the **document** → Fix major metadata in the **header**

Write text in markdown syntax

Embed R code in chunks

Render your document

Share your work
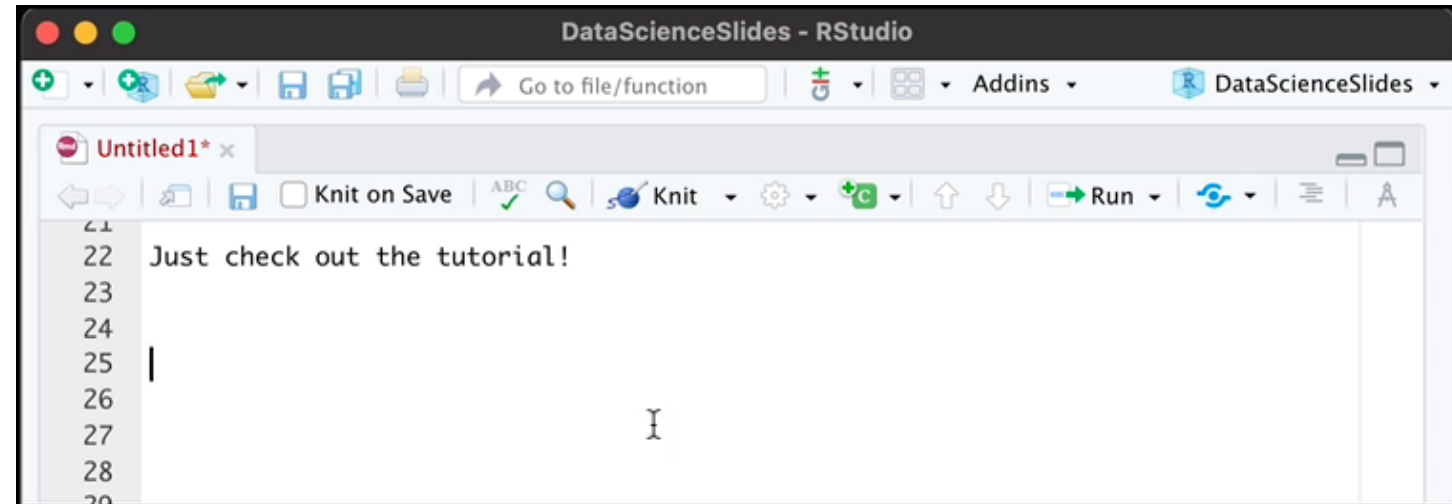
R Markdown step-by-step
4. Embed R code into your document

- R code is written within **chunks**

  - Shortcut on Mac: ⌘ ⌥ i

- Each chunk starts with a line
  ```` ```{r} ```` and ends with ```` ``` ````

- Within the chunk you write R code just as you already know it

- You can refer to variables defined in previous chunks

  - You could in principle refer to all objects defined but you should make sure that they were defined in chunks above the one you work on → doing otherwise would cause problems when rendering the file

  - To execute the chunk or all previous chunks you might use the buttons:

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R Markdown step-by-step
4. Embed R code into your document

- How the R code gets shown and executed in the final document is controlled via the chunk options

- They can be added to the first line of the chunk:

```
```{r name, echo=FALSE}

```
```

This is a chunk with `echo=TRUE` :

