R Markdown

28.04.2020, Data Science (SpSe 2022): T8

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Prologue:

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Feedback and exercises

- XX of you filled out the feedback survey. Main take-aways:
  - TBA
- What were the main problems with the exercises?

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…

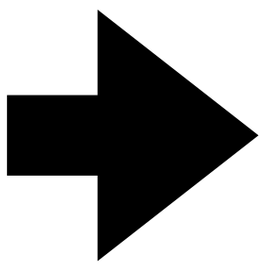
```
# Formatting in markdown
This is the source code. It is ugly,
but it is readable.

> **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 😉)
  - 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…
- 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

```yaml
---
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

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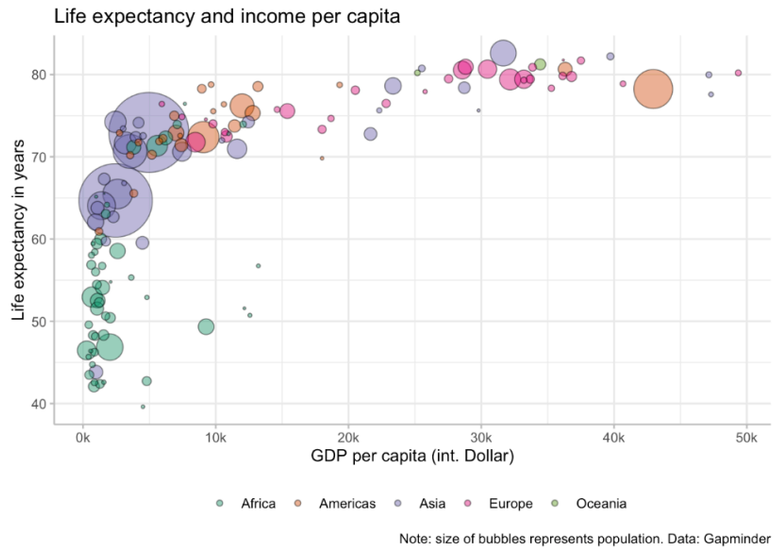


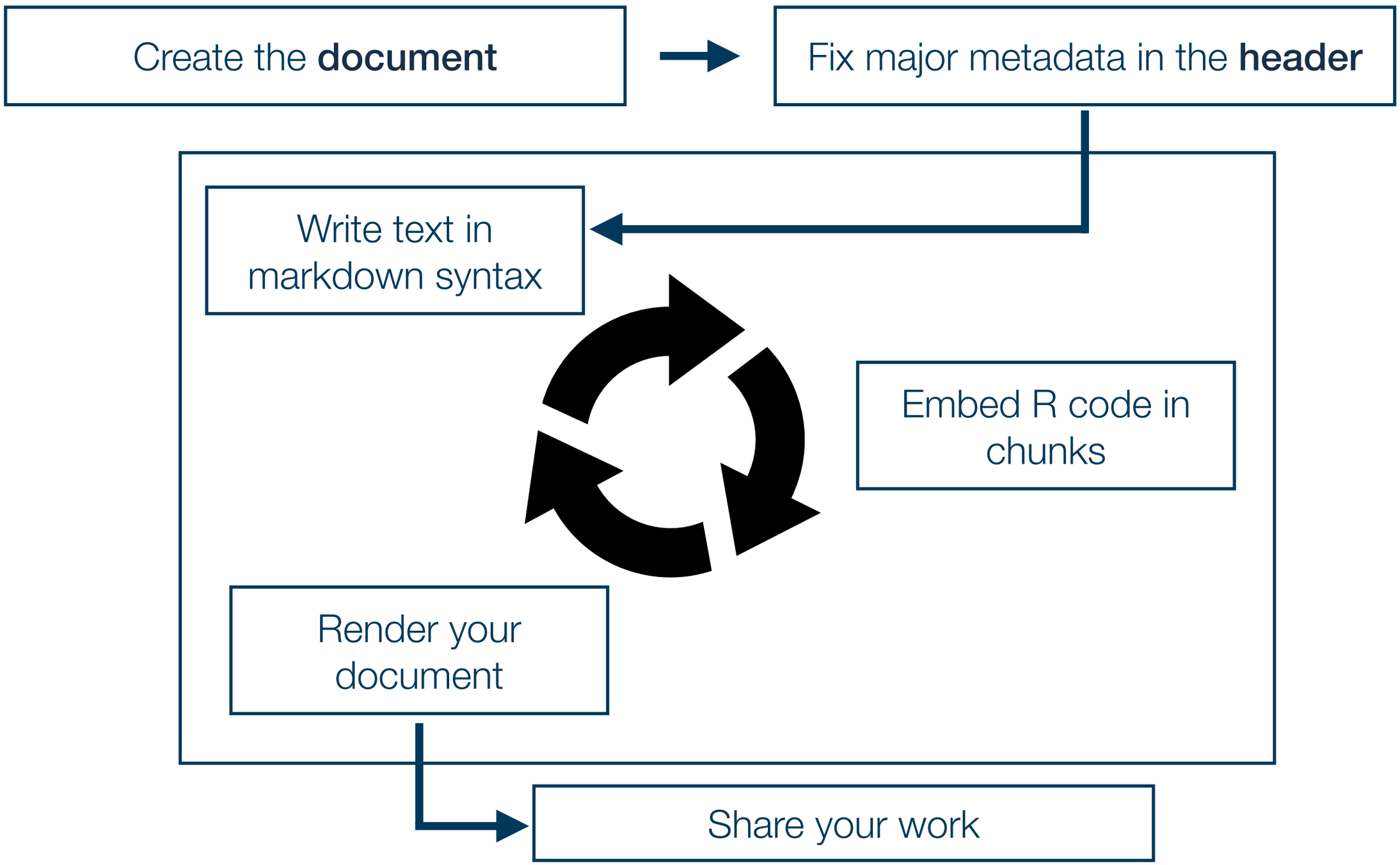
This relationship seems to be, however, heterogeneous across countries.

What is R Markdown?

