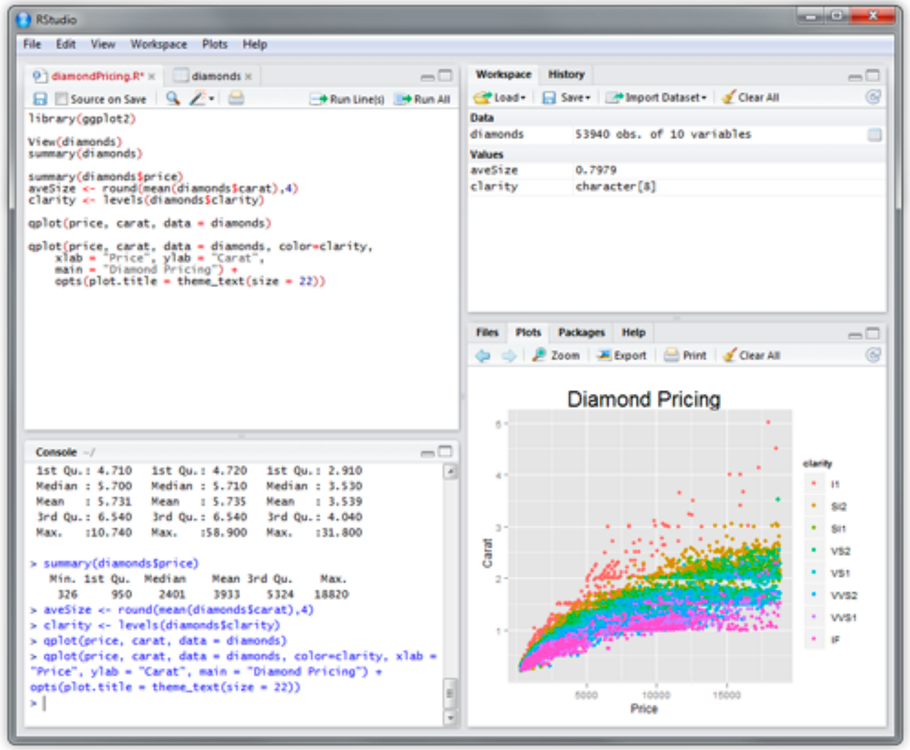
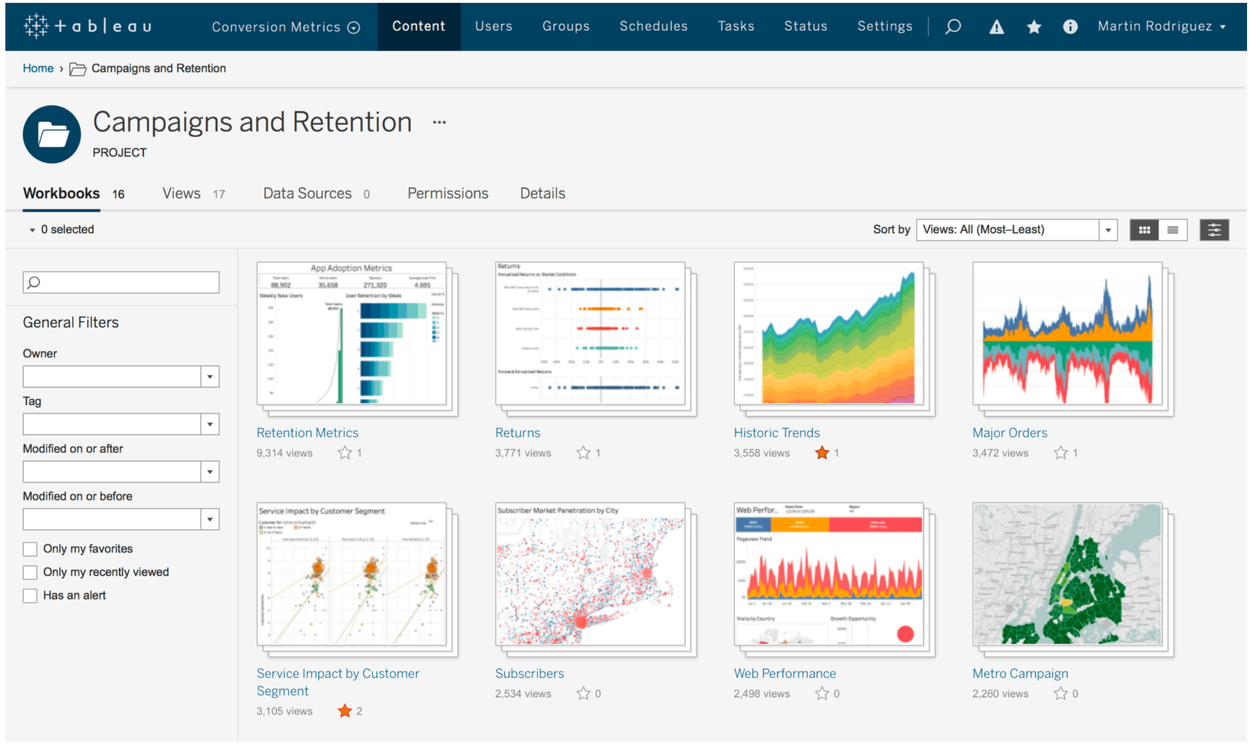
Meet the Toolkit!

STA313 - Data Visualization

RStudio®

ggplot2 Shiny rmarkdown knitr

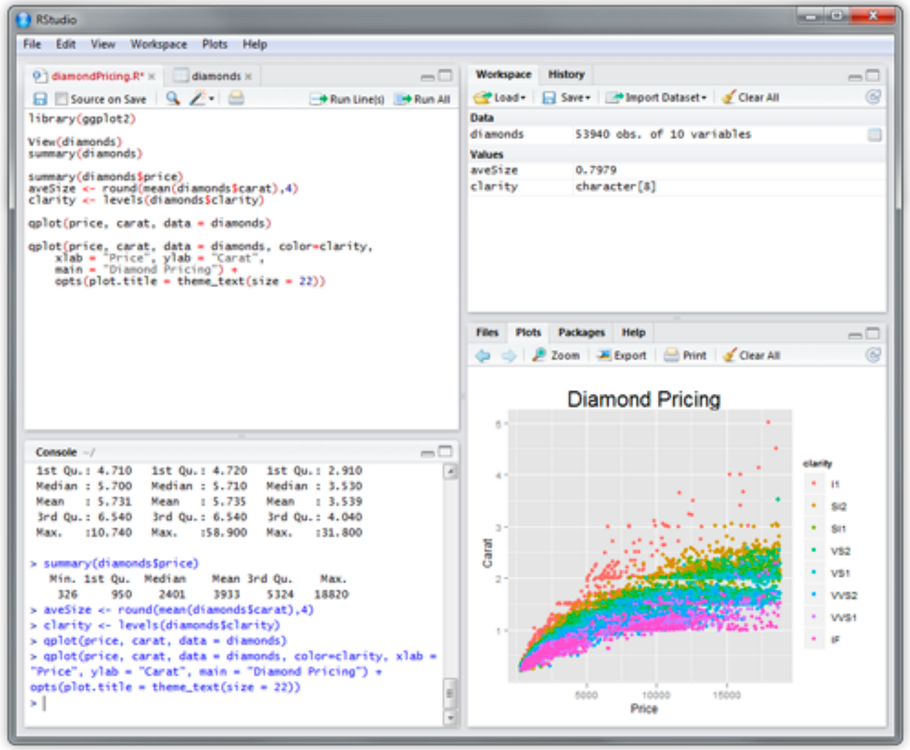




+ableau SOFTWARE

RStudio®

TODAY



Two Options for Using R in this course

LOCALLY

Install and run your own copies of RStudio on your machine.

ONLINE

Run RStudio online via the University of Toronto **JupyterHub for Teaching**

Two Options for Using R in this course

LOCALLY

Install and run your own copies of RStudio on your machine.

Local R installations are fine. We will show you how to set this up, but we will not guarantee support.

ONLINE

Run RStudio online via the University of Toronto **JupyterHub for Teaching**

Two Options for Using R in this course

LOCALLY	ONLINE
Install and run your own copies of RStudio on your machine.	Run RStudio online via the University of Toronto **JupyterHub for Teaching**

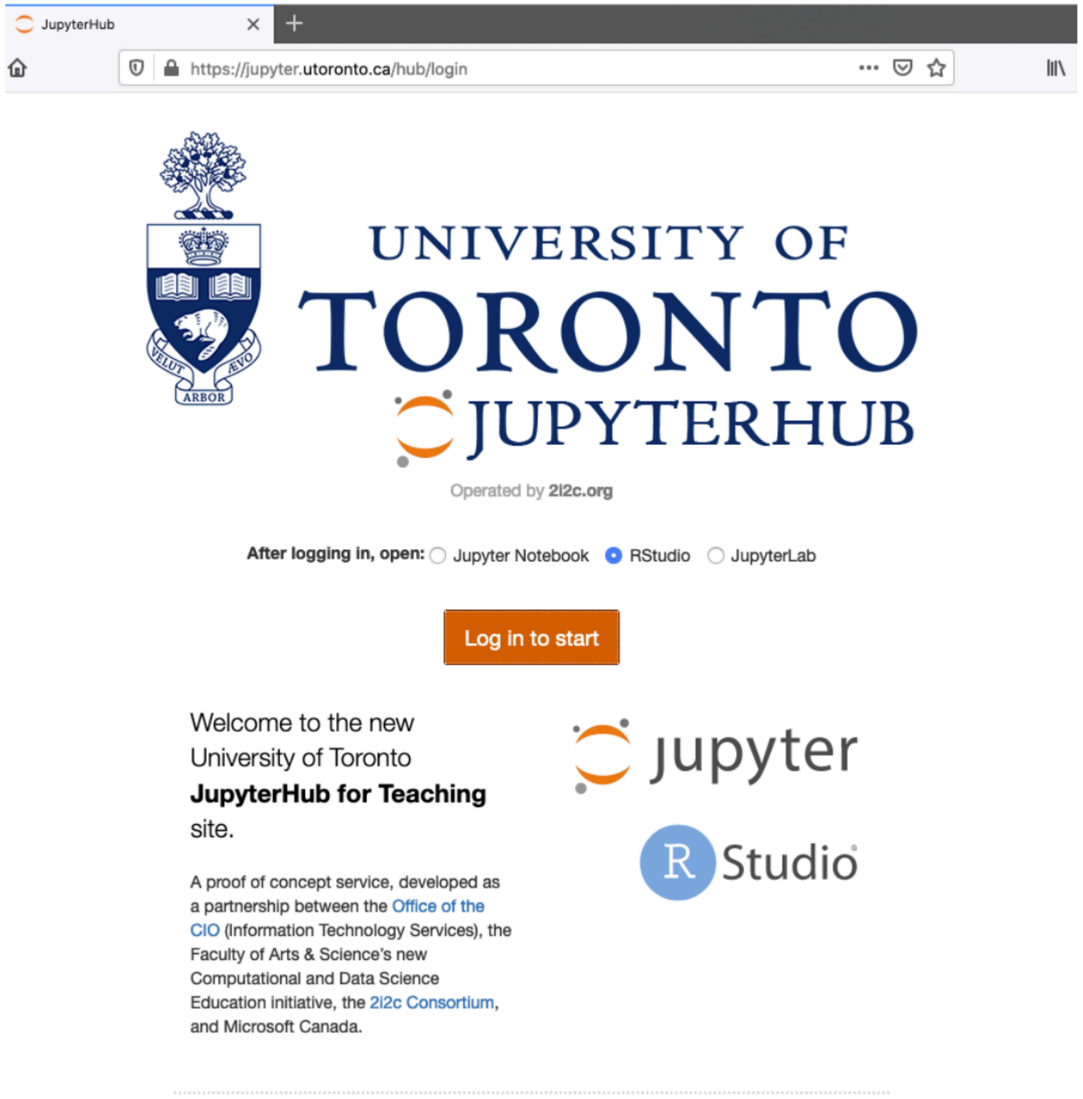
This is the recommended option for this course.

