A brief introduction to literate programming using Quarto

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Credit is due

Many thanks to

- Devin Pastoor, PhD (A2-AI)

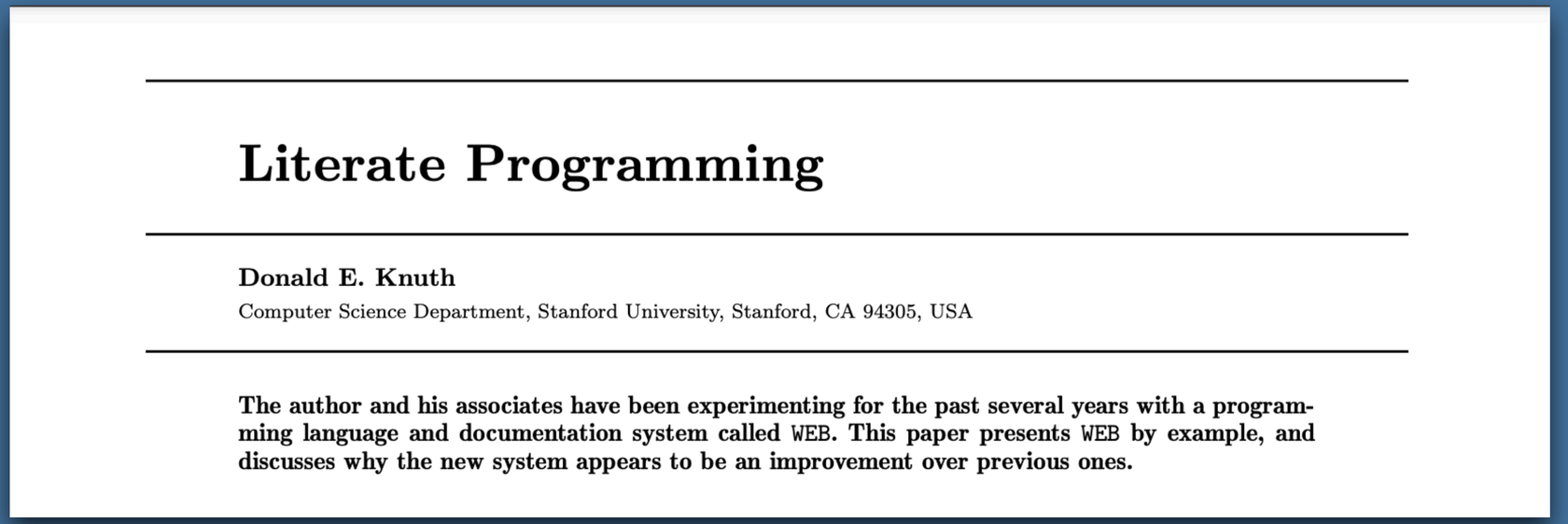
- Ana Ruiz, PharmD, PhD (Gilead Sciences, Inc)

- Nieves Velez de Mendizabal, PhD (Gilead Sciences, Inc)

- CTSI Staff and members

Disclosure

We are not affiliated with Posit Co or the development of Quarto software. Our purpose is to provide information and instruction to use the software. The views and information presented here are those of the authors and not Gilead Sciences Inc.



Literate Programming

Donald E. Knuth
Computer Science Department, Stanford University, Stanford, CA 94305, USA

The author and his associates have been experimenting for the past several years with a programming language and documentation system called WEB. This paper presents WEB by example, and discusses why the new system appears to be an improvement over previous ones.

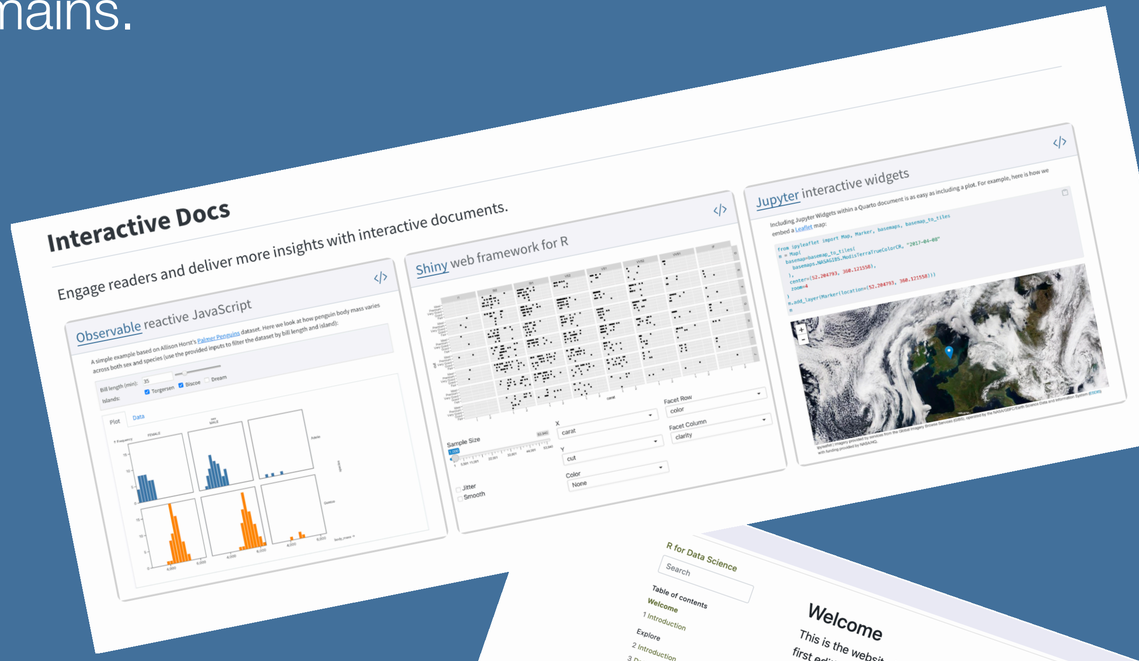
"Literate programming is a methodology that combines a programming language with a documentation language, thereby making programs more robust, more portable, more easily maintained, and arguably more fun to write than programs that are written only in a high-level language."