```
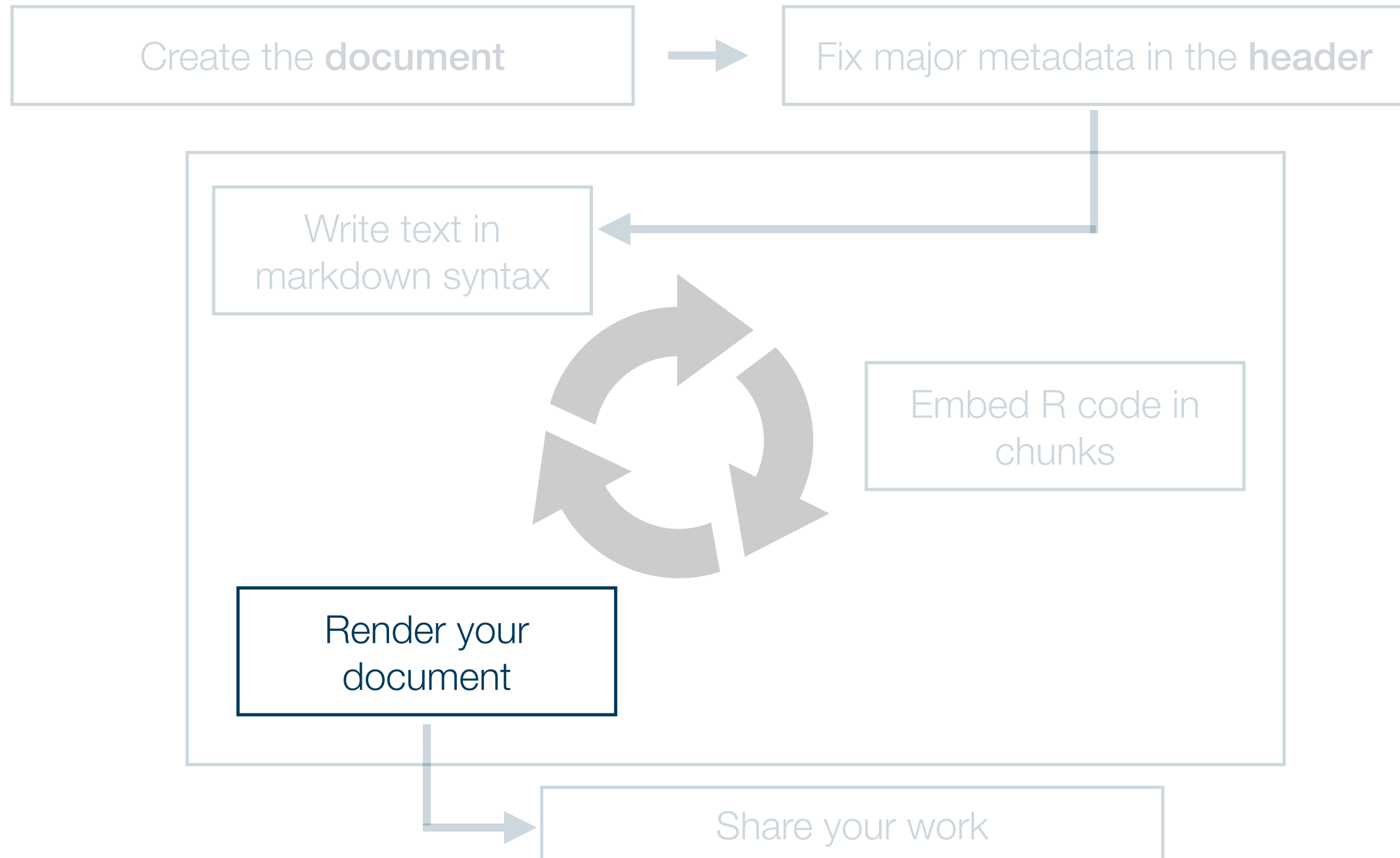2 + 2
```

```
## [1] 4
```

This is a chunk with `echo=FALSE` :

```
## [1] 4
```

- You can set default options for chunk options in the beginning of the document:

```
```{r setup, include=FALSE}
knitr::opts_chunk$set(
  echo = TRUE,
  message = FALSE,
  warning = FALSE
)
```
```

- A full list of all chunk options can be found here: https://yihui.org/knitr/options/

# R Markdown step-by-step



Create the **document** → Fix major metadata in the **header**

Write text in markdown syntax

Embed R code in chunks

Render your document

Share your work

# R Markdown step-by-step
## 4. Render the documents

- This should in fact be done regularly during step 3

  - Otherwise its hard to identify the source of an error



- You can also render the document via a function directly

- You can adjust the output via the output options in the header

# R Markdown step-by-step
## 4. Render the documents - examples for output options

The indented options below only apply to documents that are rendered into html format using `rmarkdown::html_document()`

General property sets (fonts, paragraphs, etc.)

How to color the code in chunks

Specification of the table of contents

Activate the numbering of sections