JupyterHub

JupyterHub

Follow the steps to run RStudio online.

1. Go to UofT **JupyterHub** https://jupyter.utoronto.ca/hub/login

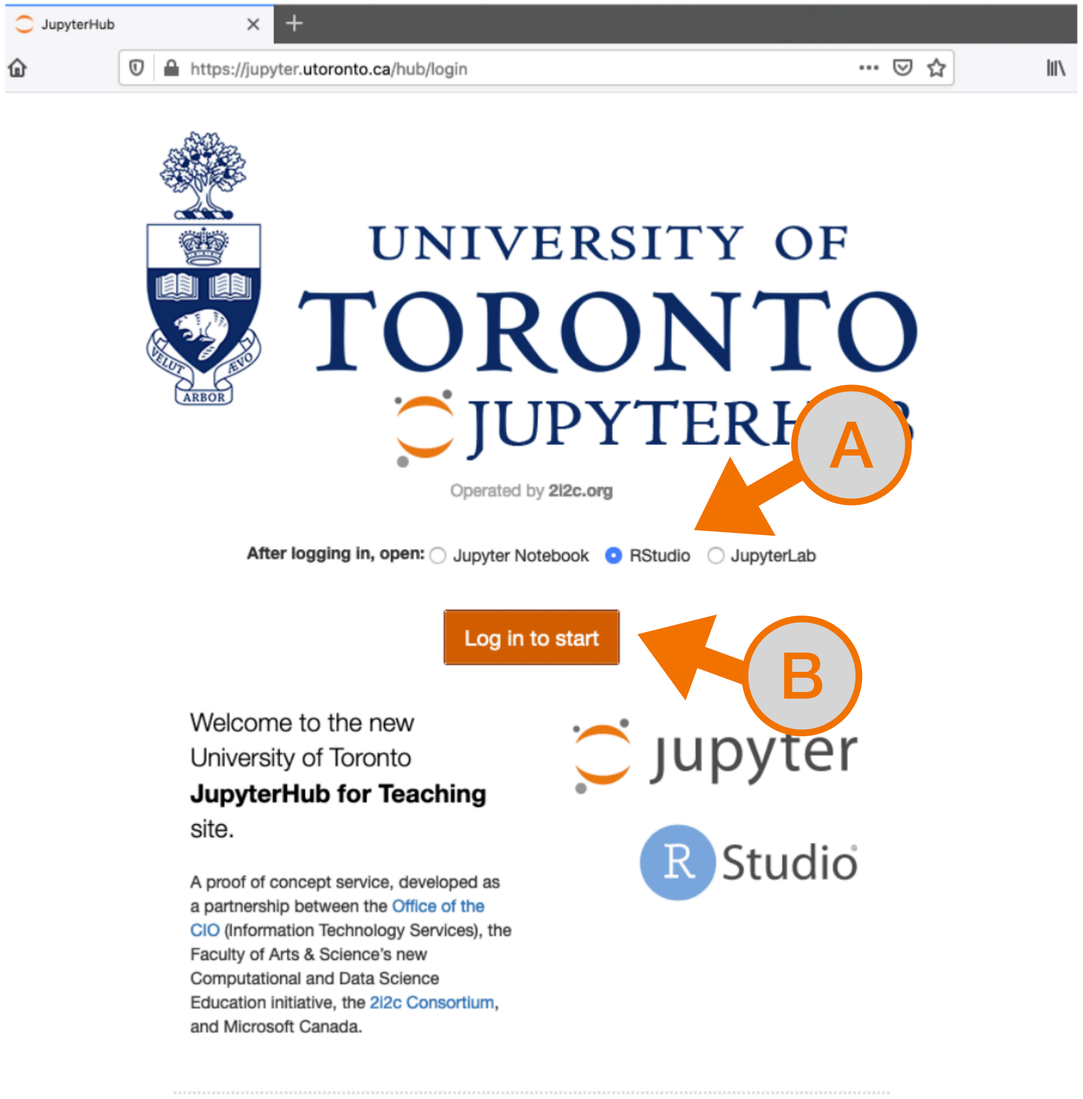


JupyterHub

Follow the steps to run RStudio online.

1. Go to UofT **JupyterHub** https://jupyter.utoronto.ca/hub/login

2. Select RStudio (A) and click ‘Log in to start’ (B)



JupyterHub

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1. Go to UofT **JupyterHub**
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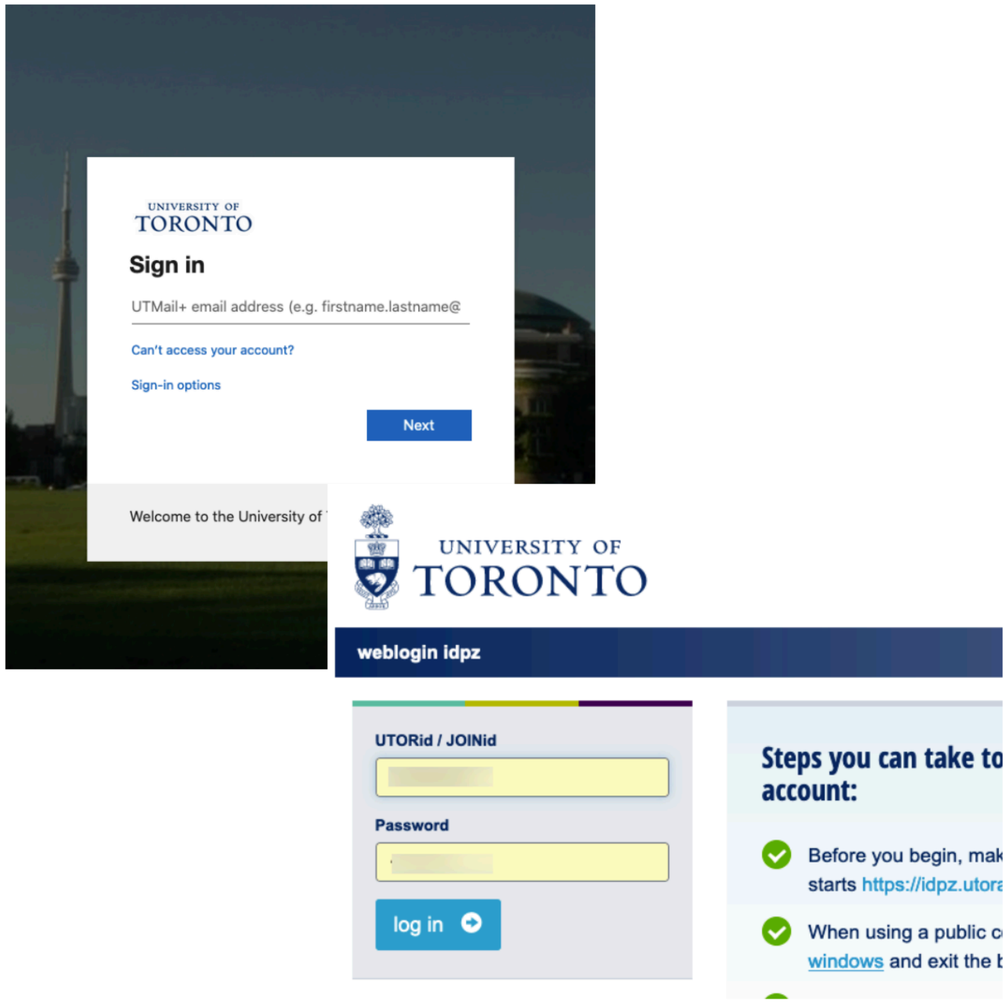
2. Select RStudio (A)
   and click ‘Log in to start’ (B)