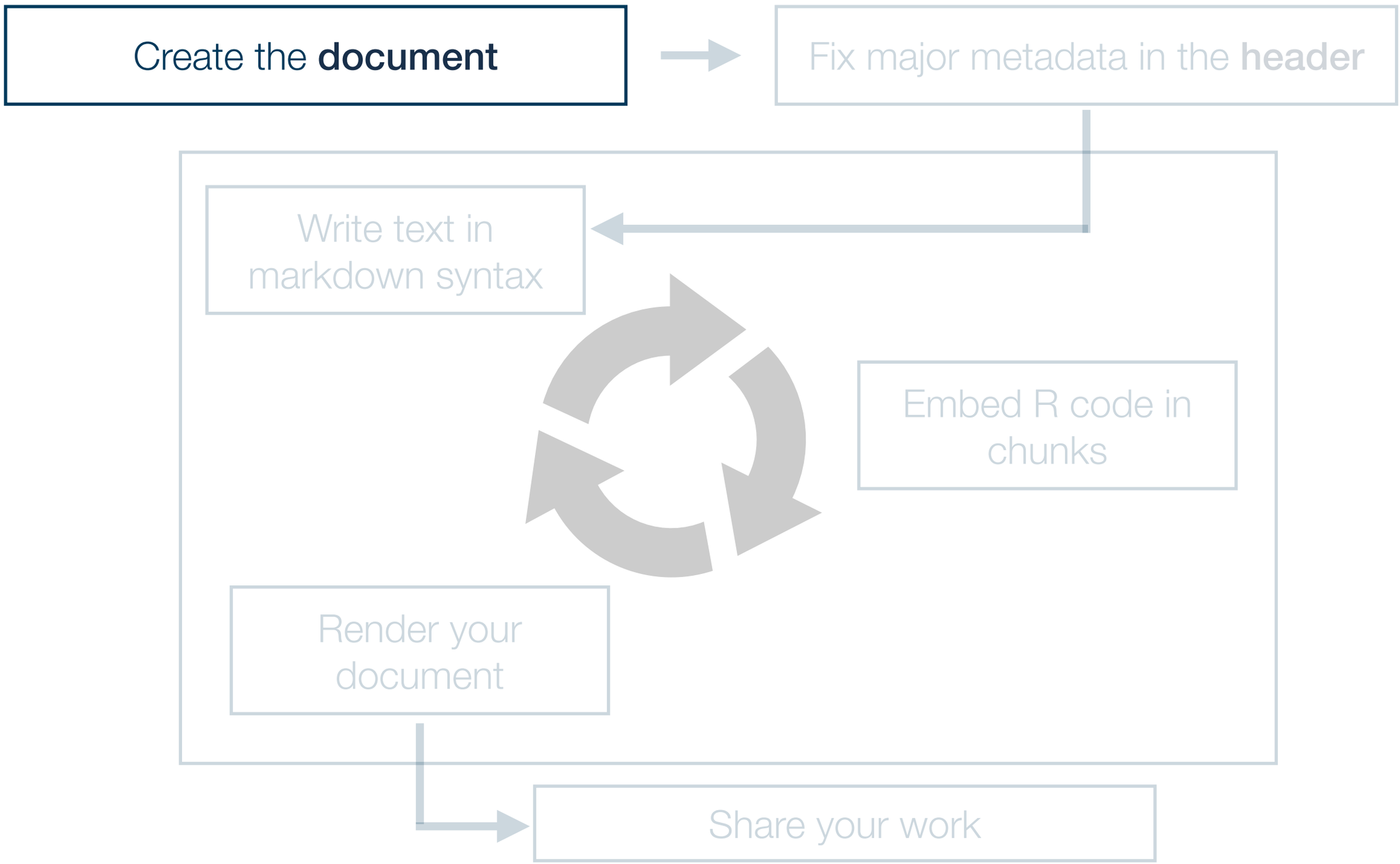
- R Markdown documents can be rendered to very different formats
  - HTML, PDF, Word, …
- There are also many extensions available…
  - b**ookdown** to write books
  - `blogdown` to create websites
  - `learnr` to create exercises
  - And many more…
- Basic **syntax the same** for all applications → 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

