



# Reproducible Workflow

R Markdown

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# General Remarks About Working with R

(or, really, just doing data analysis)

- Standardization: Think about your folder structure.
- Clean coding: Develop your own style guide, ideally consistent within the lab.
- Use comments throughout the analysis (R Markdown can help).
- Use relative paths (“../material/example-paper.pdf” instead of “/home/julia/Documents/Git/ReproducibleWorkflowWorkshop/material/example-paper.pdf”)!

### **3. What is R Markdown and how can I use it?**

## What is R Markdown?

- Document format embedding code chunks into Markdown documents.
- What's Markdown? "A lightweight markup language."
- Easy-to-read and easy-to-write plain text format. Easier than latex (but supports latex).
- Supports many output formats (html, pdf, ms word, ...)

# Basic Rules of Markdown

## Line Break

This is an example sentence.

This is another example sentence.

This is an example sentence.

This is another example sentence.

This is an example sentence. This is another example sentence.

This is an example sentence.

This is another example sentence.

# Basic Rules of Markdown

Header

*# Level 1 Header*

*## Level 2 Header*

*### Level 3 Header*

## Level 1 Header

Level 2 Header

Level 3 Header

# Basic Rules of Markdown

## Bold and Italic

To write text in bold or in italic, just add \*'s around the word(s)

You can print one word **bold** and another *italic*.

Or *multiple words* can **be altered**.

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Or *multiple words* can **be altered**.

# Basic Rules of Markdown

## Lists

- This
- Is
- A
- List

- This
- Is
- A
- List



# Basic Rules of Markdown

## Lists

1. This
2. Is
4. Another
5. List

1. This
2. Is
3. Another
4. List

# Basic Rules of Markdown

## Overview

Check out the cheat sheets in the folder [material](#).

## Task I

Go to [hackmd.io](https://hackmd.io) ► Click on 'Use for free' ► Write Markdown!

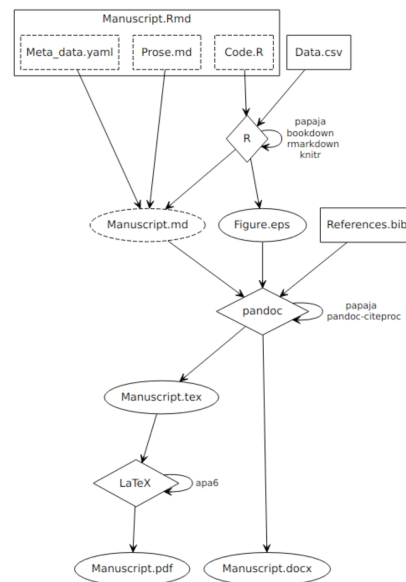


# R Markdown

What is Possible?

- Scientific papers (which we will do later)
- Slides
- HTML sites
- CVs
- ...

## From Rmd to PDF



## Task II

- Open RStudio.
- Go to 'File' ► 'New File' ► 'R Markdown'
- Add title and author, choose PDF, and click 'ok'.
- Save the file.
- Click the 'knit' button.



## YAML header

YAML = “Yet Another Markup Language”

```
---  
title: "My first Markdown"  
author: "My name"  
output: pdf_document  
---
```

## YAML header

YAML = “YAML Ain’t Markup Language”

```
---
title: "Does Every Study? Implementing Ordinal Constraint in Meta-Analysis"
author:
  - name: "Julia Haaf"
    affiliation: "1"
affiliation:
  - id: "1"
    institution: "University of Amsterdam"
abstract: "here."
bibliography: ["lab.bib", "r-references.bib"]
figsintext: yes
header-includes:
  - \usepackage{pcl}
class: "man"
output: papaja::apa6_pdf
---
```



## R code chunks

```
```${r name, options = ...}  
1 + 1  
```
```

```
## [1] 2
```

- Code chunks include code (mostly R but python is possible).
- Code is executed when knitting a R Markdown file.
- In R Studio you can use the shortcut `Ctrl + alt + i` to insert a code block.
- No underscore in chunk name, no name twice.

## Chunk options

- `eval = FALSE`
- `echo = FALSE`
- `warnings = FALSE`
- `cache = TRUE`
- `child = "rmdfilename.Rmd"`
- See [rmarkdown-cheatsheet2](#) for most important options.

## Global chunk options

Adjust all chunk options in a Rmd file with the following command:

```
knitr::opts_chunk$set(echo = TRUE)
```

## Task III

- Go back to your Rmd file.
- Add a chunk calculating the standard deviation (`sd ( )`) of the speed of cars.
- Print the results in a sentence below the chunk.
- Knit the PDF.
- Not happy with result? Round it!



## Inline R-Code

This is an inline expression ``r sd(cars$speed)`` in the output.