```
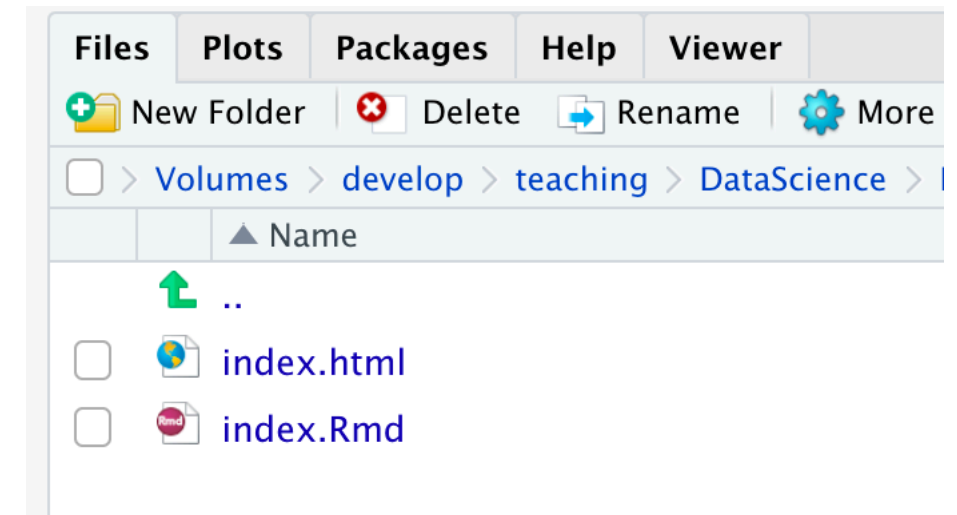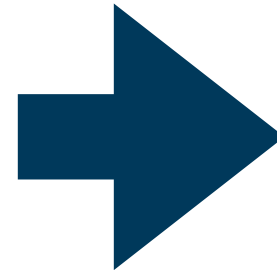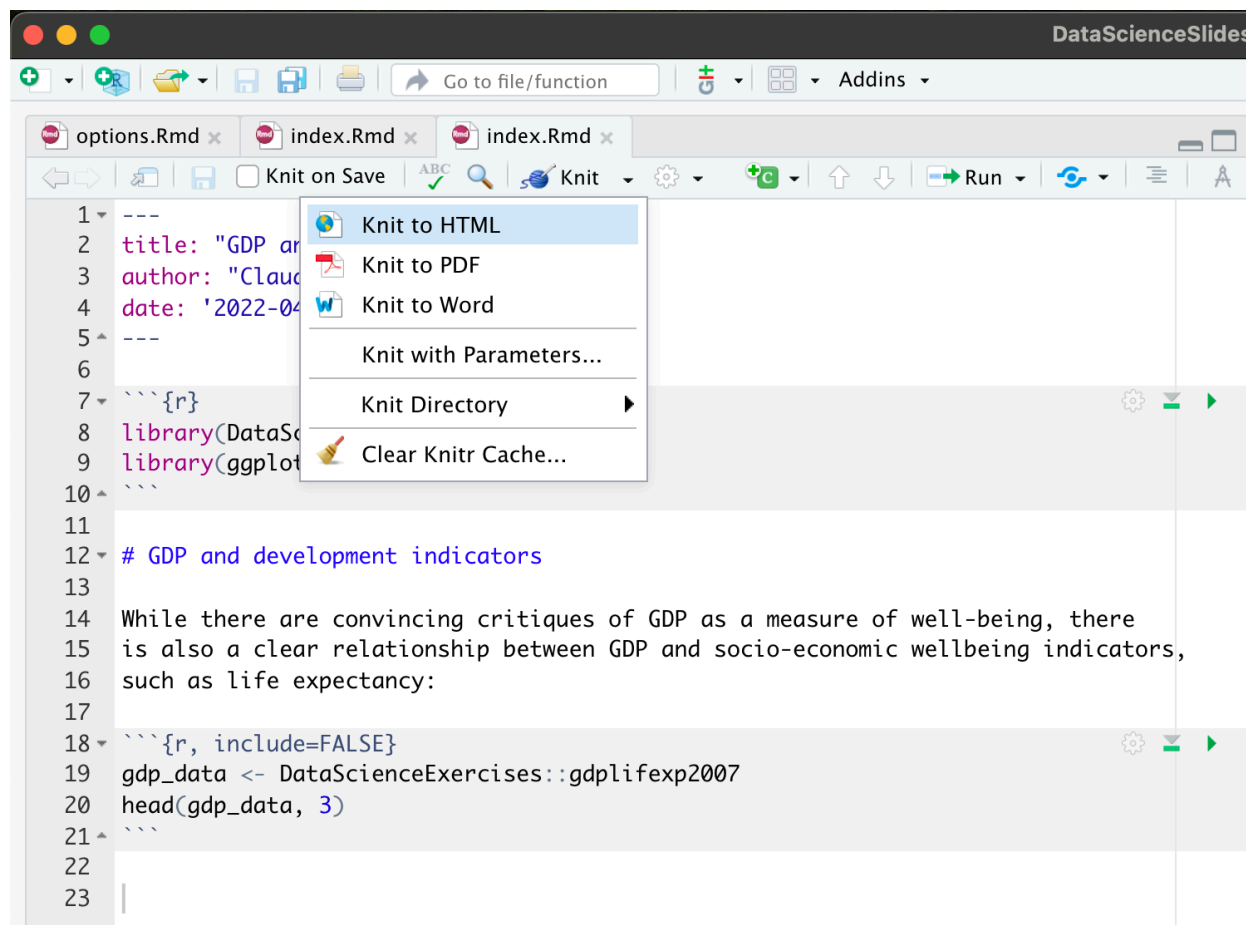1  ---
2  title: 'GDP and development'
3  author: Claudius
4  date: '2022-04-06'
5  output:
6    html_document:
7      theme: readable
8      highlight: tango
9      toc: true
10     toc_depth: 2
11     number_sections: true
12 ---
```

For a complete overview over output options and possible themes you should check the internet for the desired output format!

R Markdown step-by-step
4. Render the documents - implications of output options