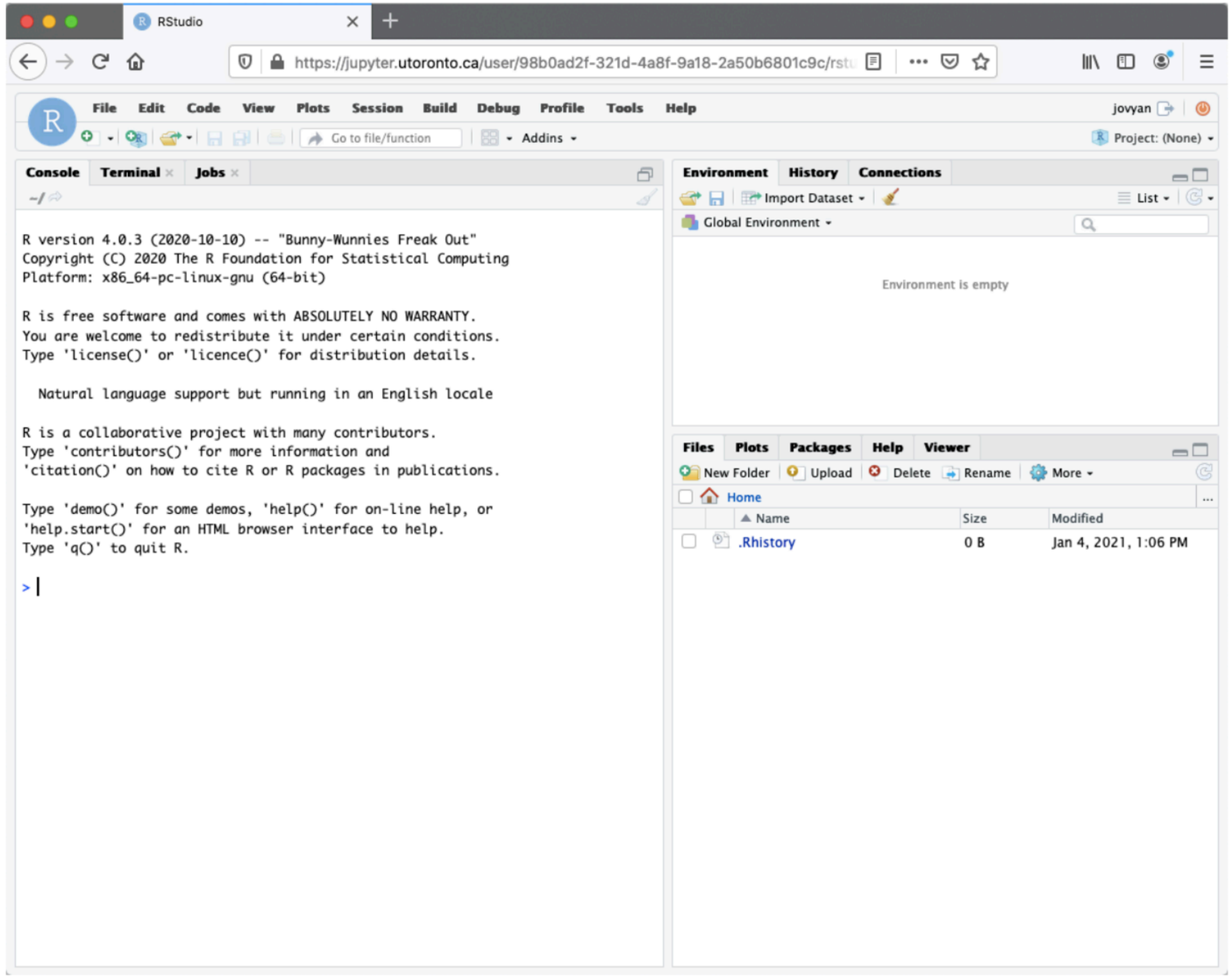
3. Follow the prompt to log in using your UTORid



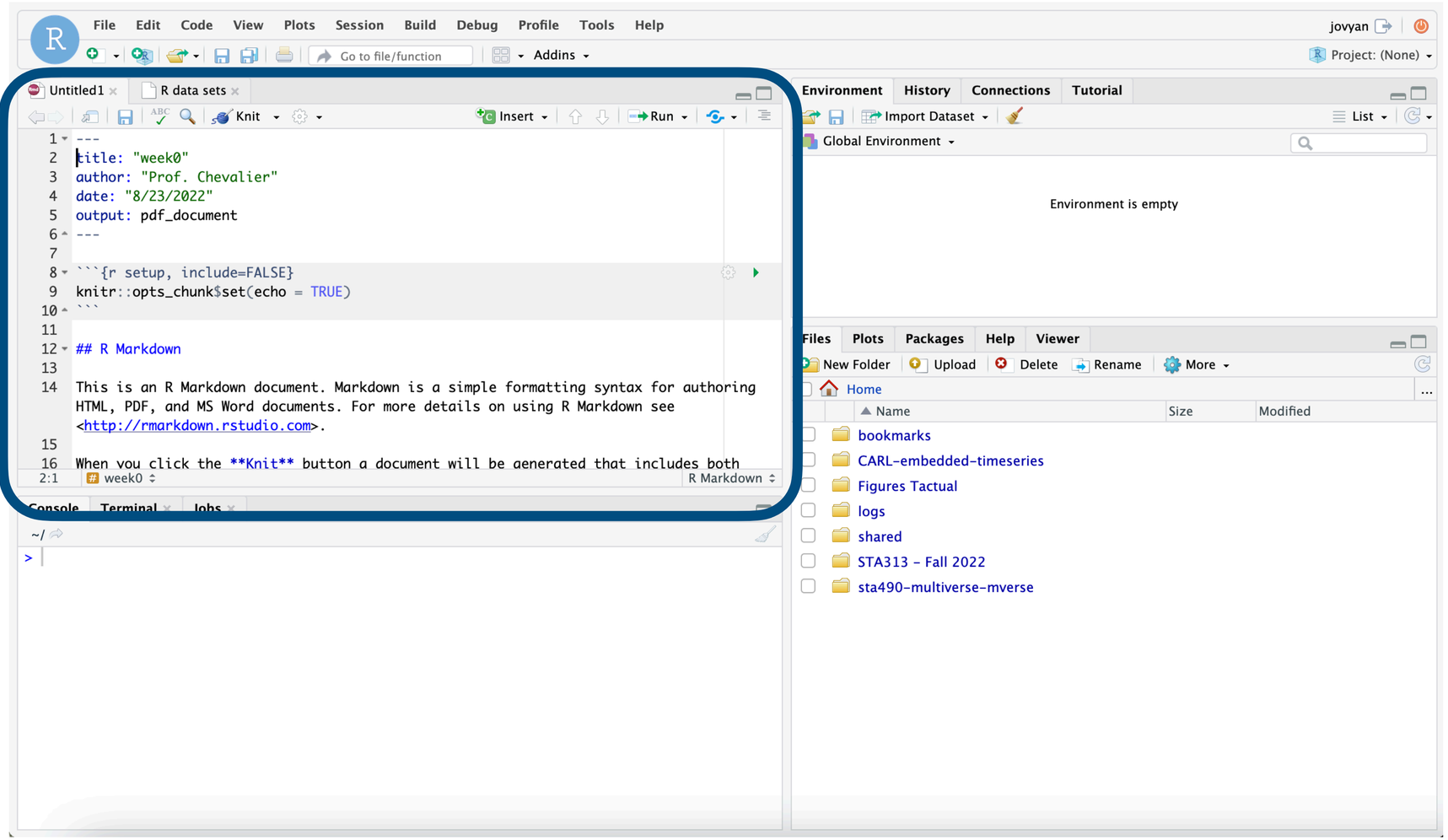
JupyterHub

You will now have access to your personal instance of RStudio Server.

The environment comes with most required packaged installed, including rmarkdown.