quarto

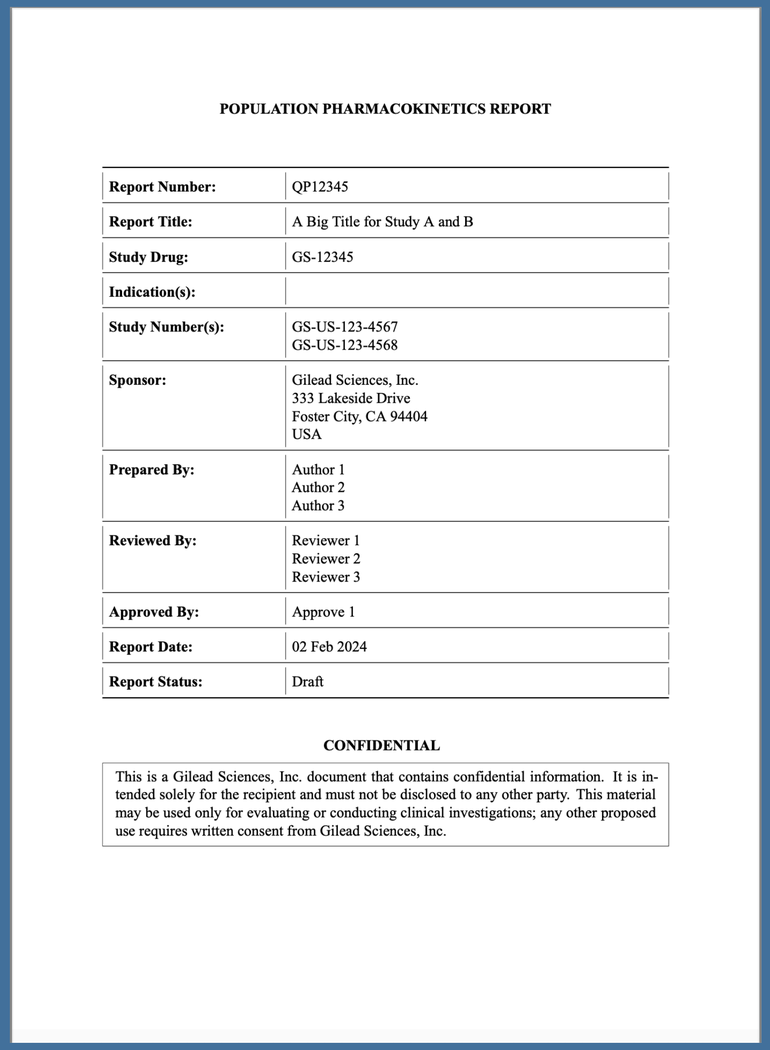
http://www.literateprogramming.com/knuthweb.pdf

Beyond documentation, literate programming offers benefits in education, research, and various technical domains.

- Manuscripts
- Technical Reports
- Academic theses
- Documentation
- Class material
- Many others



We use it in our pharmacometric analysis workflow to create reports and presentations



POPULATION PHARMACOKINETICS REPORT

Report Number:	QP12345
Report Title:	A Big Title for Study A and B
Study Drug:	GS-12345
Indication(s):	
Study Number(s):	GS-US-123-4567 GS-US-123-4568
Sponsor:	Gilead Sciences, Inc. 333 Lakeside Drive Foster City, CA 94404 USA
Prepared By:	Author 1 Author 2 Author 3
Reviewed By:	Reviewer 1 Reviewer 2 Reviewer 3
Approved By:	Approve 1
Report Date:	02 Feb 2024
Report Status:	Draft

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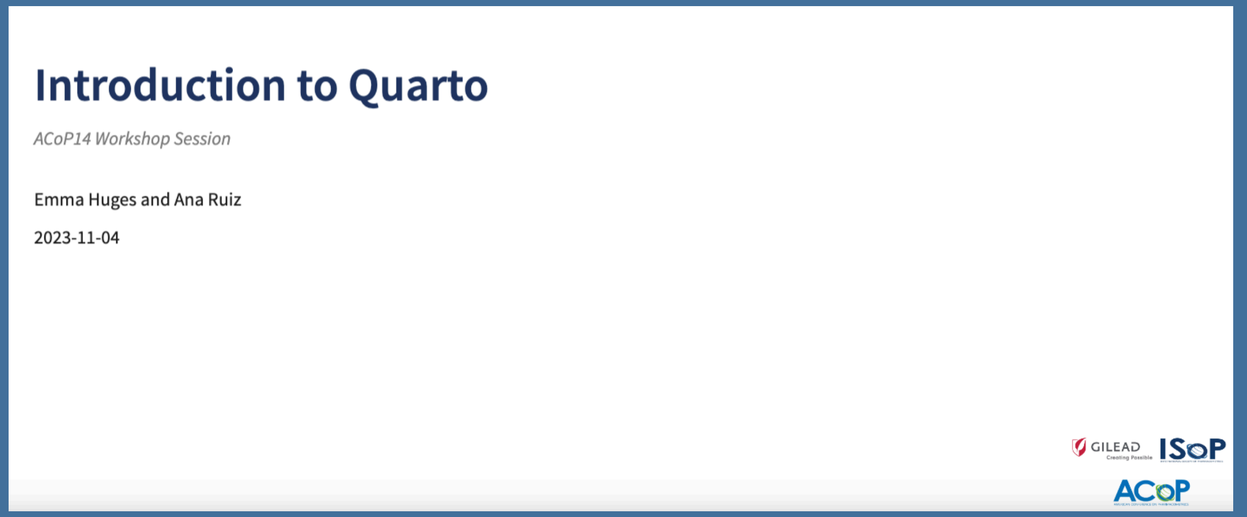
GS-12345 Weekly Meetings

My Awesome Pharmacometrics Project Title

Author Author

June 15, 2023

GILEAD | Clinical Pharmacology Sciences



Introduction to Quarto

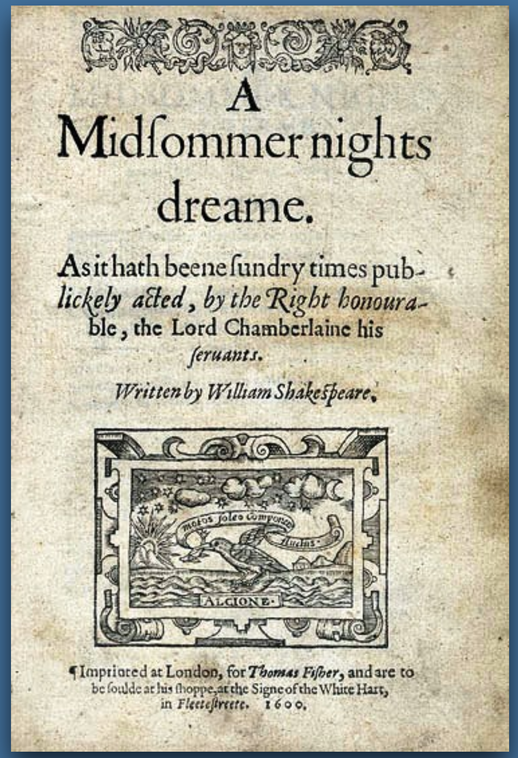
ACoP14 Workshop Session

Emma Huges and Ana Ruiz

2023-11-04

GILEAD ISoP ACoP

Hello, Quarto!



A
Midſommer nights
dreame.

As it hath beene ſundry times pub-
lickely acted, by the Right honoura-
ble, the Lord Chamberlaine his
ſeruants.

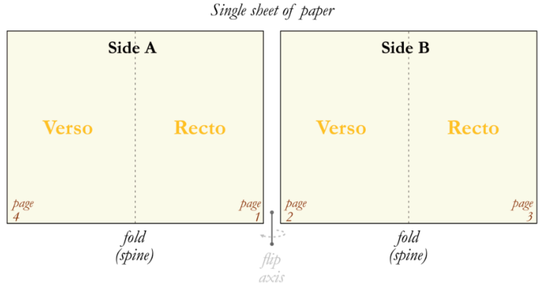
Written by William Shakeſpeare.