```
1   ---
2   title: 'GDP and development'
3   author: Claudius
4   date: '2022-04-06'
5   ---
6
```

```
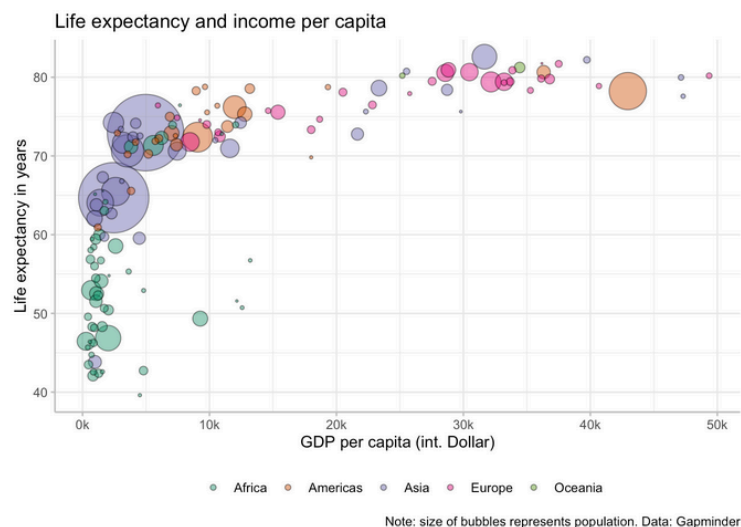1    ---
2    title: 'GDP and development'
3    author: Claudius
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5    output:
6      html_document:
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R Markdown step-by-step

Create the **document** → Fix major metadata in the **header**

Write text in markdown syntax

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Render your document

Share your work

R Markdown step-by-step
5. Share your work

- Many different possibilities → check the further readings

  - Key question is often about the format

- Here we consider a very straightforward solution for html-documents

  - Netlify Drop: https://app.netlify.com/drop

- Prerequisites:

  - You create an html document

  - All relevant output data is in one folder

  - You produce an output `index.html`

- Then its a nice way to distribute your document quickly

R Markdown step-by-step
5. Share your work

- Many different possibilities → check the further readings

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- Here we consider a very straightforward solution for html-documents

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- Then its a nice way to distribute your document quickly

  - If you are registered you can also choose a custom URL and much more

R Markdown step-by-step

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Share your work

Practice!