R Script


File Edit Code View Plots Session Build Debug Profile Tools Help
jovyan
Go to file/function
Addins
Project: (None)
Untitled1
R data sets
Knit
Insert
Run
---
title: "week0"
author: "Prof. Chevalier"
date: "8/23/2022"
output: pdf_document

```{r setup, include=FALSE}
knitr::opts_chunk$set(echo = TRUE)
```
R Markdown
This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.
When you click the **Knit** button a document will be generated that includes both
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Packages
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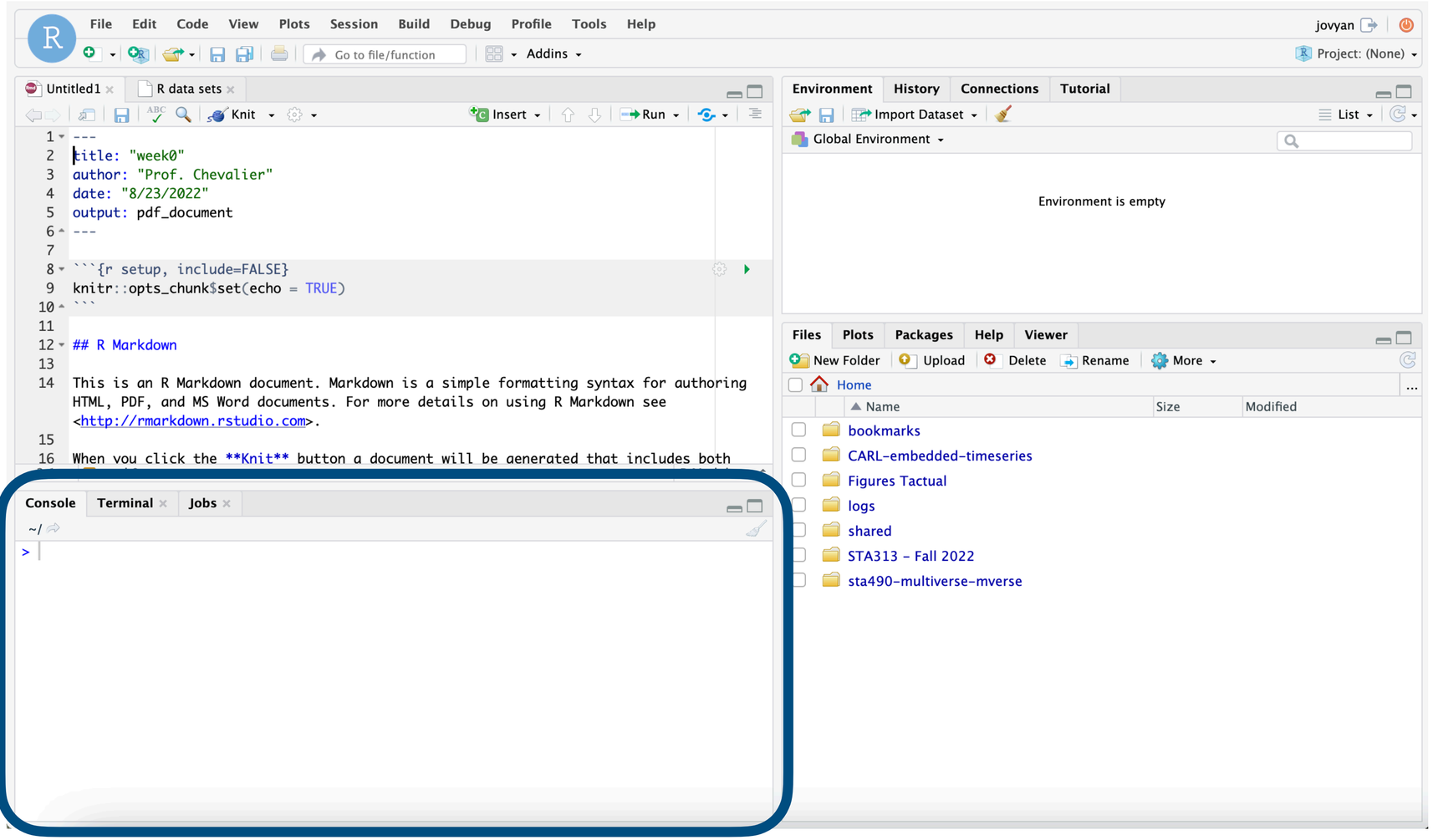
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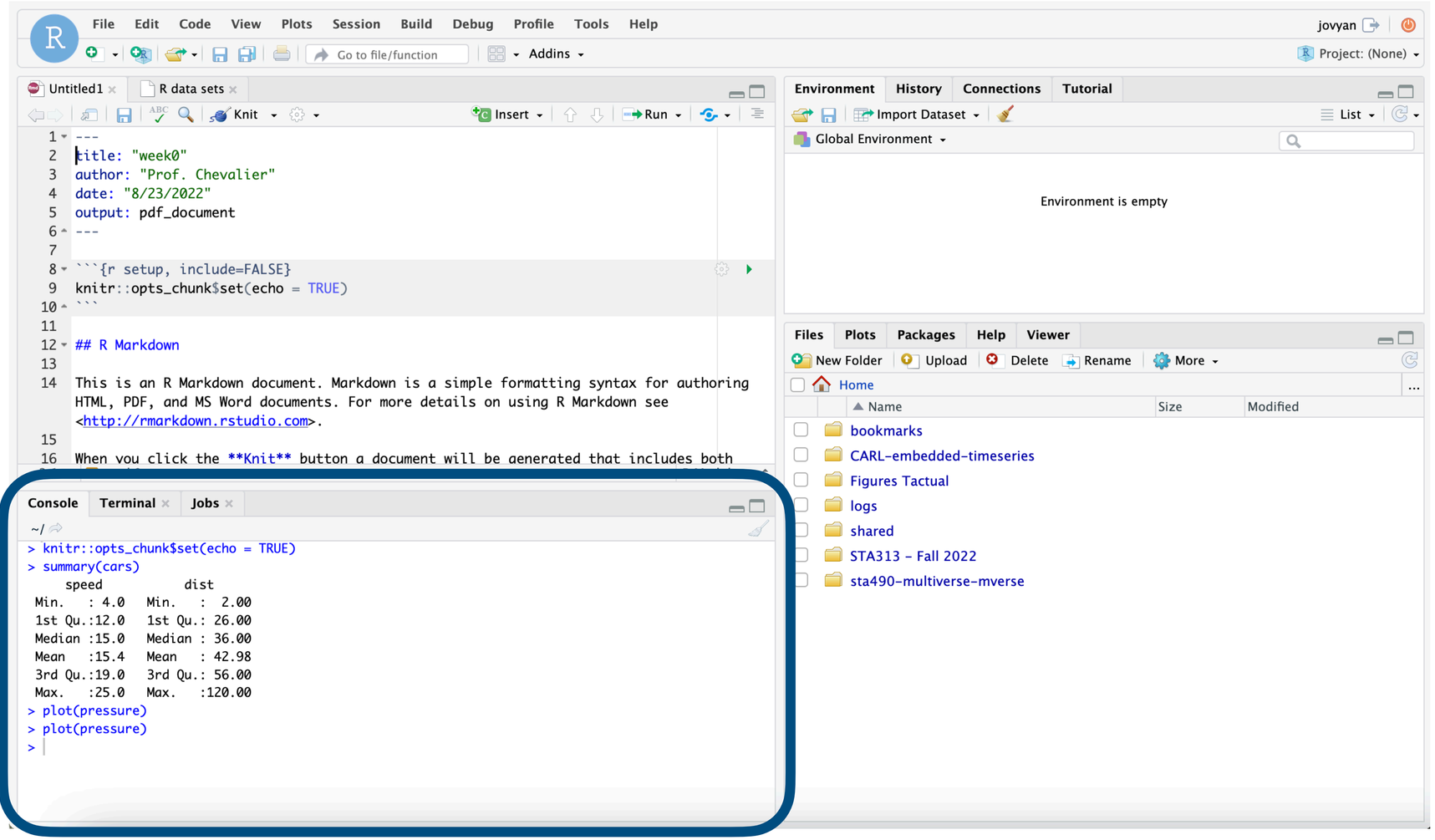
R Console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STA313 - Fall 2022
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Console
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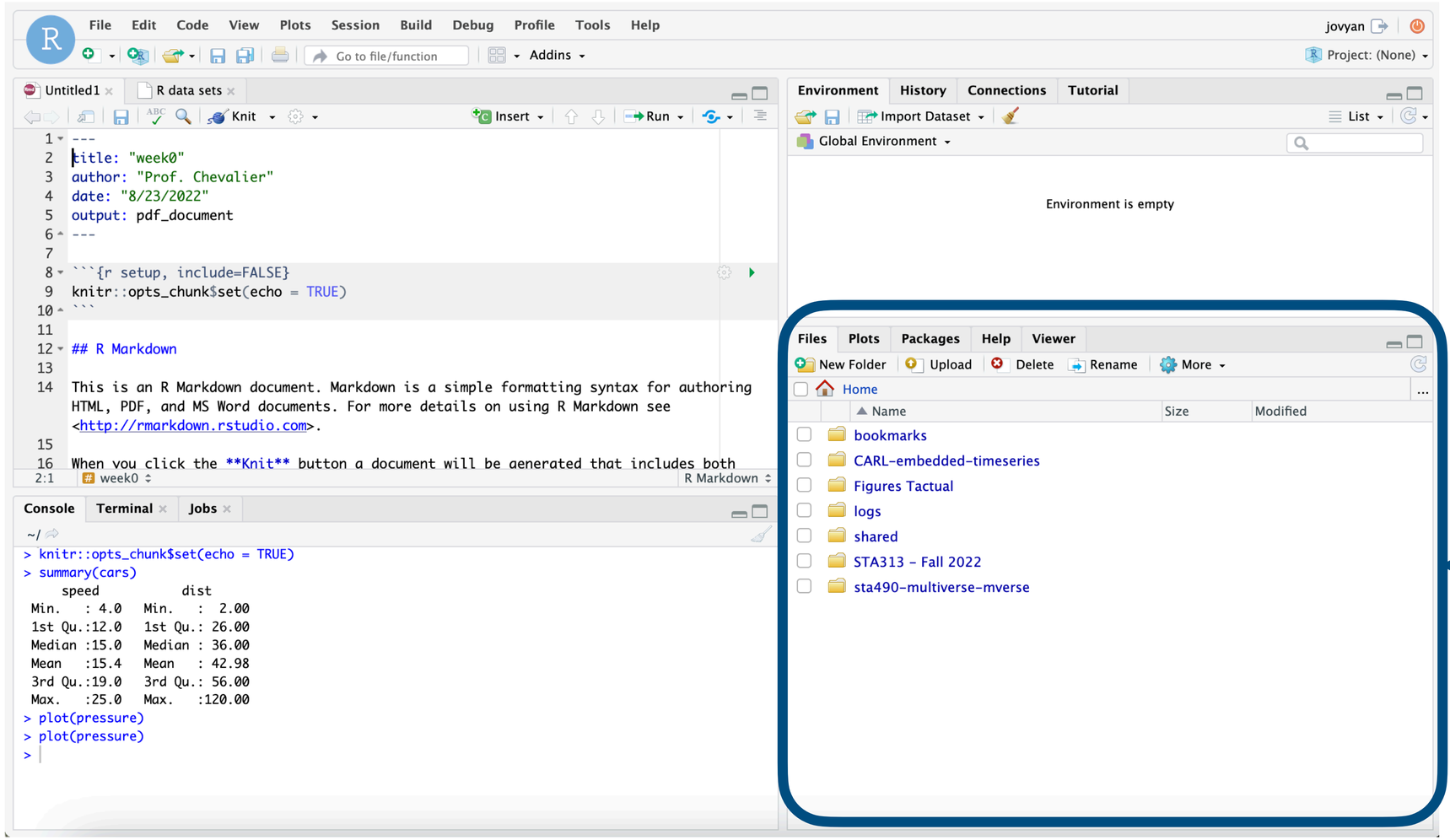
Jobs
~/
> knitr::opts_chunk$set(echo = TRUE)
> summary(cars)
speed dist
Min. : 4.0 Min. : 2.00
1st Qu.:12.0 1st Qu.: 26.00
Median :15.0 Median : 36.00
Mean :15.4 Mean : 42.98
3rd Qu.:19.0 3rd Qu.: 56.00
Max. :25.0 Max. :120.00
> plot(pressure)
> plot(pressure)
>
R Console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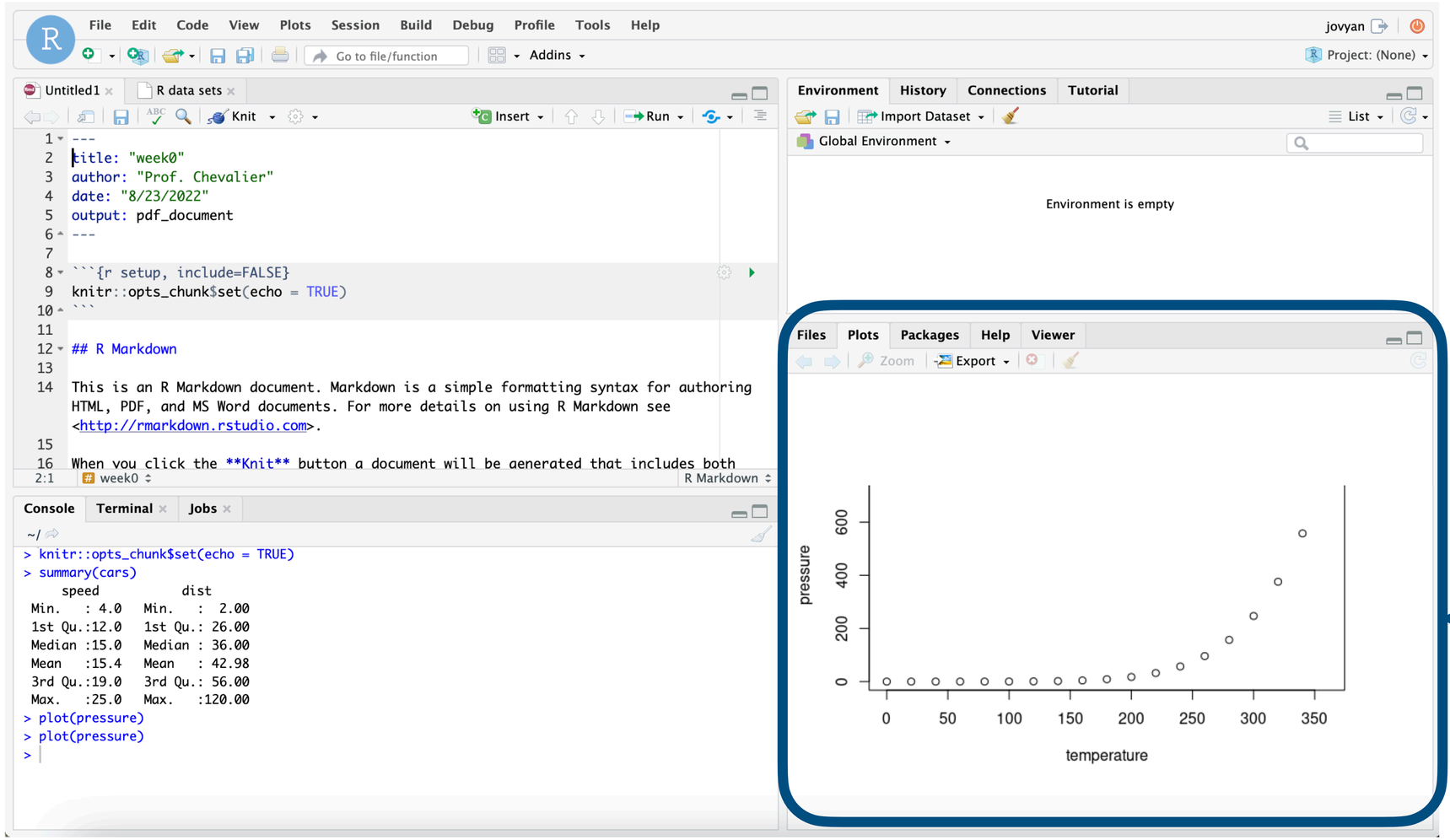
STA313 - Fall 2022
sta490-multiverse-mverse
File system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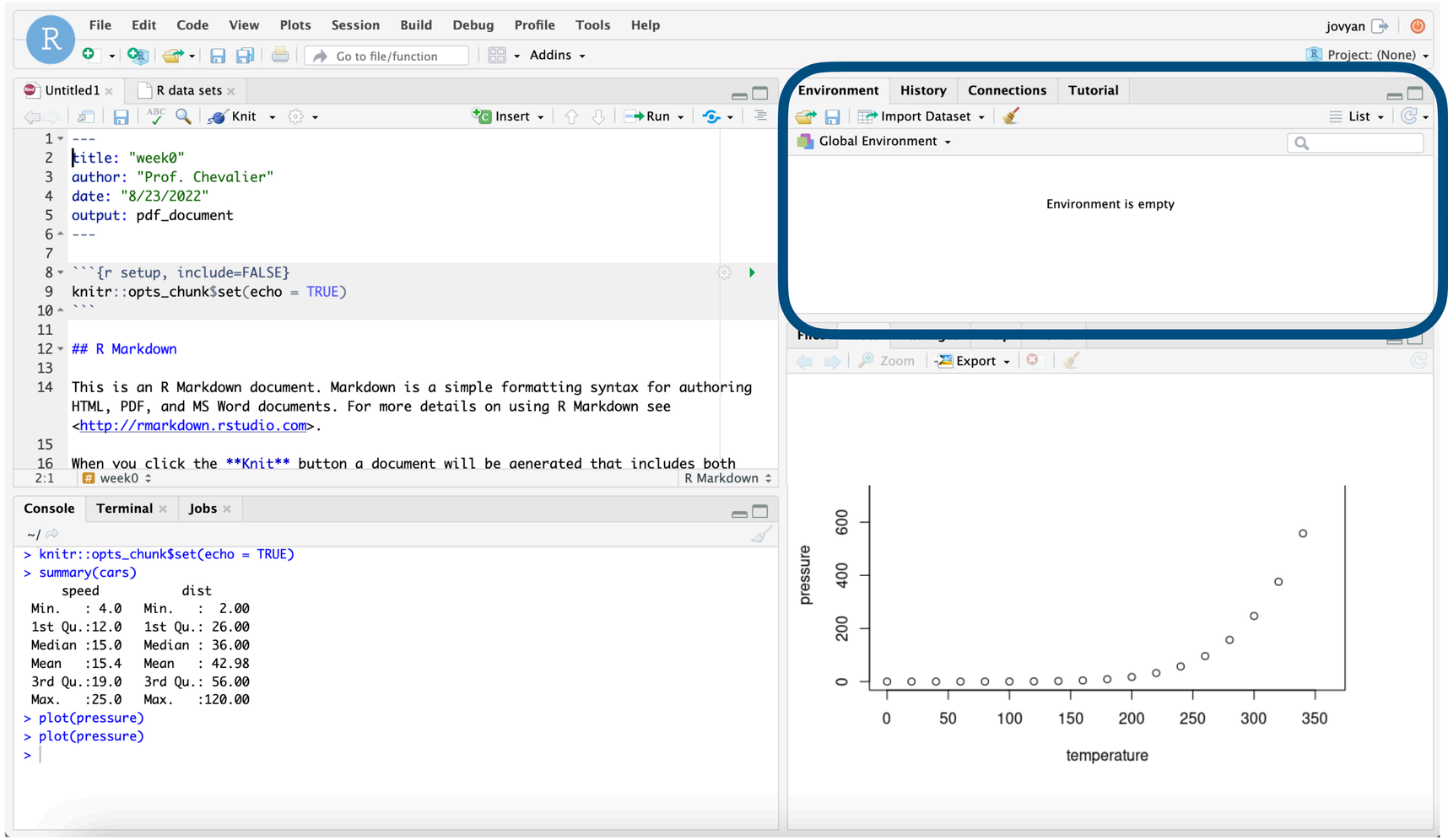
Graphical output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temperature
R environment