¶Imprinted at London, for Thomas Fisher, and are to
be ſoulde at his ſhoppe, at the Signe of the White Hart,
in Fleetſtreete. 1600.

*Wikipedia: Title page of the **first quarto edition** of Shakespeare's Midsummer Night's Dream, 1600, from the Folger Shakespeare Library*

FOLIO

abbreviated
fo 2°

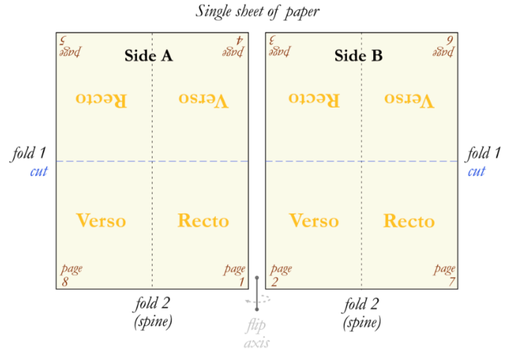


- *4 pages of printed text*
- *2 on each side*
- *1 fold*
- *creates 2 leaves*
- *each leaf is 1/2 size of the original sheet*

https://en.wikipedia.org/wiki/Folio

QUARTO

abbreviated
Qto, 4to or 4°

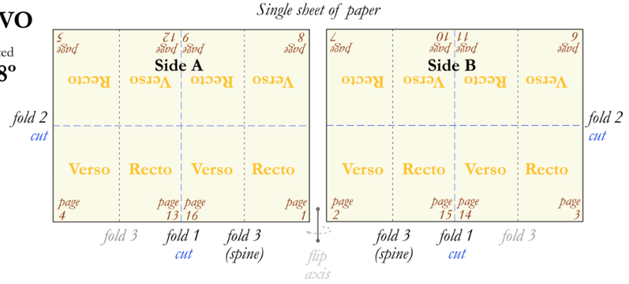


- *8 pages of printed text*
- *4 on each side*
- *2 folds, 1 cut*
- *creates 4 leaves*
- *each leaf is 1/4 size of the original sheet*

https://en.wikipedia.org/wiki/Quarto

OCTAVO

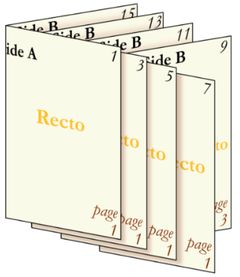
abbreviated
8vo, 8°



- *16 pages of printed text*
- *8 on each side*
- *3 folds, 2 cuts*
- *creates 8 leaves*
- *each leaf is 1/8 size of the original sheet*

https://en.wikipedia.org/wiki/Octavo

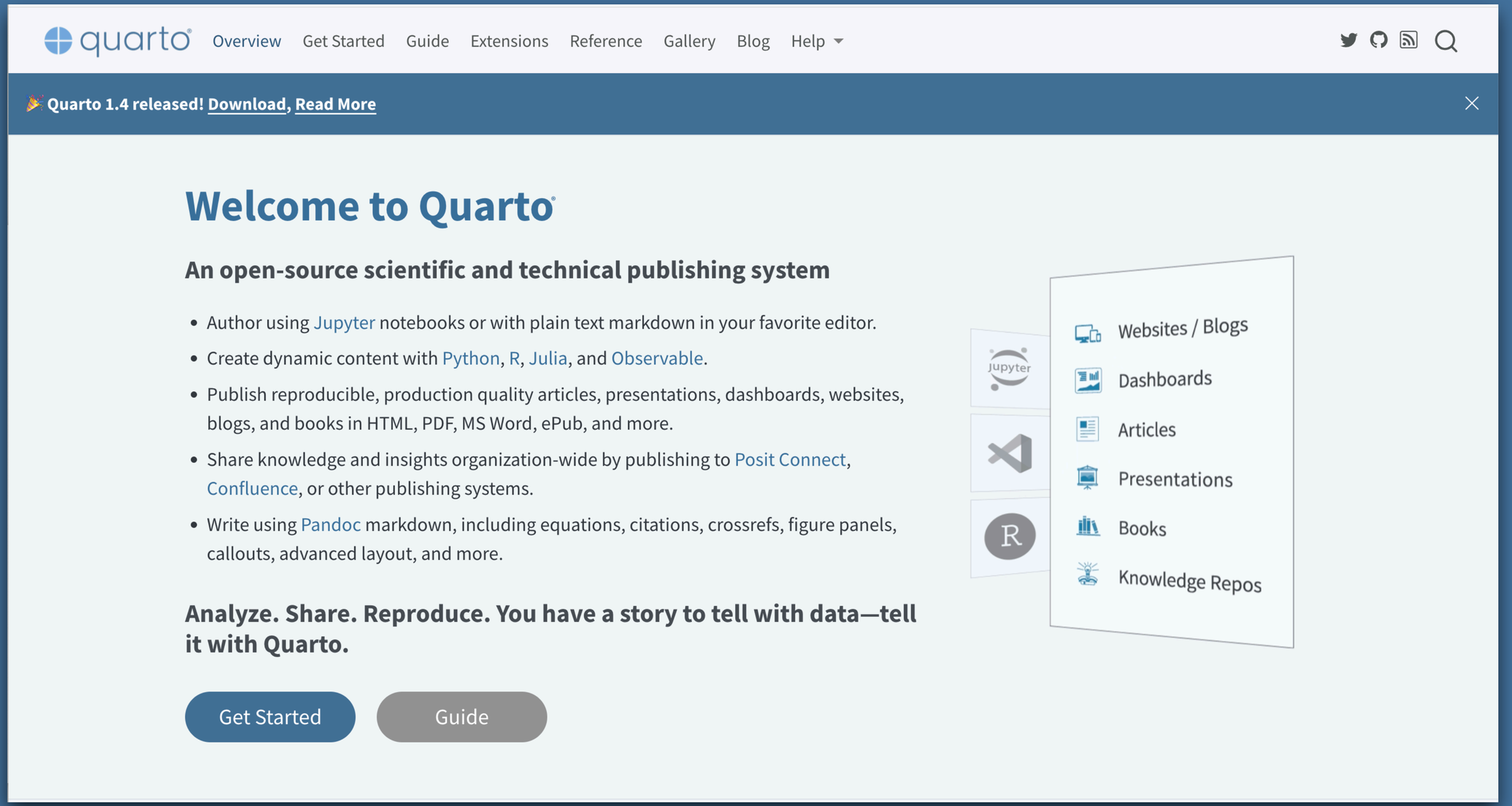
Example of a Folio Gathering



Folios would be inserted within each other to form, for example, gatherings of 8 leaves (above). Gatherings are sewn through the central fold prior to binding the book. Multiple gatherings are stacked and made into a book.

For "left-to-right reading" books.