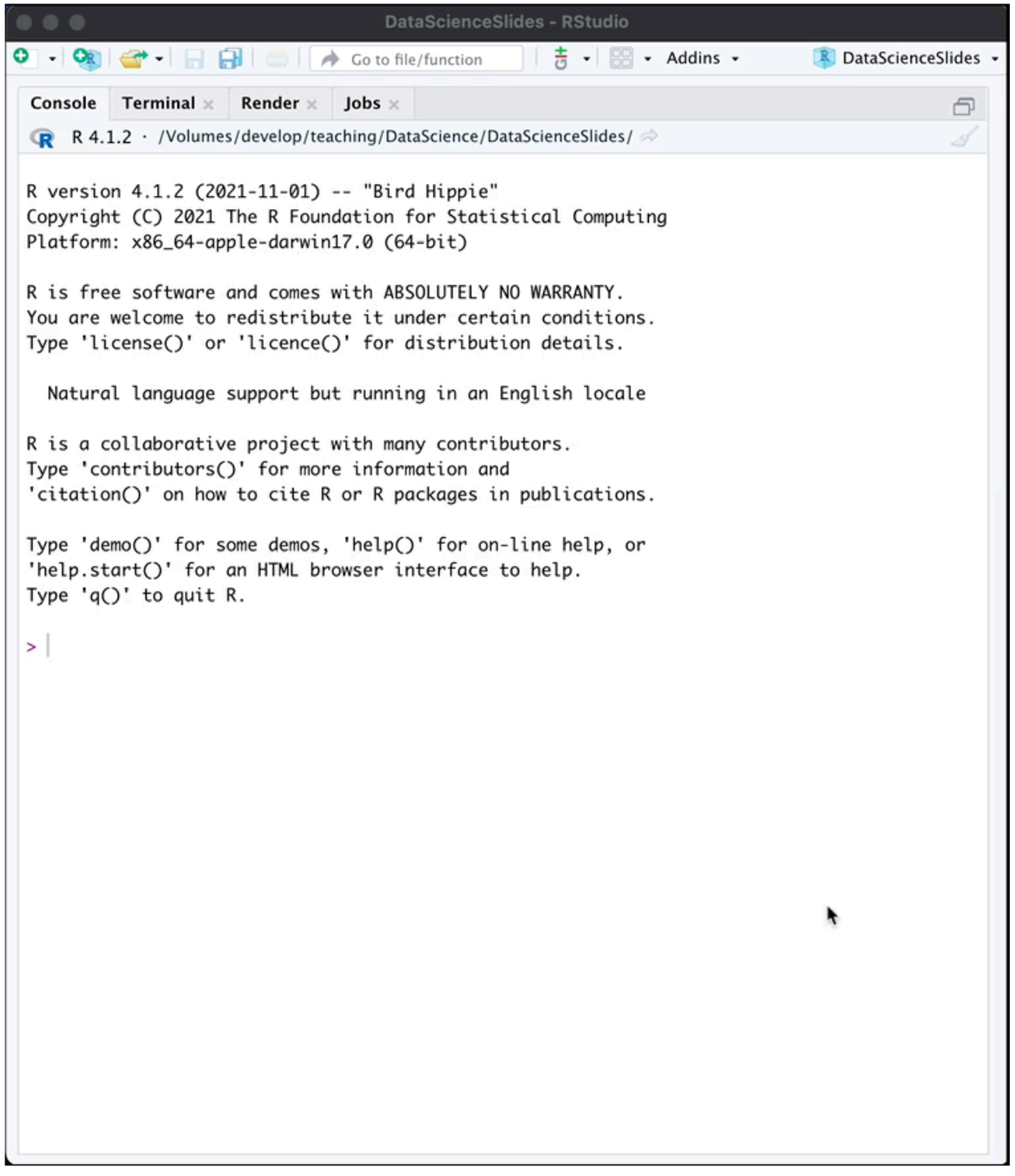


R Markdown step-by-step

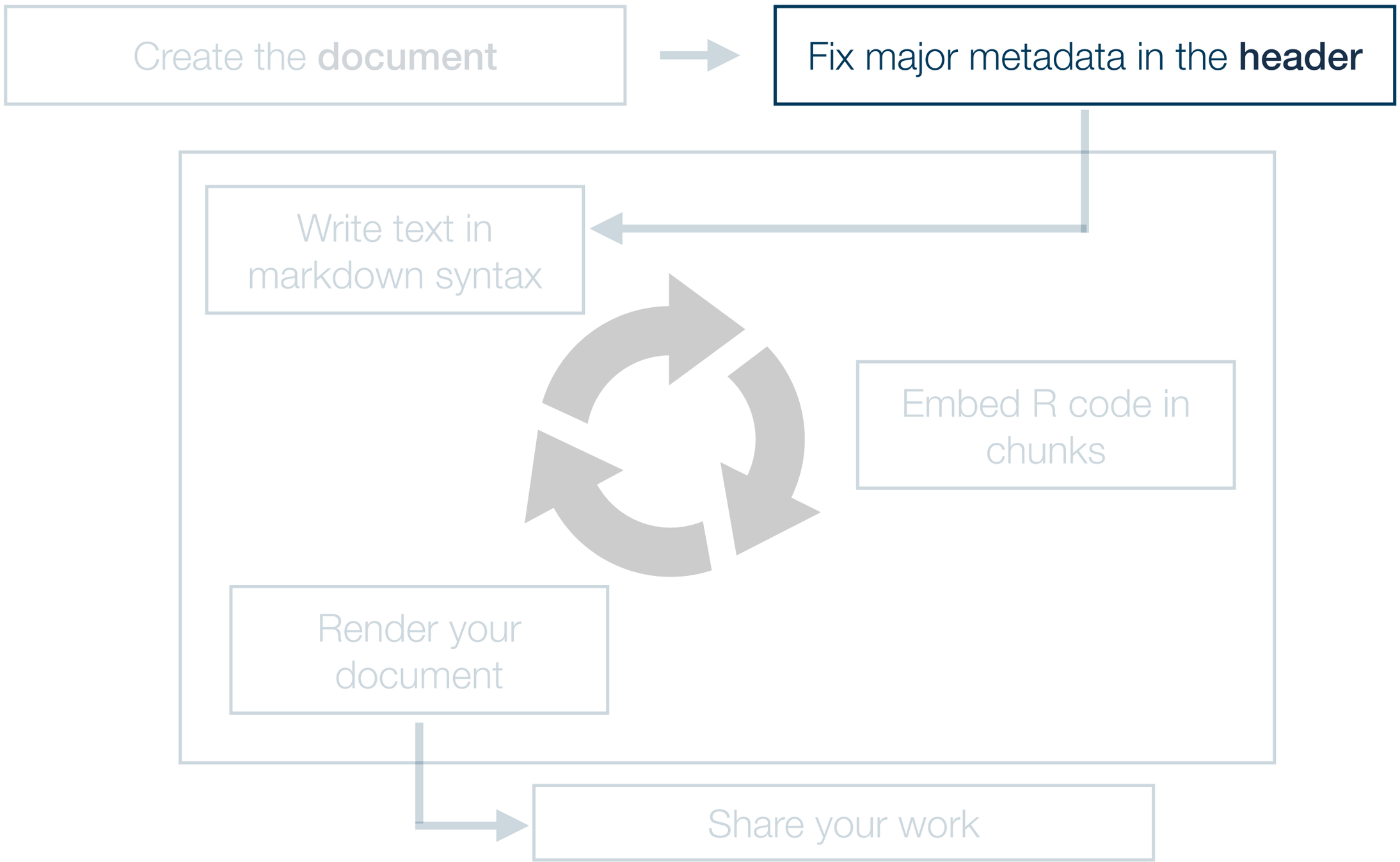


R Markdown step-by-step
1. Creating the document

- 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



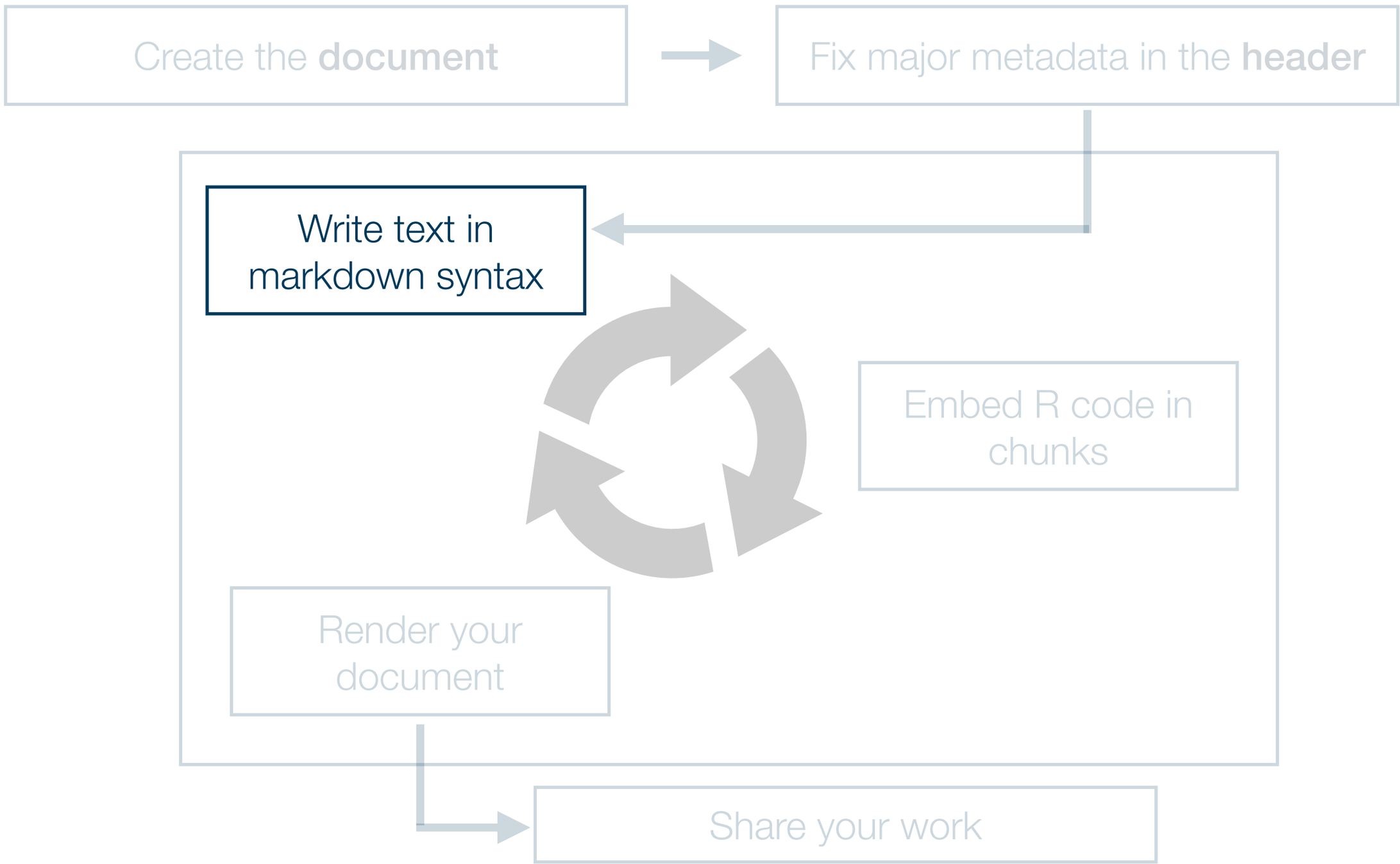
R Markdown step-by-step
2. Specify the header

- The header contains meta data
  - It starts and ends with `---`
  - Usually you should set at least `title`, `author`, and `date`
- The output arguments are usually set later

```yaml
---
title: "The title of my document"
author: "Claudius"
date: "3/23/2022"
output:
  html_document:
    toc: true
    toc_float: true
---
```