- Write and render a document!

- The text should include…

  - …a heading of level 1 and 2

  - …a text body

  - …a plot made with `ggplot2`

- Also add meta data on the `author`, `title`, and `date`

- Render the document into `html`

- Deploy the document via Netlify Drop and post the link on Moodle:

  - https://app.netlify.com/drop (Note: the .html file must be called **index.html**)

```
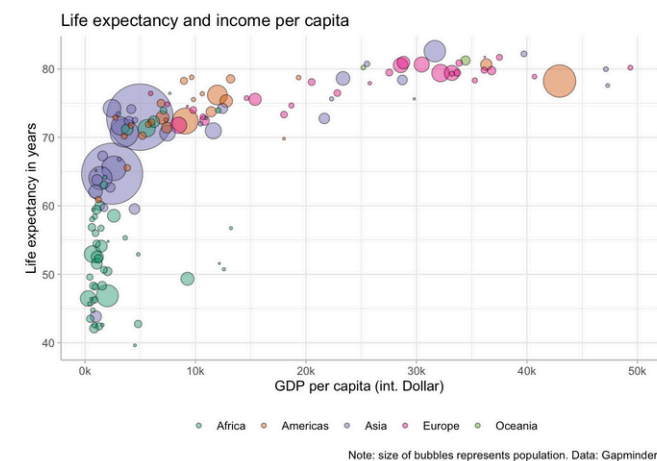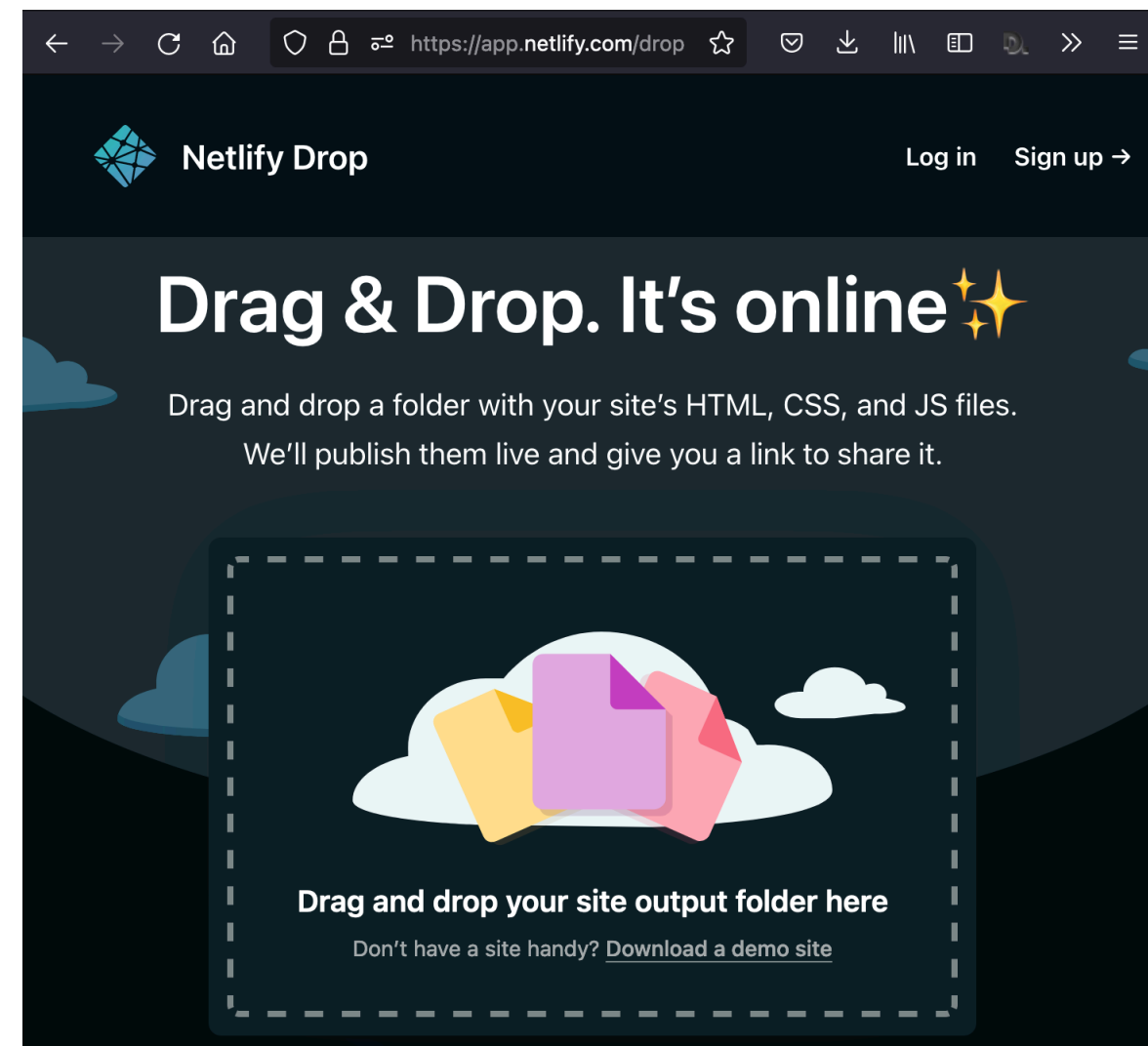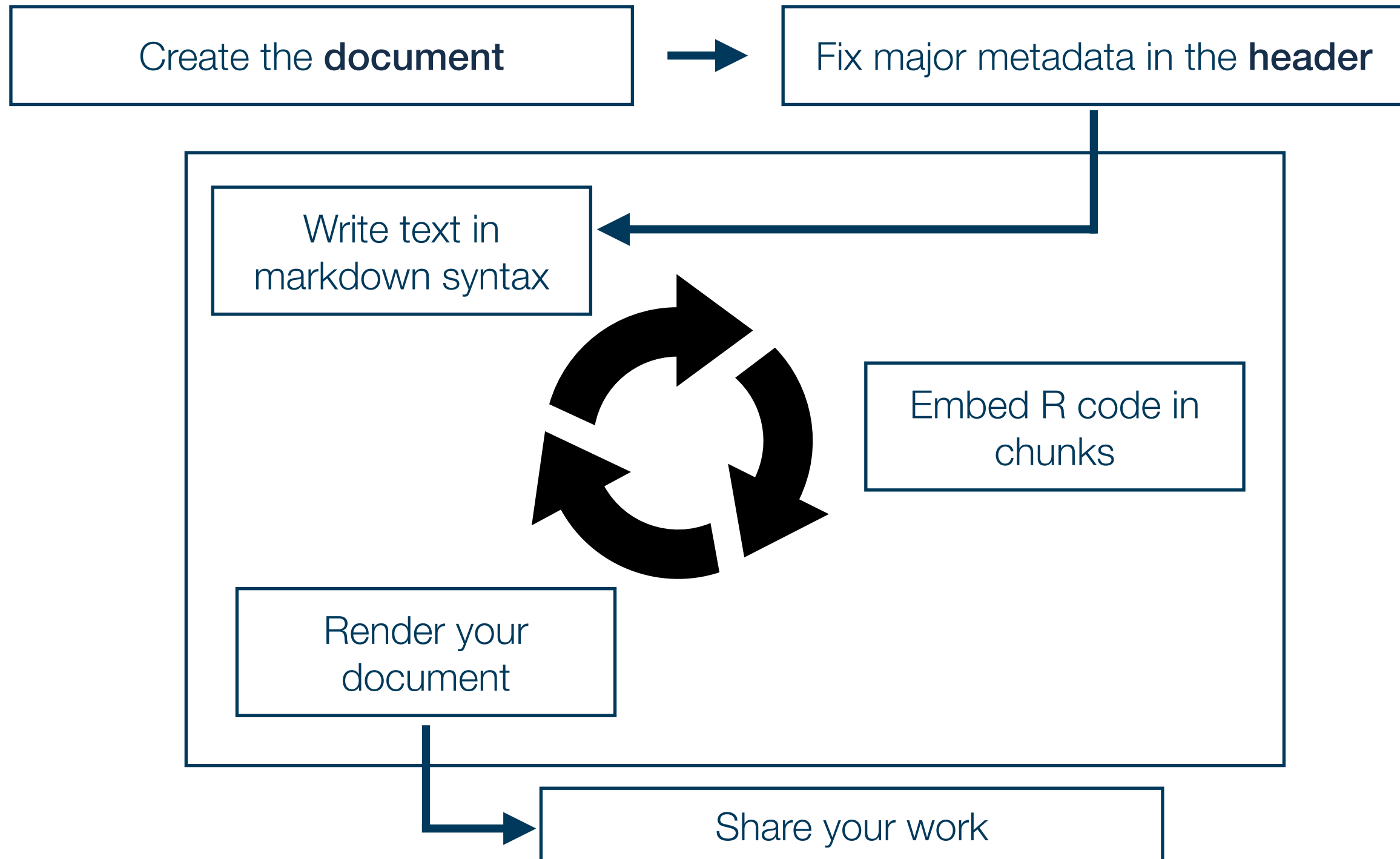library(ggplot2)
ggplot(
  data = DataScienceExercises::aggGDPlifexp,
  mapping = aes(
    x = gdpPercap,
    y = lifeExp,
    color=continent)
) +
geom_point() +
theme_bw()
```