Hello, Modern Quarto: www.quarto.org/



Quarto workflow

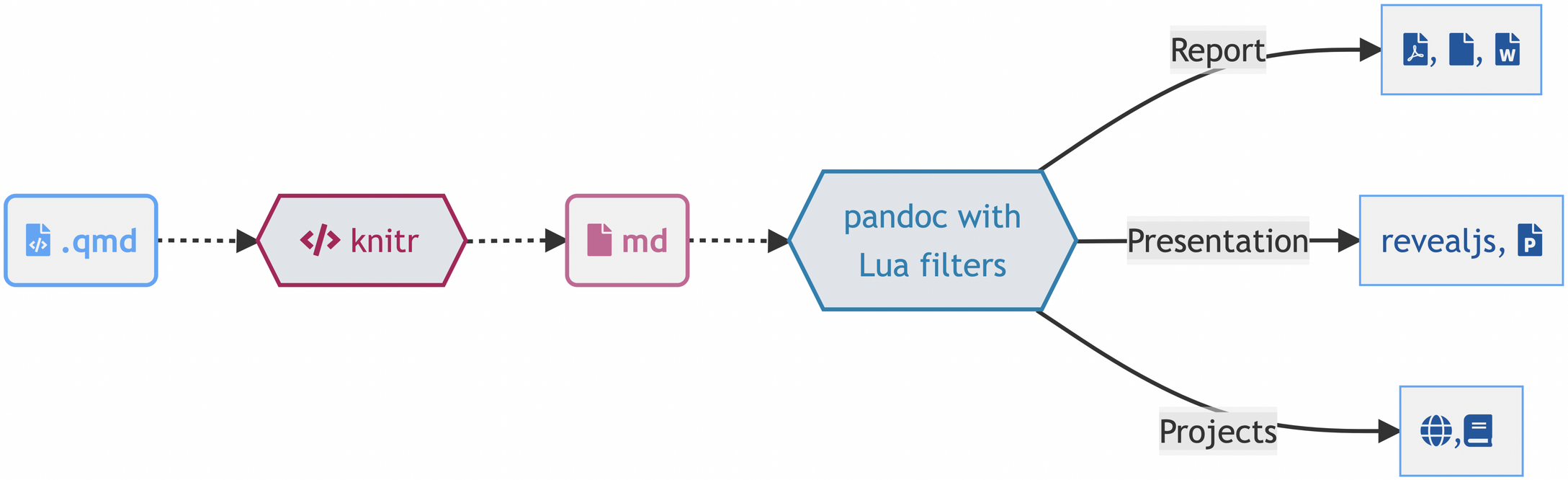


Image was captured from: https://rstudio-conf-2022.github.io/get-started-quarto

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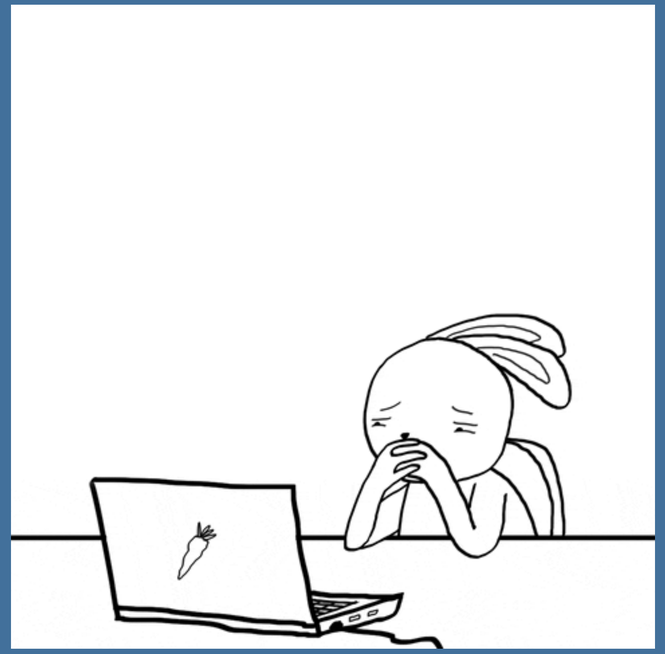
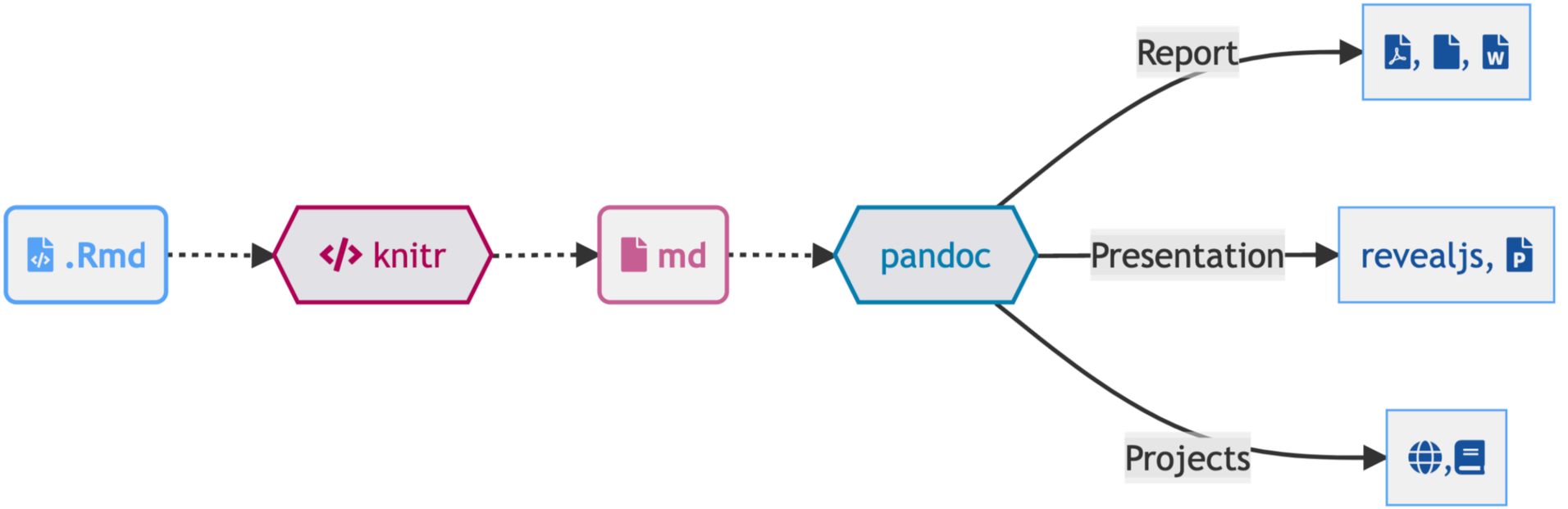
Wait! What about RMarkdown?