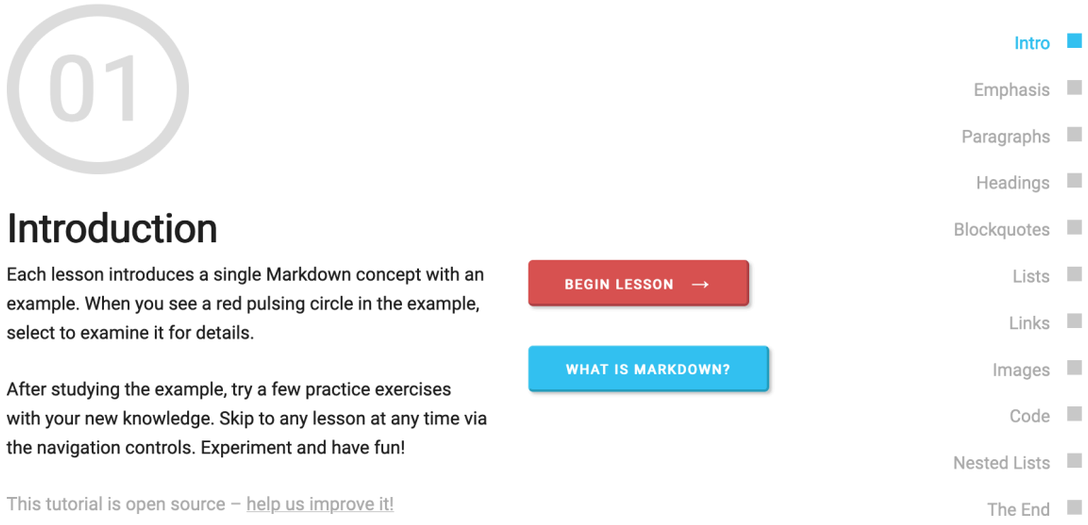
  - Determines the function used by the markdown package to render output (`rmarkdown::html_document()`, `rmarkdown::pdf_document()`,...)
  - The more specific comments translate into arguments of `rmarkdown::*_document()`
- The headers is written in YAML -
  - There is a nice overview over the major keywords in the Markdown Coodbook (see further readings)