Some final remarks on project organisation

- The use of the `here` package is especially important when writing R markdown documents

    - When rendering an Rmd document, your computer is **not** using your current working directory

    - Rather, the **working directory** is set to the **location of the Rmd file**

    - This means that you cannot copy-paste code from R scripts that contains relative paths, except you use the `here`-package

- Its usually a good idea to put Rmd-files either into the folder R or create a separate top level directory markdown

Avoid common mistakes

Avoiding common markdown mistakes

- There are some very common mistakes

  - These screw up you document considerable and make it painful to read…

  - …but are actually very easy to avoid

- Thus, after completing a markdown document, always look at the rendered version

  - Check whether any of the problems below still exists and eliminate them when necessary

Task:

Download `DesasterMarkdown.pdf` from the course homepage and collect the aspects that bother you the most!

The black list of markdown turpitudes

Problem	Solution

- Upgrade: make tables pretty with `knitr::kable()` and `kableExtra`

- See the overview over all chunk options here: https://yihui.org/knitr/options/

Summary & outlook

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Summary and outlook

- R Markdown is a document format that allows you to write documents that contain…

  - R code to perform statistical analysis

  - Markdown code to create formatted text using a plain text editor

- This allows you to do and describe your statistical analysis within one consistent document → makes research fully transparent and reproducible

- We covered the main steps of working with R Markdown:

  - (1) create the documents, (2) set meta-data in the header, (3) write text, (4) embed R code, (5) render the document, and (6) share the final result

  - To learn markdown, just do the interactive tutorial

- There are a few mistakes that might easily screw up your document, but are just as easy to avoid

Summary and outlook

- We have now covered all the fundamentals of data preparation

- This was the most important part of the lecture since these are the tools you *always* need

- Now we will turn to some more advanced programming techniques and statistical applications: theory and modelling

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Tasks until next week:
1. Fill in the **quick feedback survey** on Moodle
2. Read the **mandatory readings** posted on the course page
3. Complete the **interactive Markdown tutorial** linked on the course page
4. Do the **exercises** provided on the course page and **discuss problems** and difficulties via the Moodle forum

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