vs. JupyterHub from CS Teaching Lab

Some of you may have access to JupyterHub provided by CS Teaching Laboratories. Note that this is a separate system.

CS Teaching Laboratories

- Available at https://jupyter.teach.cs.toronto.edu/
- Uses your local CS lab accounts for file storage
- RStudio is not available

JupyterHub for Teaching

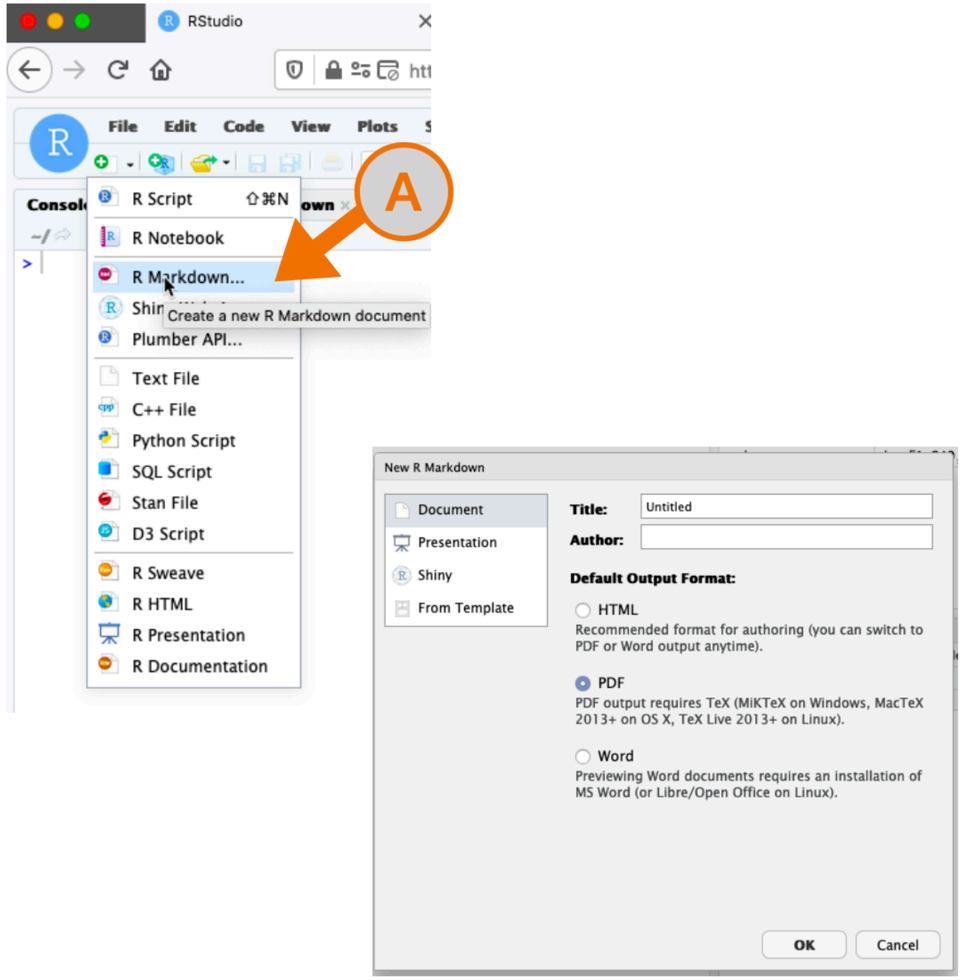
- Available at https://jupyter.utoronto.ca/
- Not linked to your local accounts
- Both RStudio and Jupyter Notebook are available
- For details on accessing and uploading files at the new JupyterHub, see this video from 0:30