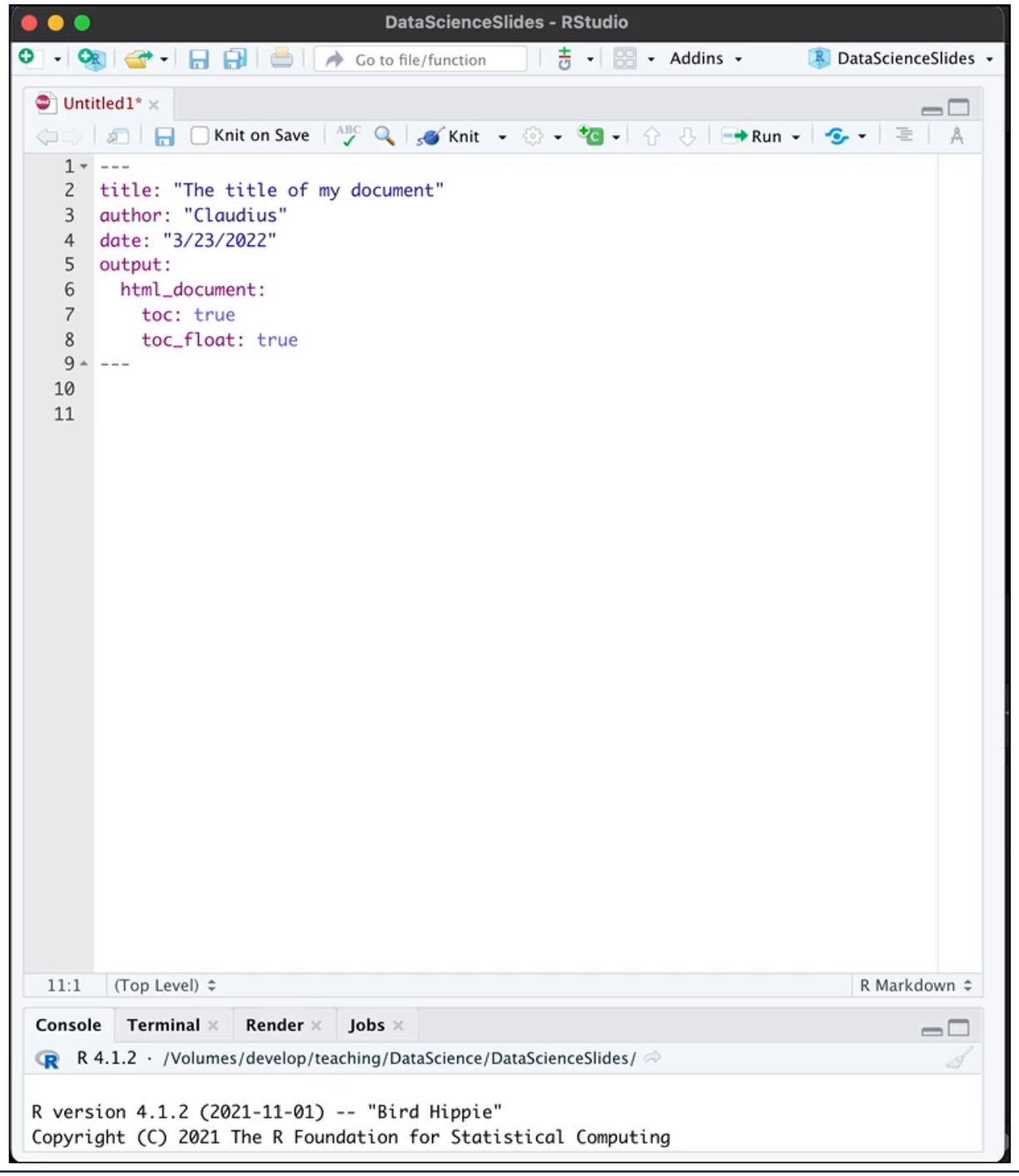
R Markdown step-by-step



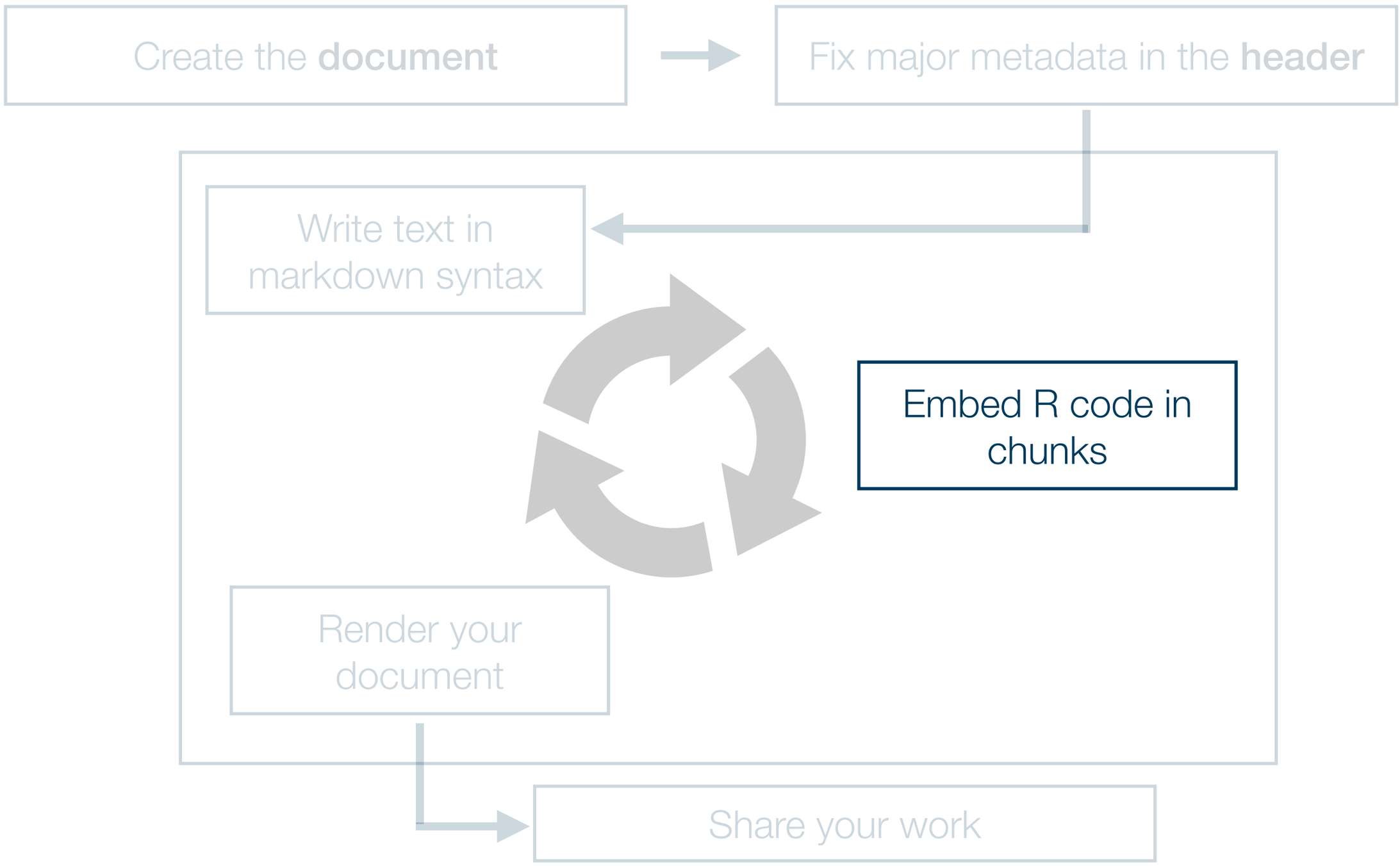
R Markdown step-by-step
3. Write the main text

- 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



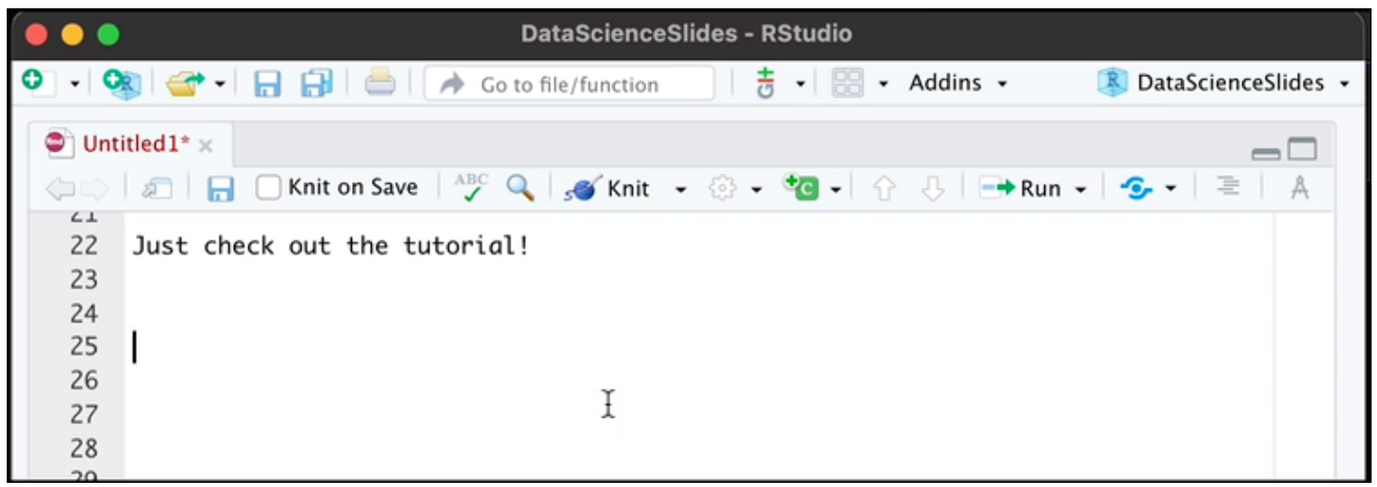


R Markdown step-by-step



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 not → would cause problems when rendering the file
  - To execute the chunk or all previous chunks you might use the buttons:

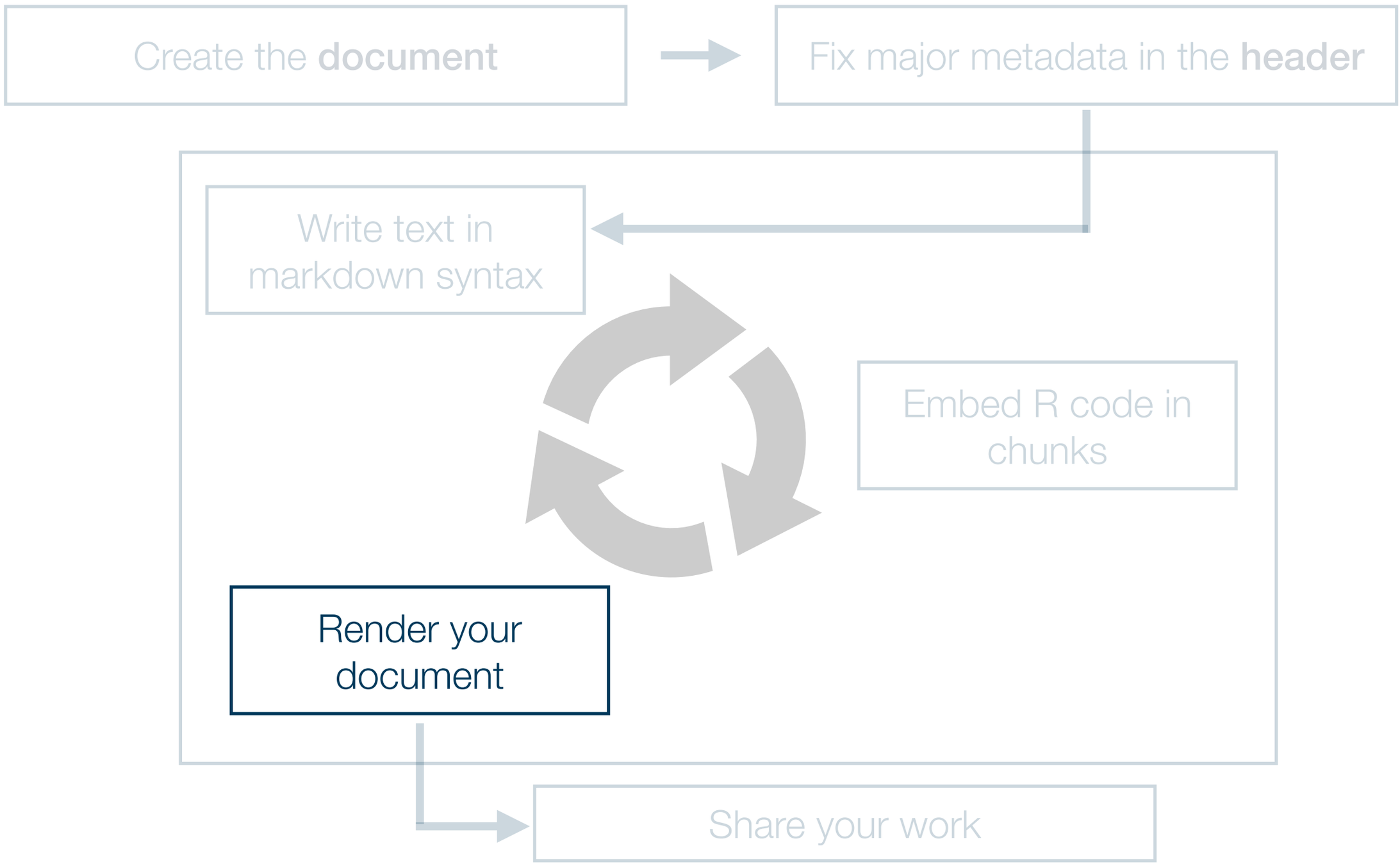
R Markdown step-by-step
4. Embed R code into your document