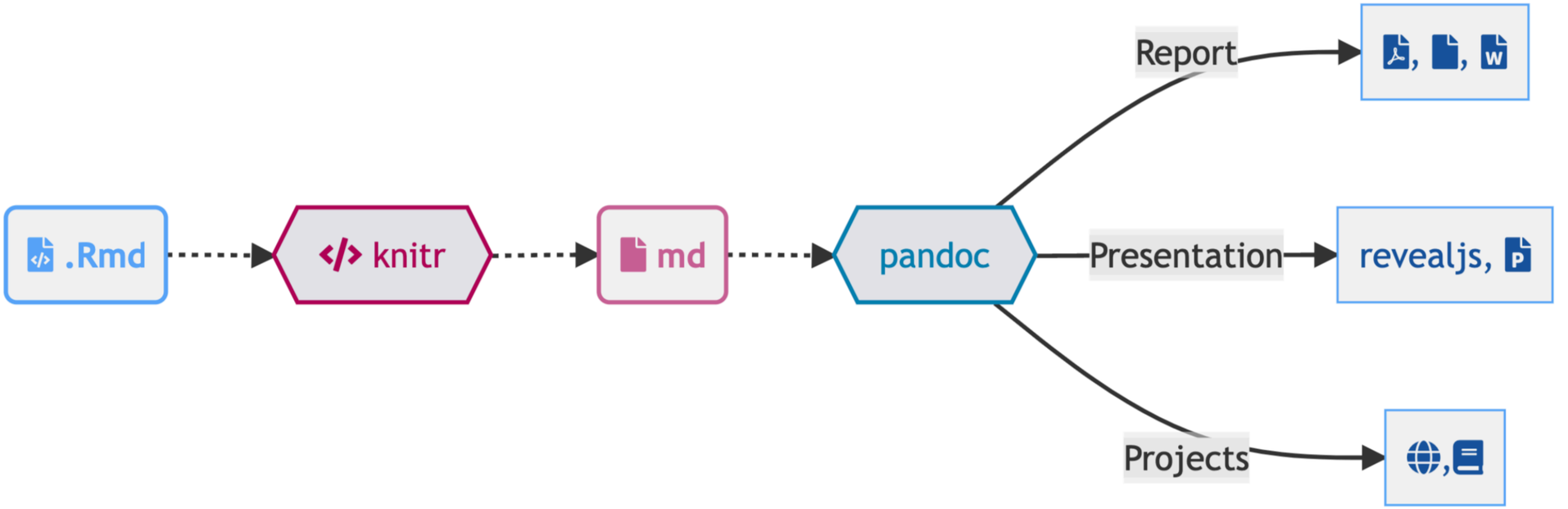


RMarkdown workflow



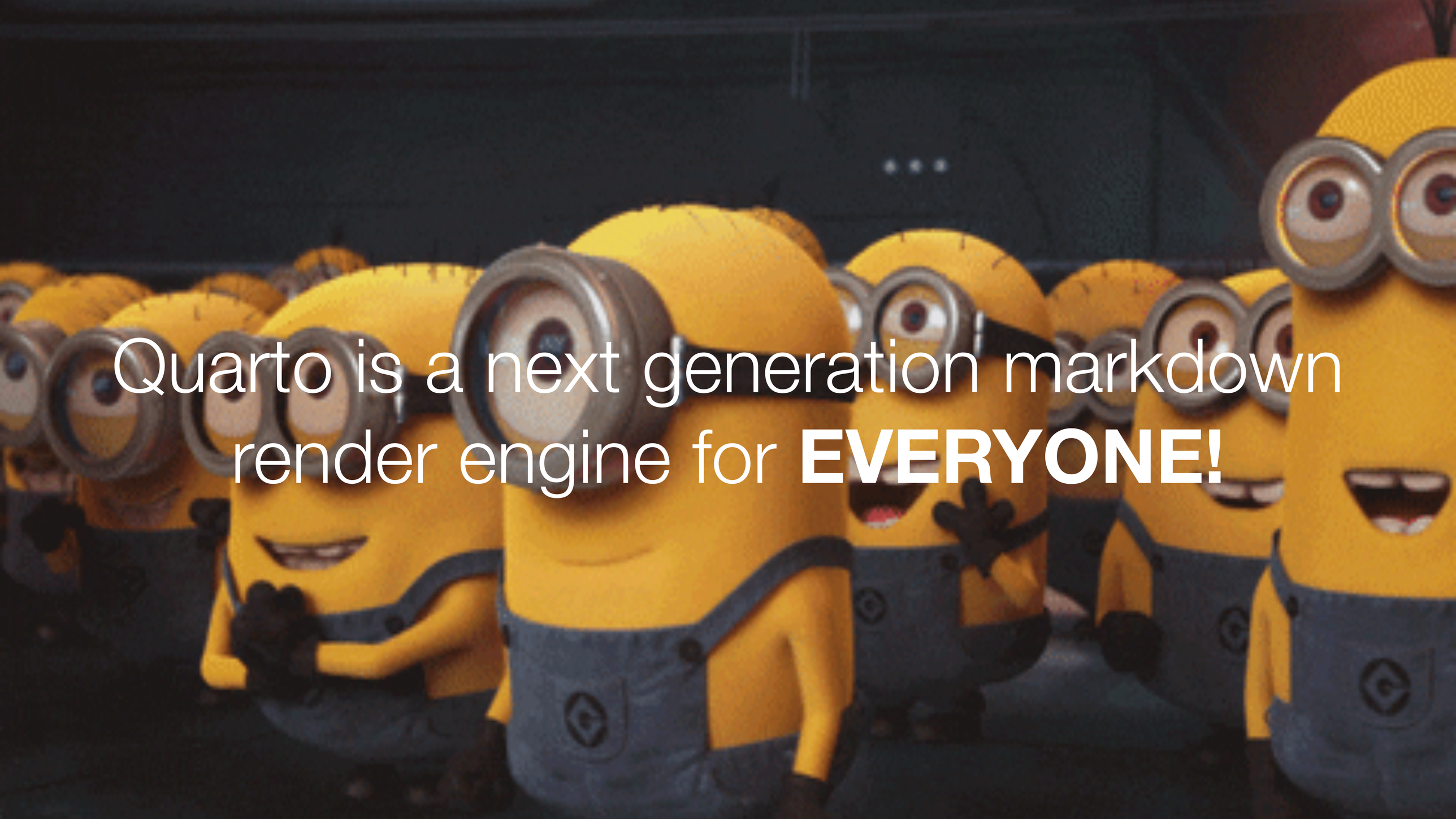
https://rstudio-conf-2022.github.io/get-started-quarto

RMarkdown workflow



The goal of **Quarto** is to make the process of creating and collaborating on scientific and technical documents **dramatically better**. Quarto combines the functionality of R Markdown, bookdown, distill, xaringian, etc into a single consistent system with "batteries included" that reflects everything we've learned from R Markdown over the past 10 years.

https://quarto.org/docs/faq/rmarkdown.html#what-can-i-use-quarto-for


Quarto is a next generation markdown
render engine for **EVERYONE!**

Quarto is a command line (CLI) interface!