Creating a PDF document using R Markdown

Create a New Document

Follow the steps to start new R Markdown document

1. Select *R Markdown…* (A) from the New File dropdown menu

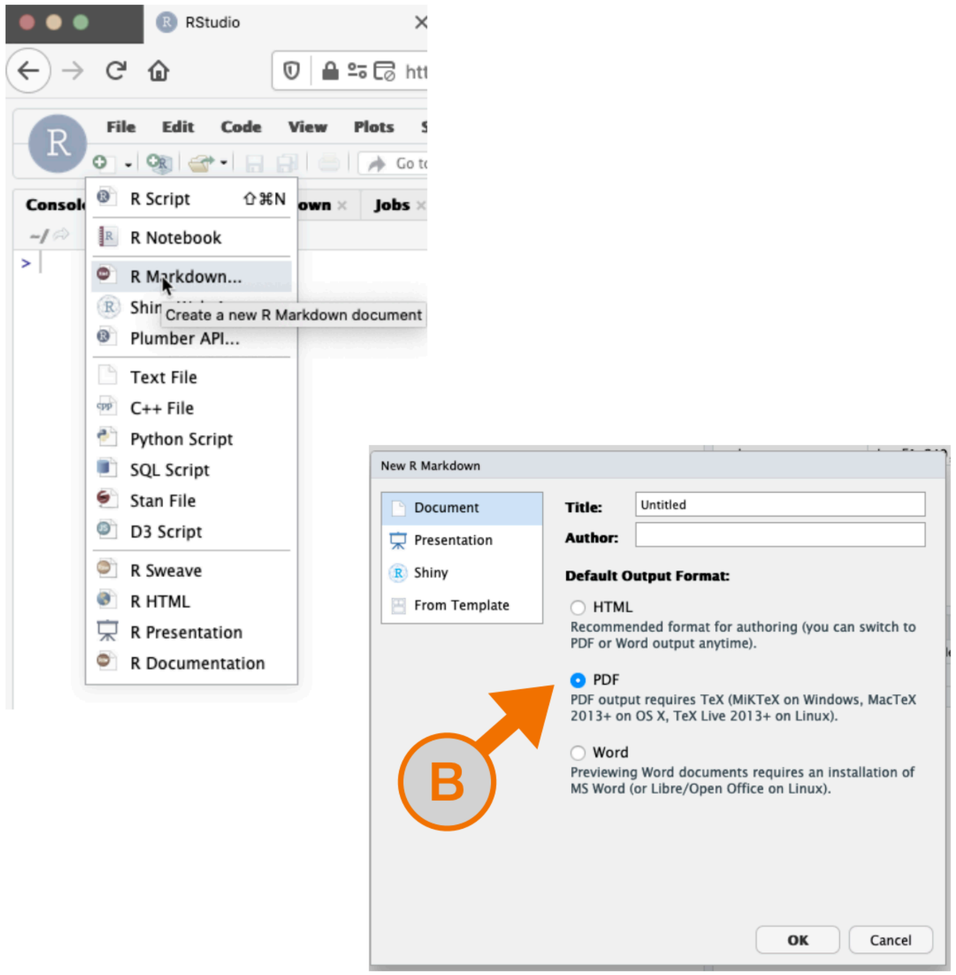


Create a New Document

Follow the steps to start new R Markdown document

1. Select *R Markdown…* (A) from the New File dropdown menu

2. Fill in *Title* and *Author*, and select PDF (B) as the output format



Create a New Document

Follow the steps to start new R Markdown document

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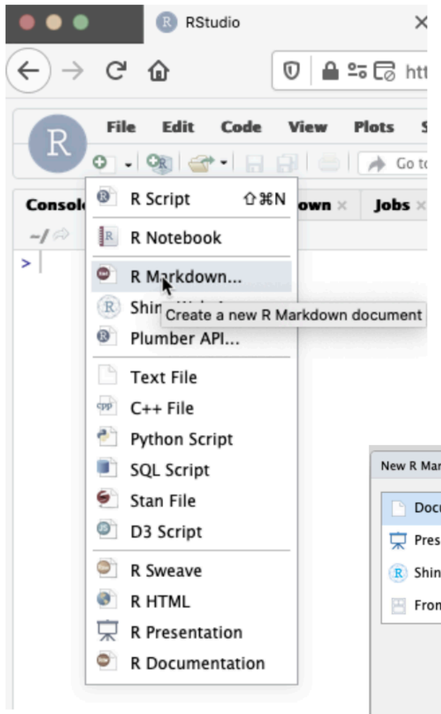
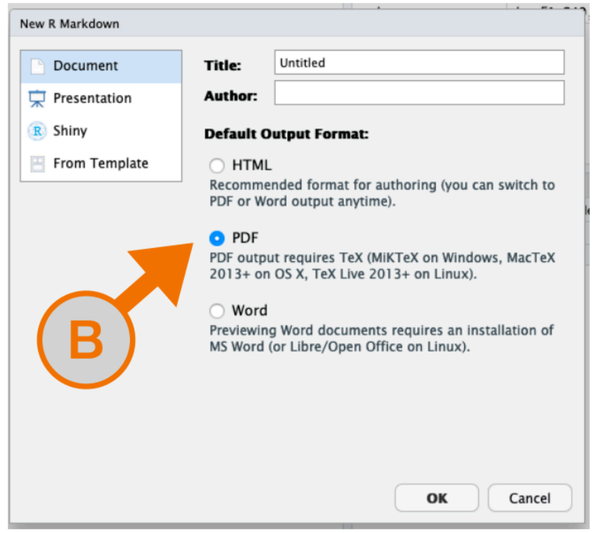


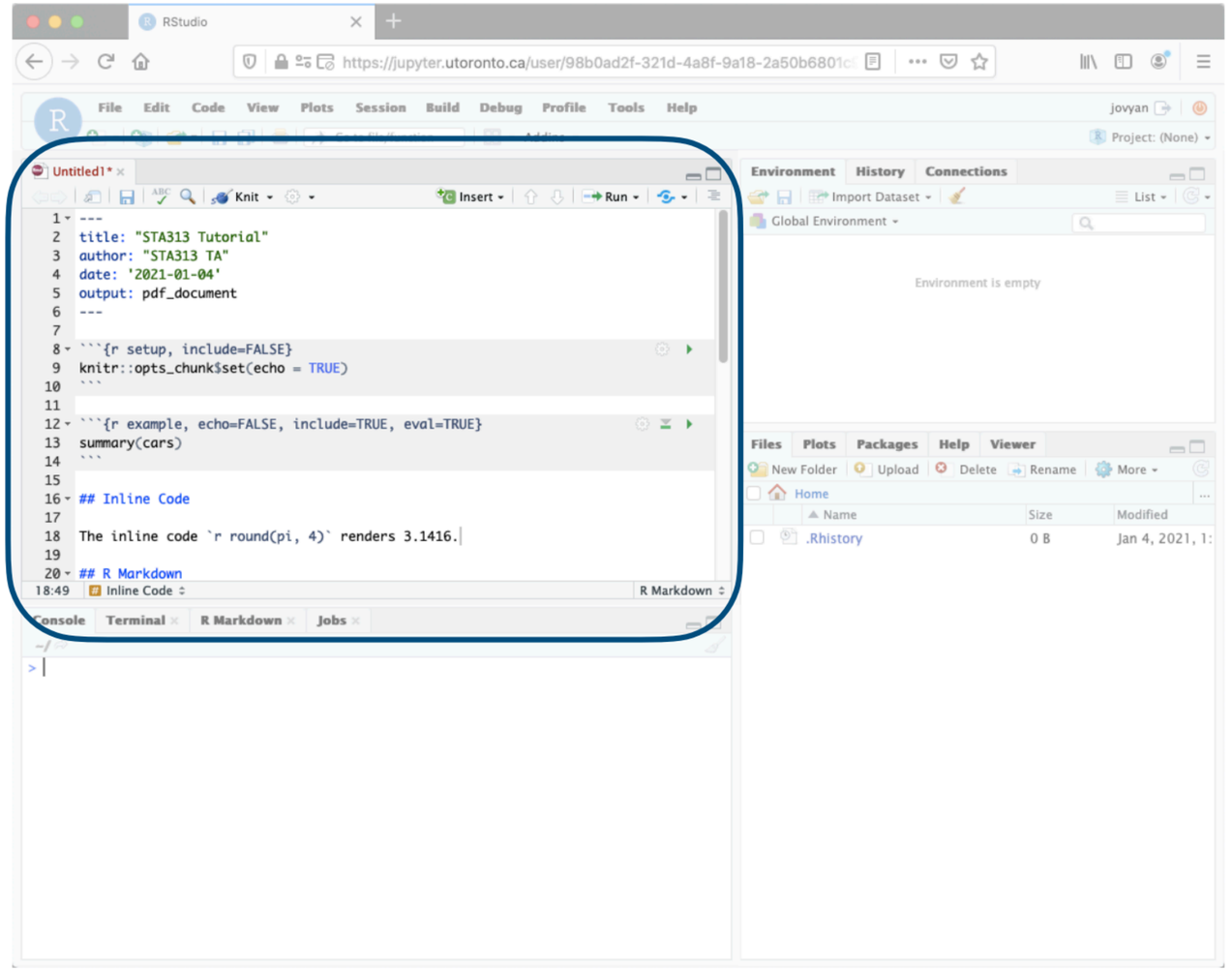


You can also render other document types such as HTML and Word from R Markdown.

This tutorial will focus on rendering PDF documents.

A R Markdown Document

You will now see a new R Markdown document with the default texts populated.



Knitting Document

Knitting renders the document into a PDF document.