- 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
  )
```
```

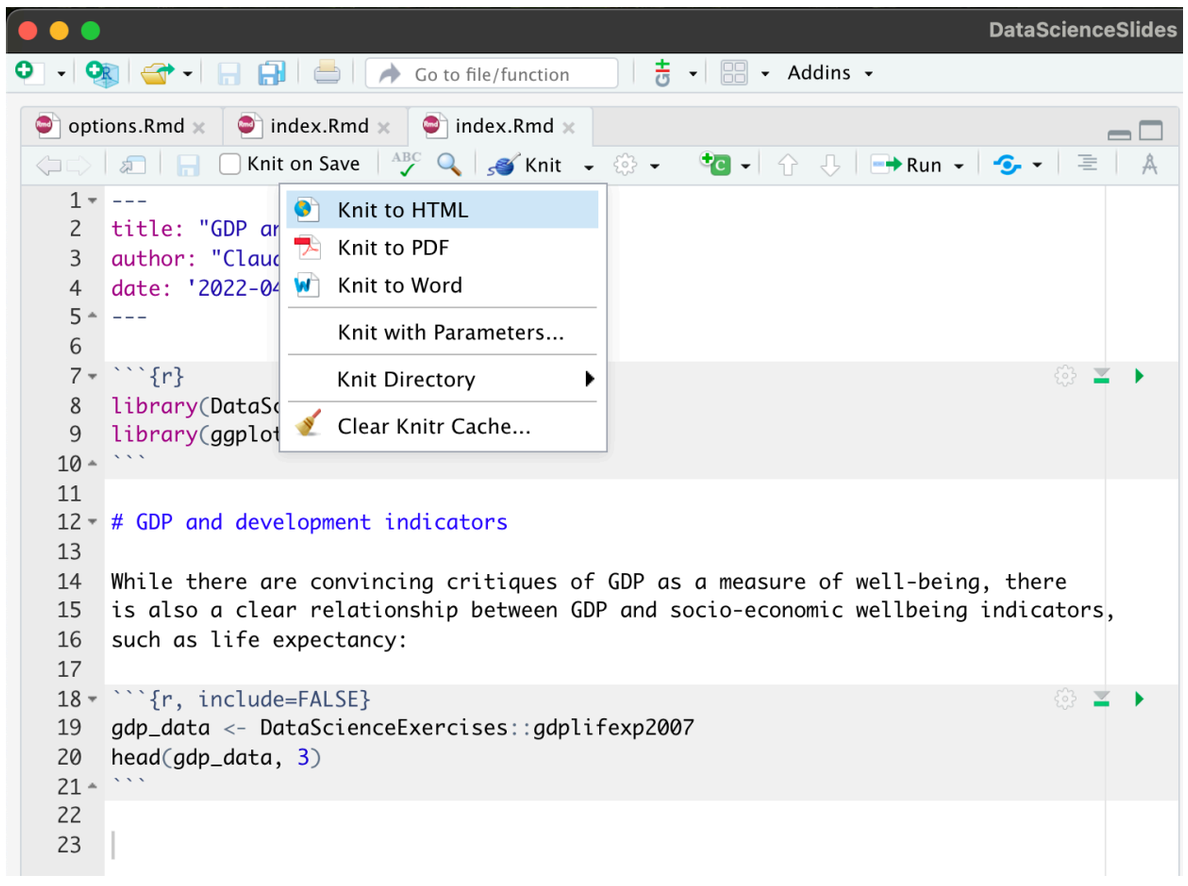
- A full list of all chunk options can be found here: https://yihui.org/knitr/options/

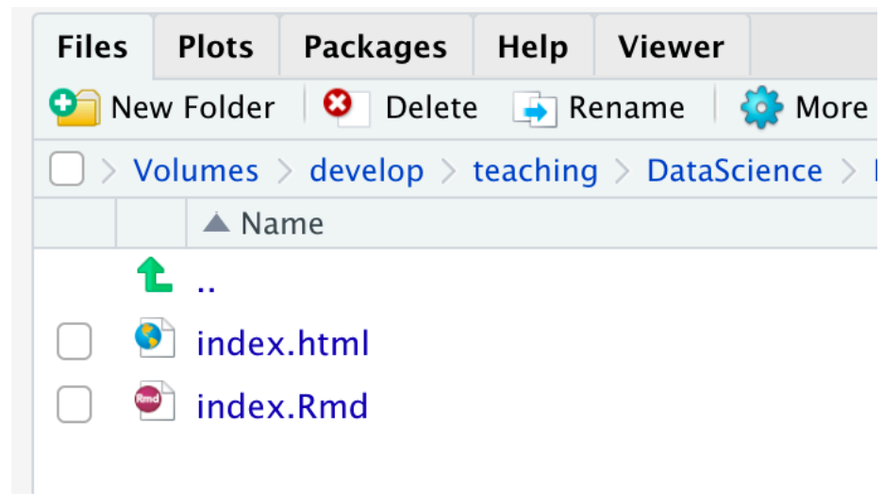
R Markdown step-by-step



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

```yaml
---
title: 'GDP and development'
author: Claudius
date: '2022-04-06'
---
```