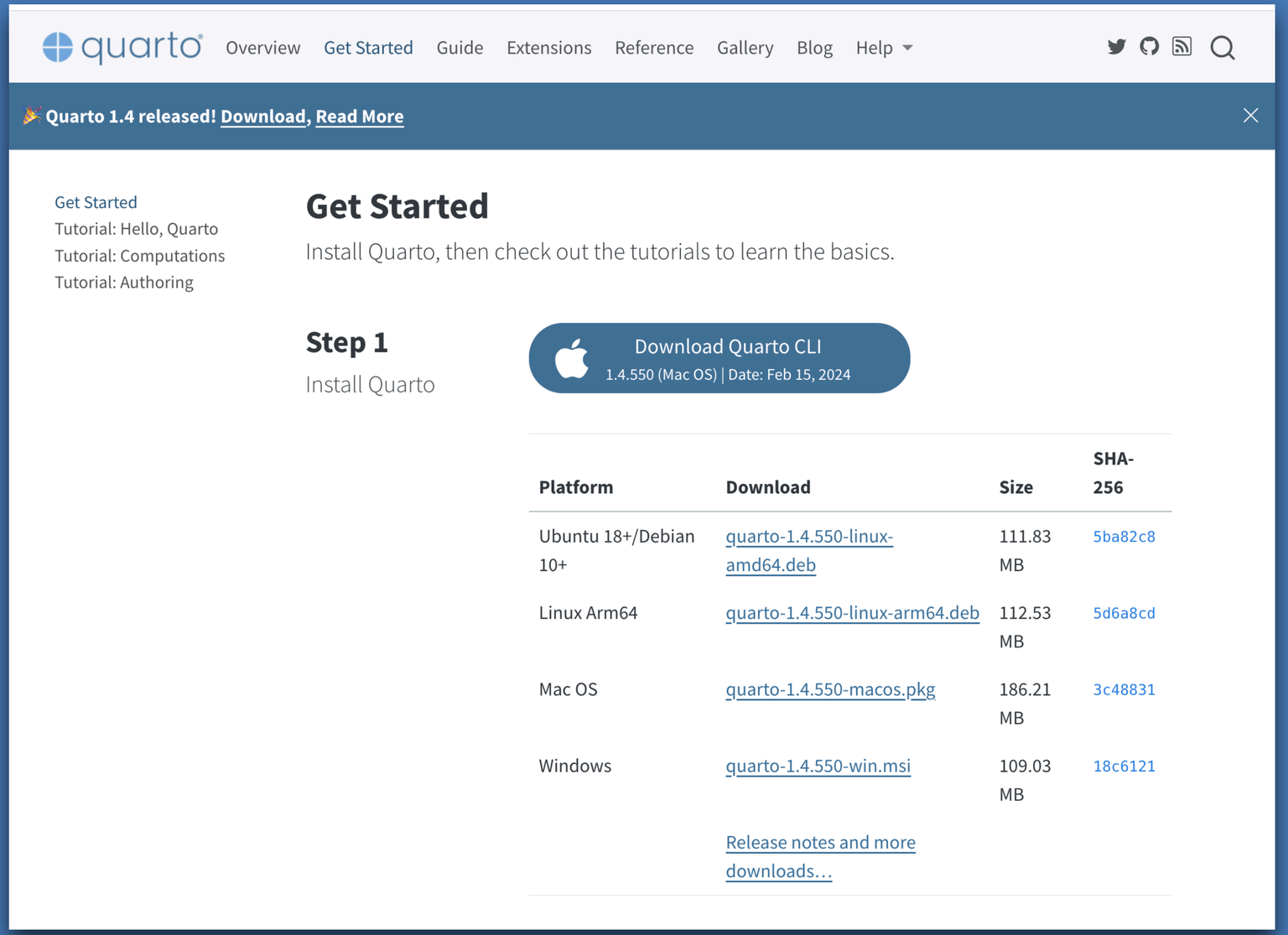
Quarto is a command line interface (CLI) that renders plain text formats (.qmd, .rmd, .md) into human readable formats

```
(base) ➜  ~ quarto --help

  Usage:   quarto
  Version: 1.5.9

  Description:

    Quarto CLI

  Options:

    -h, --help     - Show this help.
    -V, --version  - Show the version number for this program.

  Commands:

    render     [input] [args...]     - Render files or projects to various document types.
    preview    [file] [args...]      - Render and preview a document or website project.
    serve      [input]               - Serve a Shiny interactive document.
    create     [type] [commands...]  - Create a Quarto project or extension
    use        <type> [target]       - Automate document or project setup tasks.
    add        <extension>           - Add an extension to this folder or project
    update     [target...]           - Updates an extension or global dependency.
    remove     [target...]           - Removes an extension.
    convert    <input>               - Convert documents to alternate representations.
    pandoc     [args...]             - Run the version of Pandoc embedded within Quarto.
    typst      [args...]             - Run the version of Typst embedded within Quarto.
    run        [script] [args...]    - Run a TypeScript, R, Python, or Lua script.
    install    [target...]           - Installs a global dependency (TinyTex or Chromium).
    uninstall  [tool]                - Removes an extension.
    tools                            - Display the status of Quarto installed dependencies
    publish    [provider] [path]     - Publish a document or project to a provider.
    check      [target]              - Verify correct functioning of Quarto installation.
    help       [command]             - Show this help or the help of a sub-command.
```

quarto®

Installing Quarto

https://quarto.org/docs/get-started/



Basic Usage: document anatomy

````
---
title: "Diamond sizes"
date: 2022-09-12
format: html
---

```{r}
#| label: setup
#| include: false

library(tidyverse)

smaller <- diamonds |>
  filter(carat <= 2.5)
```

We have data about `r nrow(diamonds)` diamonds.
Only `r nrow(diamonds) - nrow(smaller)` are larger than 2.5 carats.
The distribution of the remainder is shown below:

```{r}
#| label: plot-smaller-diamonds
#| echo: false

smaller |>
  ggplot(aes(x = carat)) +
  geom_freqpoly(binwidth = 0.01)
```
````

Markdown flavored syntax!

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Metadata Anatomy, a.k.a YAML

````
---
title: "Diamond sizes"
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---

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smaller |>
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```
````

Controls document settings

e.g., document info, formatting, and many others

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Code chunk anatomy

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---
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```
````

Contains:

- Chunk label: references
- Chunk options: apparence
- Source code: commands

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Text (communication) anatomy