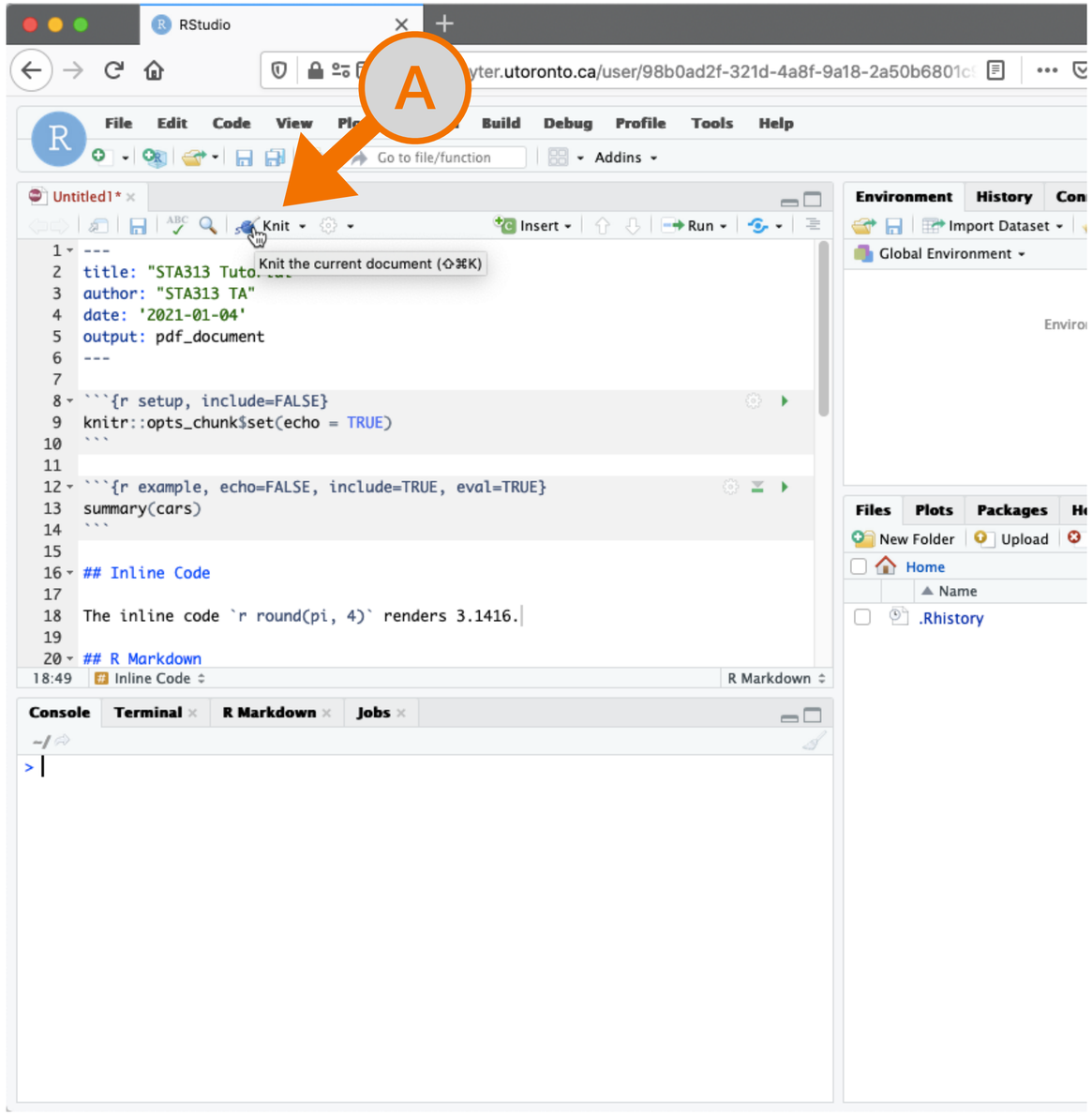
1. You can knit the document by

   i. Clicking `knit` (A) button; or

   ii. Pressing `Ctrl/Cmd+Shift+K` on keyboard

2. You will be asked to save the document if you haven't

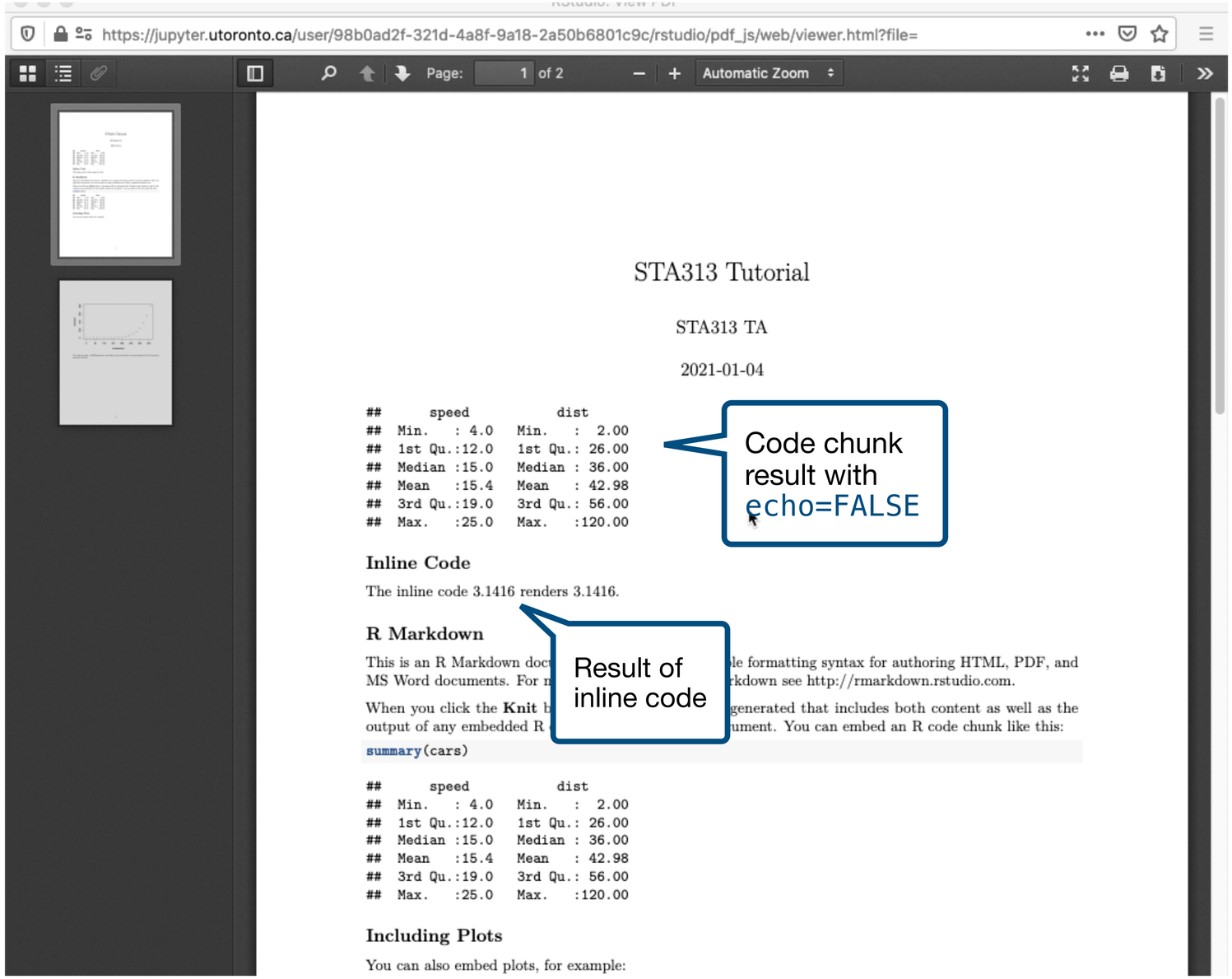
3. `Knit` often to identify errors



Knitted Document

After knitting the document, R Studio will display a preview of the PDF document.

Check to make sure it rendered properly.



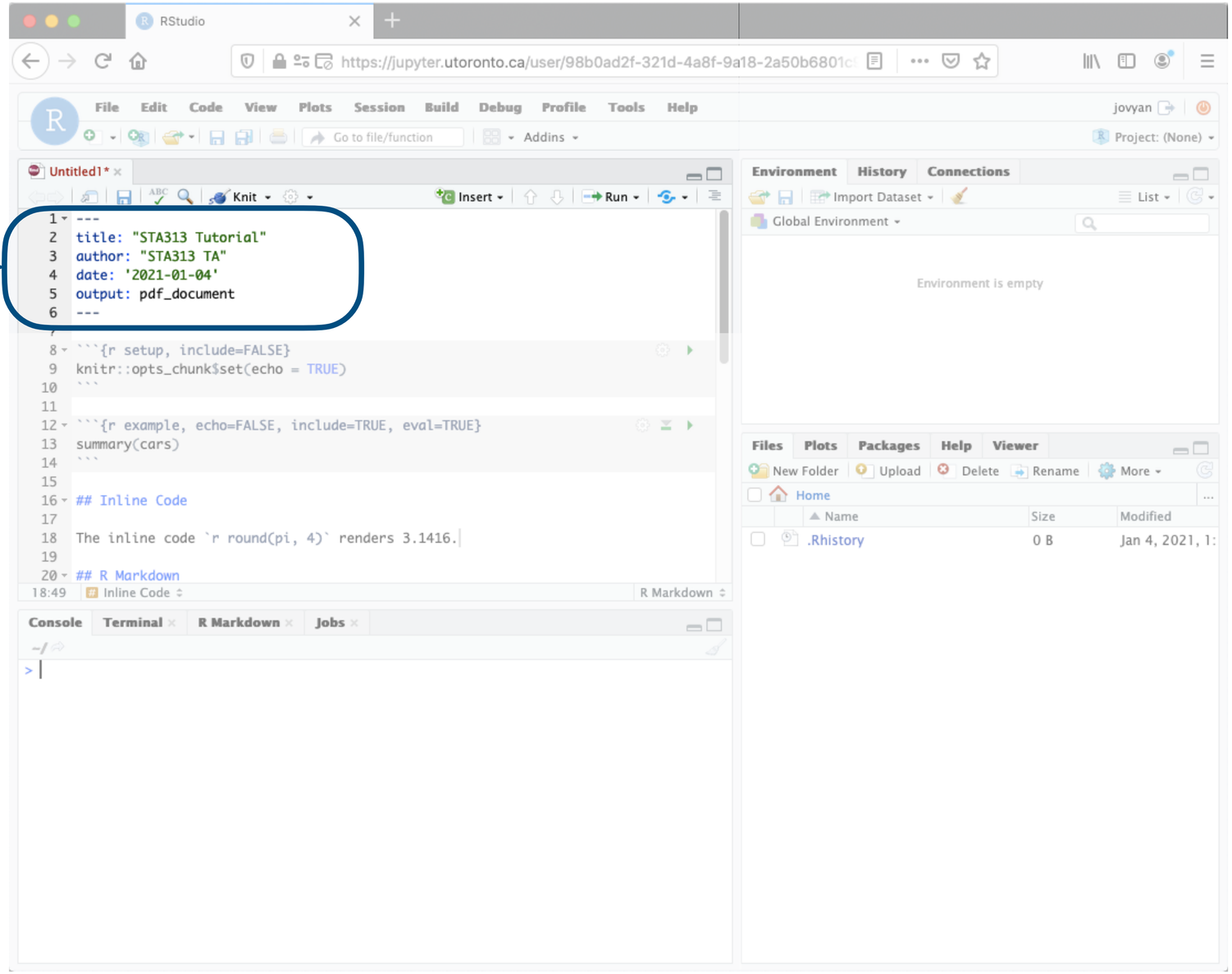
YAML Block

The YAML block at the top lists the metadata for the document. It is enclosed by '- - -'.

The list may include:

- Title, Author, Date
- Output type and output rendering options
- Font size and document dimensions