GDP and development

Claudius

2022-04-06

Packages used

```
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GDP and development indicators

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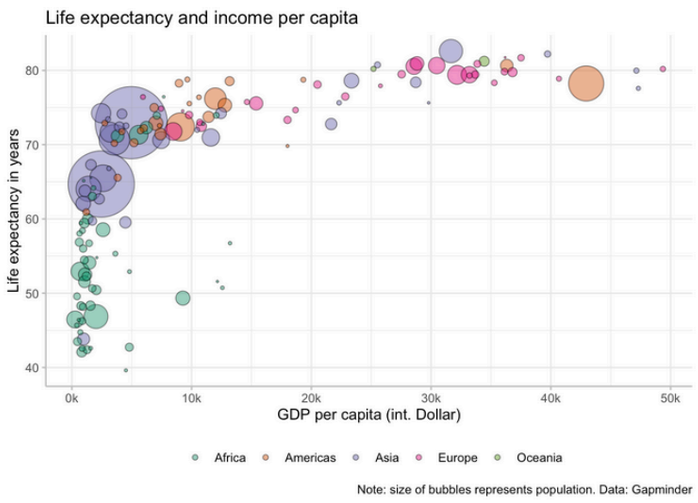

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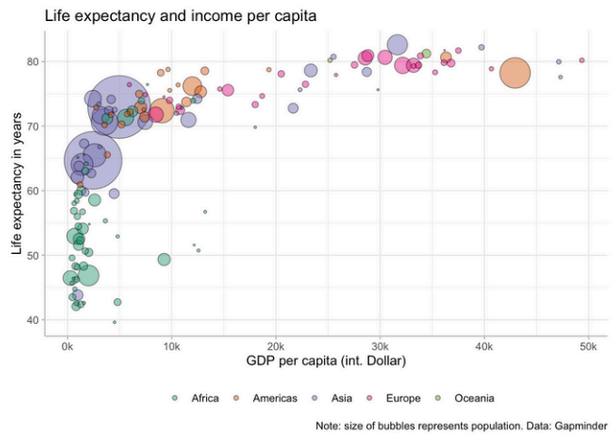

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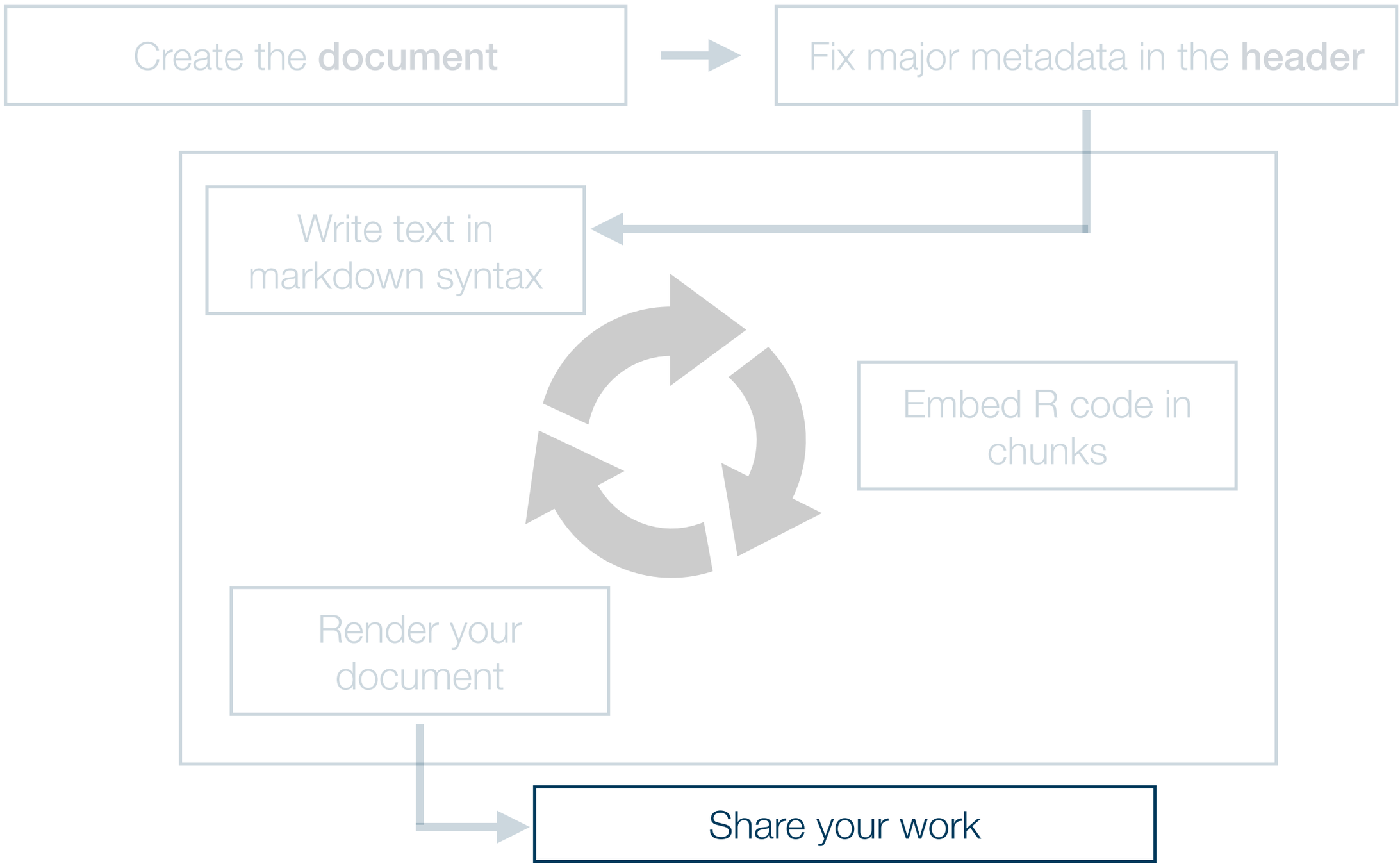
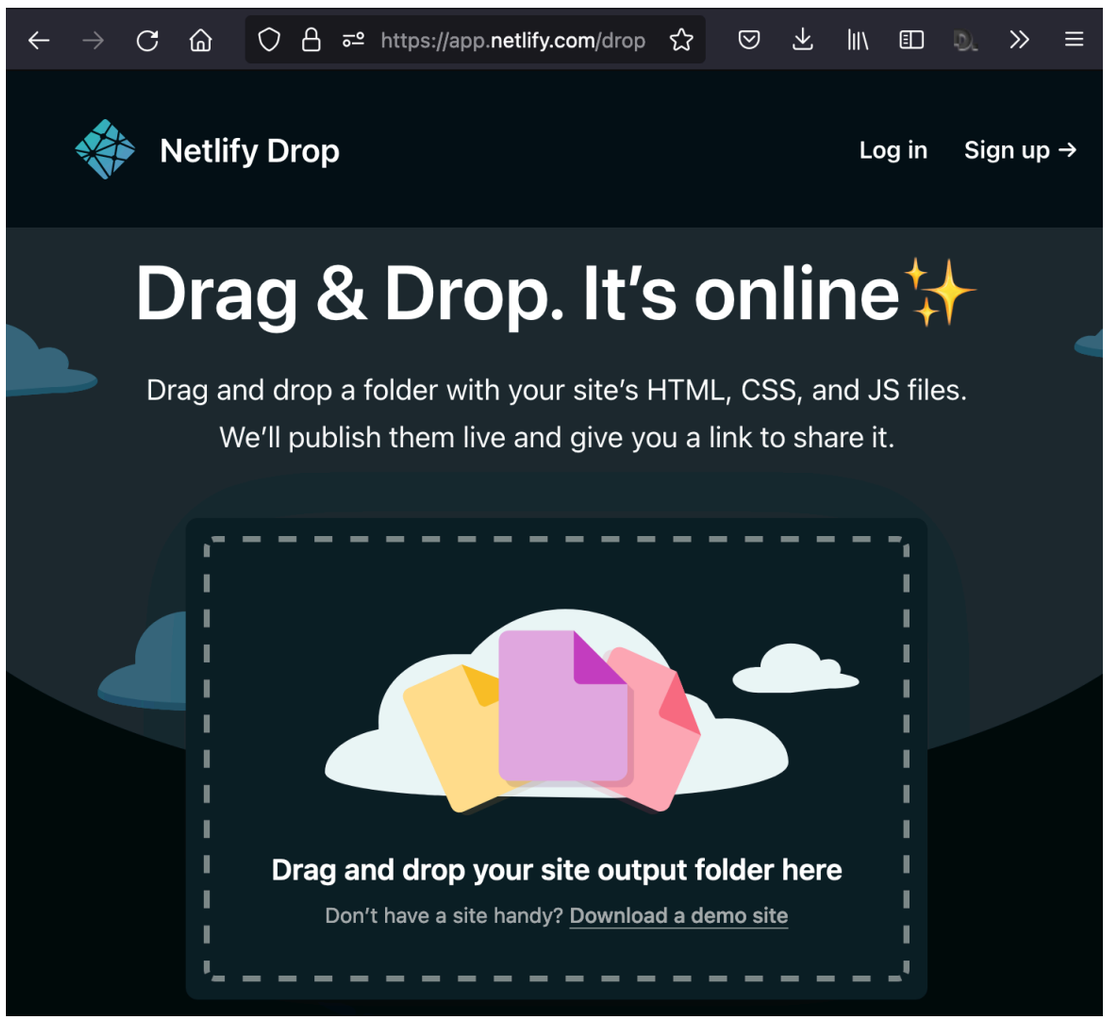
R Markdown step-by-step