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```
sdcars <- sd(cars$speed)
```

The standard deviation of the speed of cars is ``r round(sdcars, 2)``.

The standard deviation of the speed of cars is 5.29.

# L<sup>A</sup>T<sub>E</sub>X

- You can add **L<sup>A</sup>T<sub>E</sub>X** code to your text.
- Math mode for formulas.

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- Math mode for formulas.

You can simply add a formular:  $\frac{SD}{\sqrt{N}}$ .

**Result:**

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## Math mode and R code

You can use R within math mode.

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```
sd1 <- 15  
n1 <- 17
```

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```
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n1 <- 17
```

```
$se = \frac{\texttt{`r sd1`}}{\sqrt{\texttt{`r n1`}}} \approx \texttt{`r round(sd1/(sqrt(n1)), 2)`}
```

$$se = \frac{15}{\sqrt{17}} \approx 3.64$$

## **4. Writing an APA-style paper that is fully reproducible.**

## papaja

- Template + filters + functions.
- Helps writing APA6 articles.
- Still in developement.
- More information: <https://github.com/crsh/papaja>.
- Example: [material/example-paper.Rmd](#)

File ► New File ► R Markdown ► From Template ► APA article

# papaja

## apa\_print

Print statistical results.

```
great_t_test <- t.test(1:10, y = c(7:20))
```

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Print statistical results.

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```

The results were great, ``r apa_print(great_t_test)$full_result``.

The results were great,  $\Delta M = -8.00$ , 95% CI  $[-11.05, -4.95]$ ,  $t(21.98) = -5.43$ ,  $p < .001$ .

# papaja

## Figures

For factorial design: Try apa\_barplot & apa\_beeplot.

```
apa_beeplot(  
  mixed_data  
  , id = "Subject"  
  , dv = "Recall"  
  , factors = c("Task", "Valence", "Dosage")  
  , dispersion = conf_int  
  , ylim = c(0, 30)  
  , las = 1  
  , args_points = list(cex = 1.5)  
  , args_arrows = list(length = 0.025)  
)
```



papaja

Figures

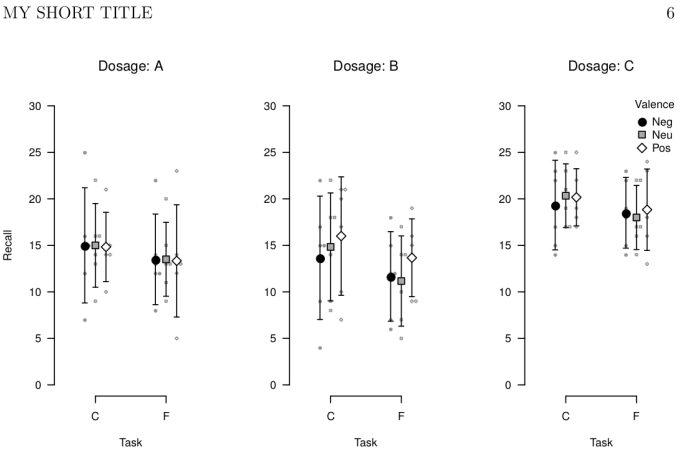


Figure 1. Bee plot of the example data set. Small points represent individual observations, large points represent means, and error bars represent 95% confidence intervals.

# papaja

## Figures

Figure reference and caption.

```
```{r some-fig, fig.cap = "Here is the figure caption."}  
plot(seq(-2, 2, .01)  
      , dnorm(seq(-2, 2, .01))  
      , type = "l")  
```
```

As can be seen in Figure \@ref(fig:some-fig)...

# papa ja

## Tables

- Tables can be produced with R code in R chunks (e.g., with `kable` or `apa_table`).
- Important: add `results='asis'` to chunk options.
- Tables can be written in Markdown directly.

# papaja

## Tables

```
rnames <- LETTERS[1:4]
tvals <- runif(4, 0, 5)
n <- round(runif(4, 15, 100))
pvals <- pt(tvals, df = n - 1, lower.tail = F)
mytab <- data.frame(rnames, tvals, as.integer(n), printp(pvals))

apa_table(mytab
  , caption = "Results from four studies."
  , col.names = c("Study", "$t$-statistic", "Sample Size" , "$p$-value")
  , escape = F)
```

# papaja

## Tables

Table 1

*Results from four studies.*

| Study | <i>t</i> -statistic | Sample Size | <i>p</i> -value |
|-------|---------------------|-------------|-----------------|
| A     | 4.57                | 70          | < .001          |
| B     | 4.69                | 59          | < .001          |
| C     | 1.43                | 78          | .078            |
| D     | 4.15                | 26          | < .001          |

# papaja

## Sources and Citing

You need:

- A biblatex file of your references (e.g., from Zotero).
- Add .bib file name to YAML bibliography: `nameoffile.bib`.
- One way: Look up citation key and insert to text with @ in front.
- `@citationkey` for in-text and `[@citationkey]` for in-parentheses citation.
- Creates proper citation and reference list.

# Citr

- Save bib file and add to YAML.
- Install `citr` (RStudio plug-in).
- Set `citr` shortcut.
- More information: [github.com/crsh/citr](https://github.com/crsh/citr).

## Summary



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- You can do your analysis using R Markdown.
- It is convenient to integrate text and code.
- Upload Rmd, bib, data, and additional analysis files, and anyone can reproduce your analysis.
- Example paper: <https://github.com/PerceptionAndCognitionLab/rm-gardiner-java>.

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**Pro-tip:** If the R chunks are too long use `source( )` to load R-files, and the chunk option `child = myanalysis.Rmd` to include other R Markdown files.