````
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format: html
---

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#| label: plot-smaller-diamonds
#| echo: false

smaller |>
  ggplot(aes(x = carat)) +
  geom_freqpoly(binwidth = 0.01)
```
````
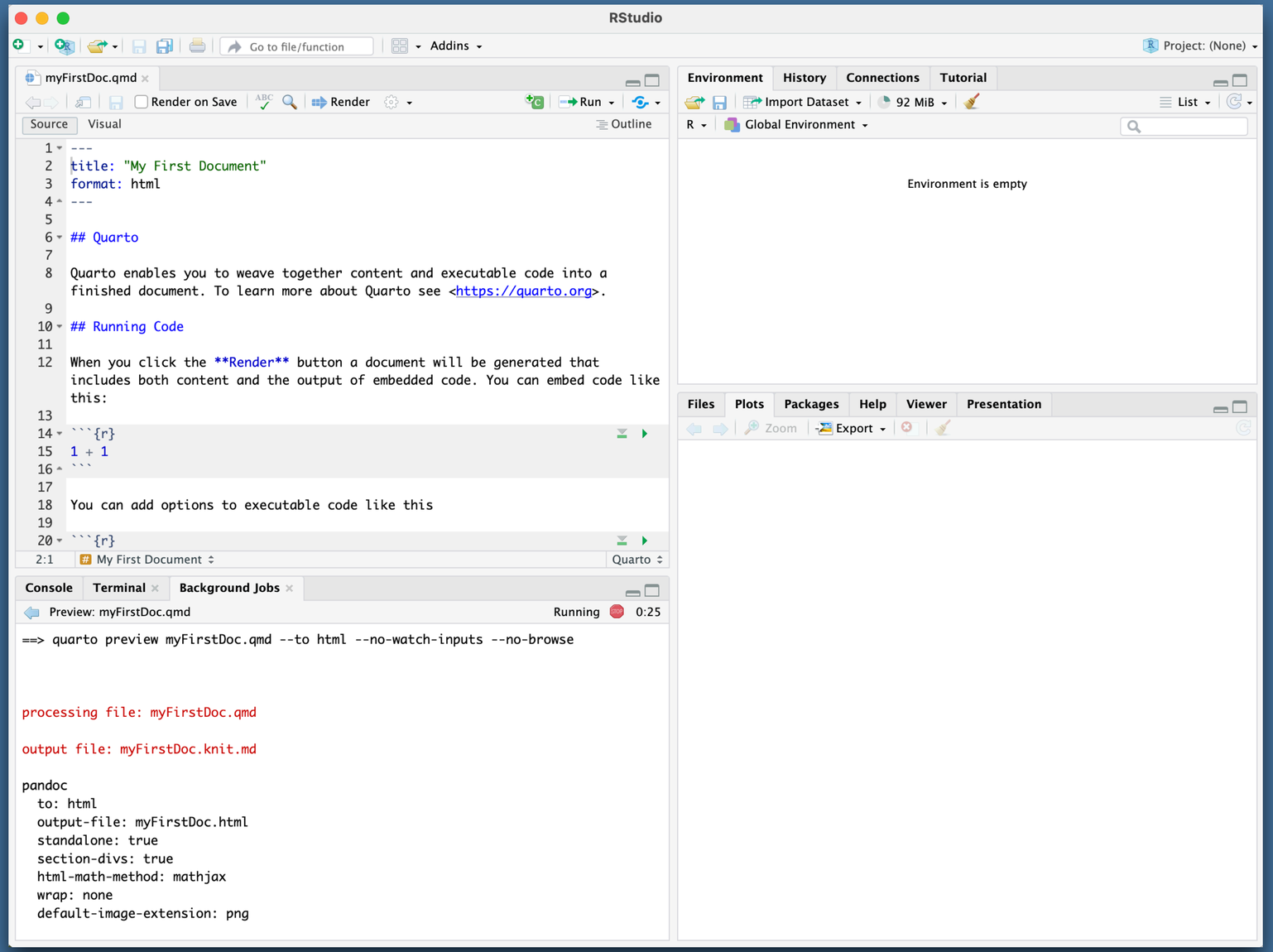
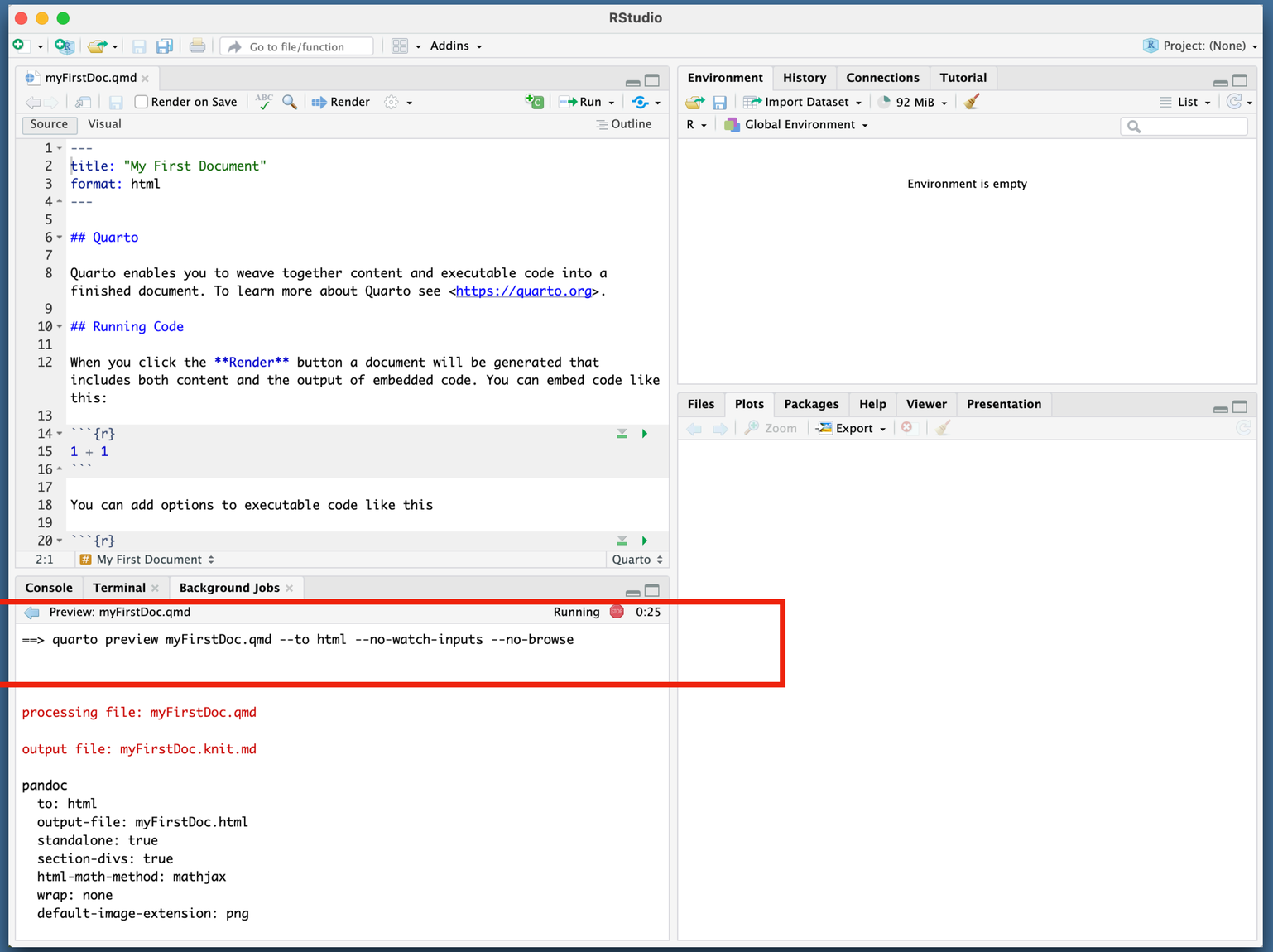