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



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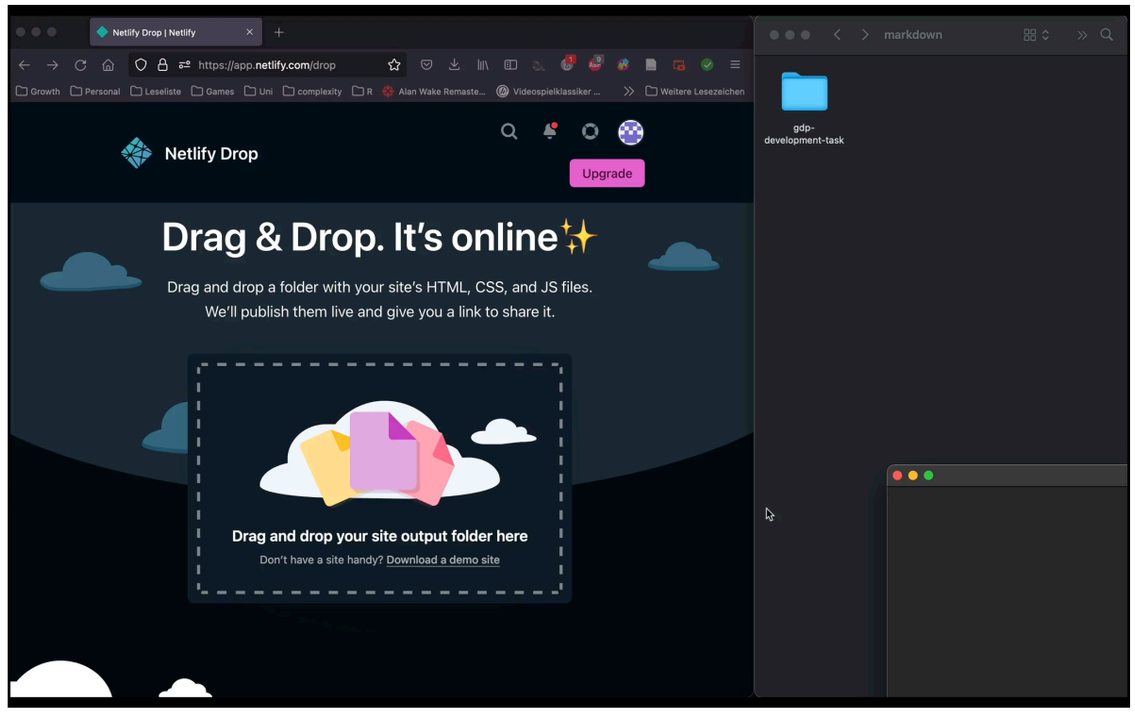
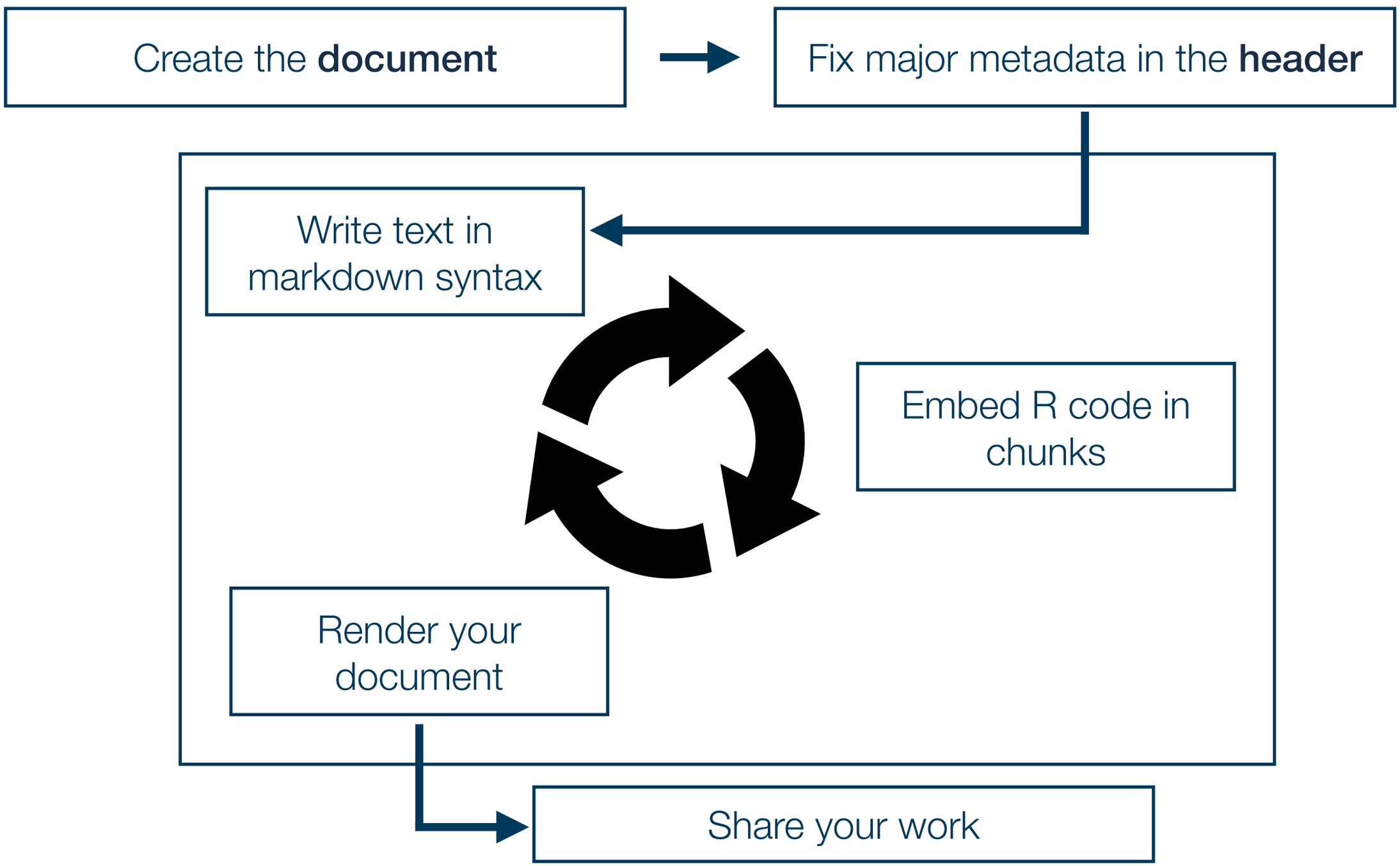
  - If you are registered you can also choose a custom URL and much more



R Markdown step-by-step



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

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

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

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