Both; human readable communications and Source code

quarto

Rendering your first document



Rendering your first document

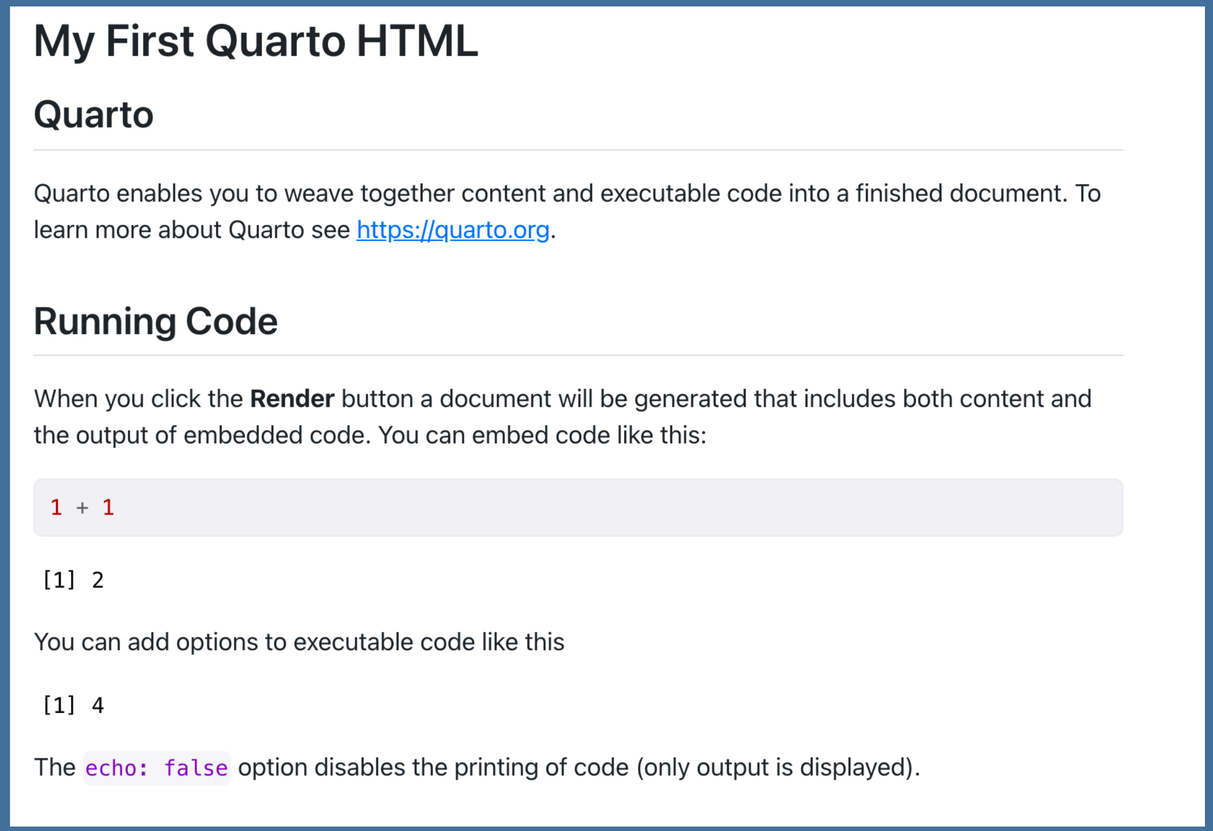


Take A Breath!

Rendering Quarto Docs

We will go over:

1. Rendering a PDF, HTML and Word document.
2. Common YAML options and add some to our document.
3. Different formatting options.
4. Inserting:
    1. Hyperlinks
    2. Figures
    3. Tables
5. R Code Chunks.



My First Quarto HTML

Quarto

Quarto enables you to weave together content and executable code into a finished document. To learn more about Quarto see https://quarto.org.

Running Code

When you click the **Render** button a document will be generated that includes both content and the output of embedded code. You can embed code like this:

```
1 + 1
```

```
[1] 2
```

You can add options to executable code like this

```
[1] 4
```

The `echo: false` option disables the printing of code (only output is displayed).

Customizing your quarto documents

We have options to customize our document

Quarto extensions is a powerful tool:

- Help modify and customize the defaults
- Creating shareable templates
- Adding additional functionalities to Quarto

Also, it is easy to get the extension you like!

```
quarto add extension <repo_name>
quarto use template <repo_name>
```

https://github.com/quarto-ext

Quarto extension

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- Help modify and customize the defaults
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```
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quarto use template <repo_name>
```

README.md

Extensions for Quarto

The `quarto-ext` organization collects extensions maintained by the core Quarto team.

Learn more about creating your extensions here: https://quarto.org/docs/extensions/

Extension name	Description	Install
latex-environment	Quarto extension to output custom LaTeX environments.	`quarto add extension quarto-ext/latex-environment`
lightbox	Create lightbox treatments for images in your HTML documents.	`quarto add extension quarto-ext/lightbox`
fontawesome	Use Font Awesome icons in HTML and PDF documents.	`quarto add extension quarto-ext/fontawesome`
pointer	A very simple RevealJS plugin extension that adds support for switching the cursor to a 'pointer' style element while presenting.	`quarto add extension quarto-ext/pointer`
attribution	Display attribution text sideways along the right edge of Revealjs slides.	`quarto add extension quarto-ext/attribution`
shinylive	Quarto extension to embed Shinylive for Python applications	`quarto add extension quarto-ext/shinylive`
fancy-text	Output nicely formatted versions of fancy strings such as LaTeX and BibTeX in multiple formats.	`quarto add extension quarto-ext/fancy-text`
holder	Quarto extension to create placholder images	`quarto add extension quarto-ext/holder`
include-code-files	Quarto extension to include code from source files.	`quarto add extension quarto-ext/include-code-files`

https://github.com/quarto-ext

Basic extension for IU*

https://github.com/Mutaz94/quarto-CTSI-2024/

*Unofficial/unapproved templates that **might or might not** follow some IU formatting rules

Improve your skills beyond this talk

Helpful References:

General resources:

- https://quarto.org/docs/get-started/hello/rstudio.html
- https://www.youtube.com/watch?v=yvi5uXQMvu4
- https://www.youtube.com/watch?v=EbAAmrB0luA
- https://r4ds.hadley.nz/quarto.html

YAML Header options

- https://quarto.org/docs/reference/formats/opml.html
- For HTML output: https://quarto.org/docs/reference/formats/html.html

Inserting figures

- https://quarto.org/docs/authoring/figures.html

Report and tips

- https://github.com/Mutaz94/report
- https://github.com/Mutaz94/quarto-tips

Take home messages

- Quarto is awesome!
- Reproducibility and maintainability
- Customizability
- Productivity


QUESTIONS?