For more options, see https://bookdown.org/yihui/rmarkdown/pdf-document.html



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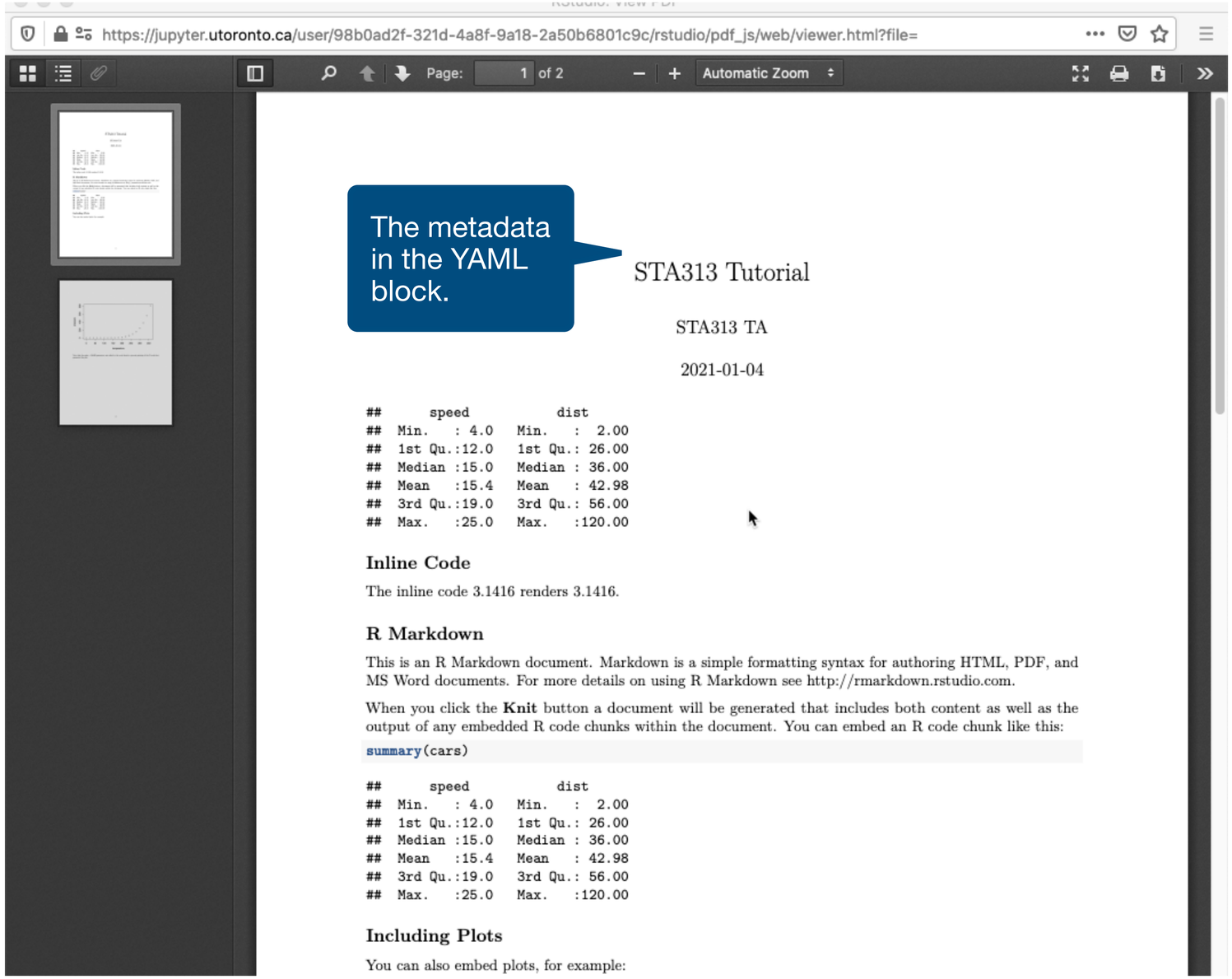
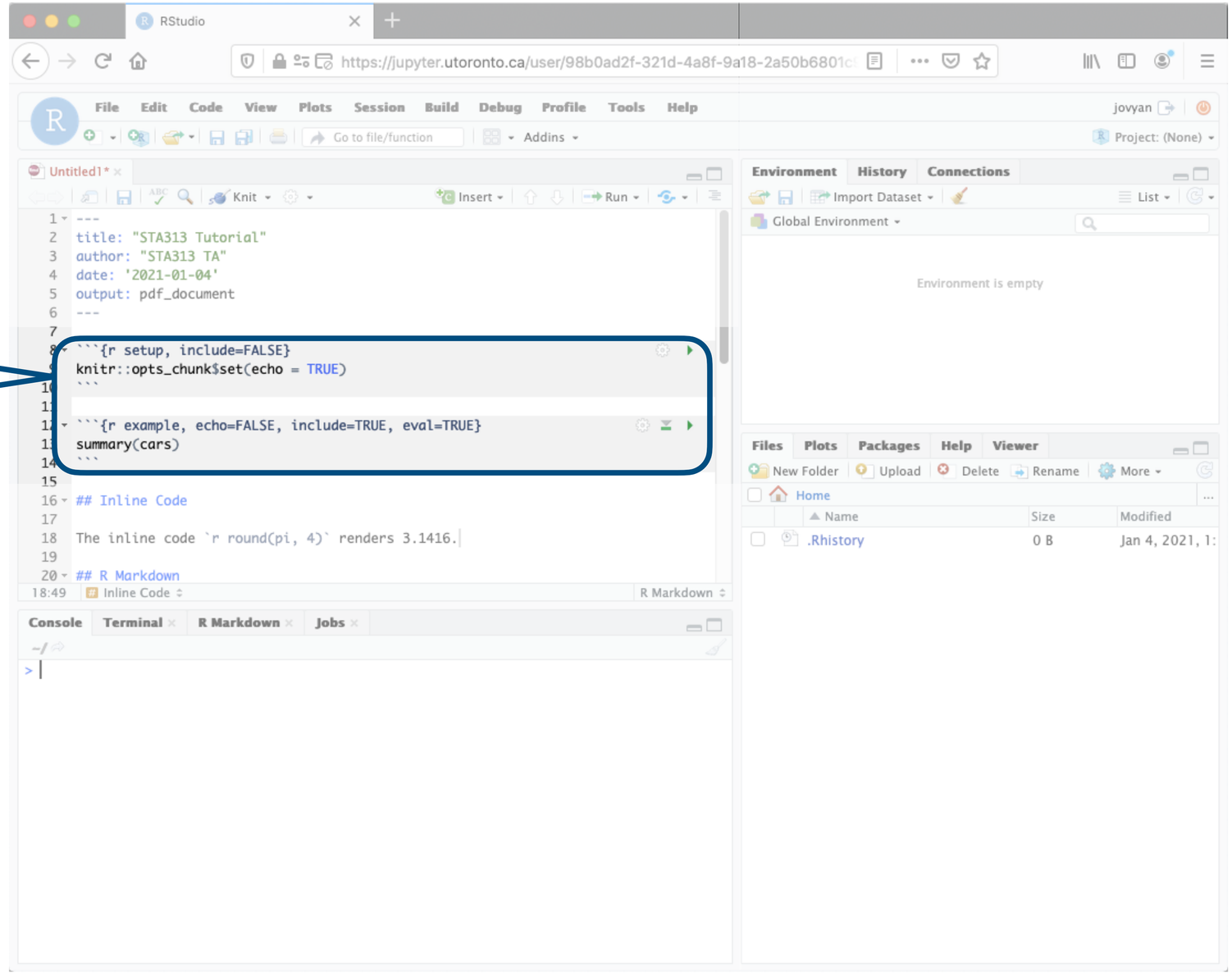


Code Chunk

Code chunks enclosed by ```` ```{r} ```` and ```` ``` ```` allow running blocks of R codes and including their outputs in the document.

Code chunks are evaluated in the order they appear in the same environment.

````
```{r <name>, <parameter(s)>}
# R codes.
```
````

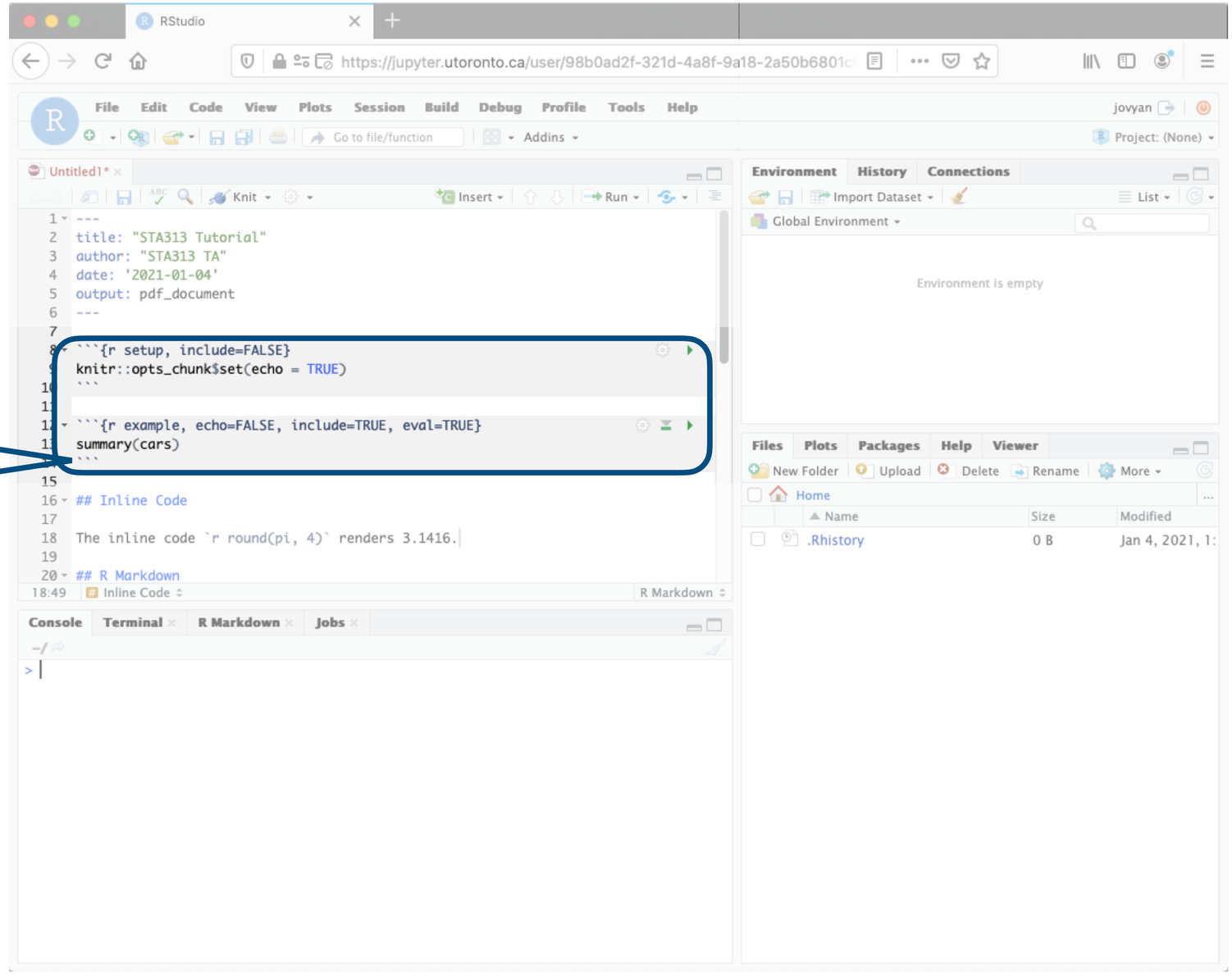


Code Chunk

Optionally, you can include chunk-specific parameters separated by commas.

- `echo=FALSE` hides the code chunk in the rendered PDF.
- `include=FALSE` hides the code chunk and the results
- `eval=FASE` prevents evaluation of the chunk
- `knitr::opts_chunk$set(…)` applies the options to all following chunks

```
```{r <name>, <parameter(s)>}
# R codes.
```
```



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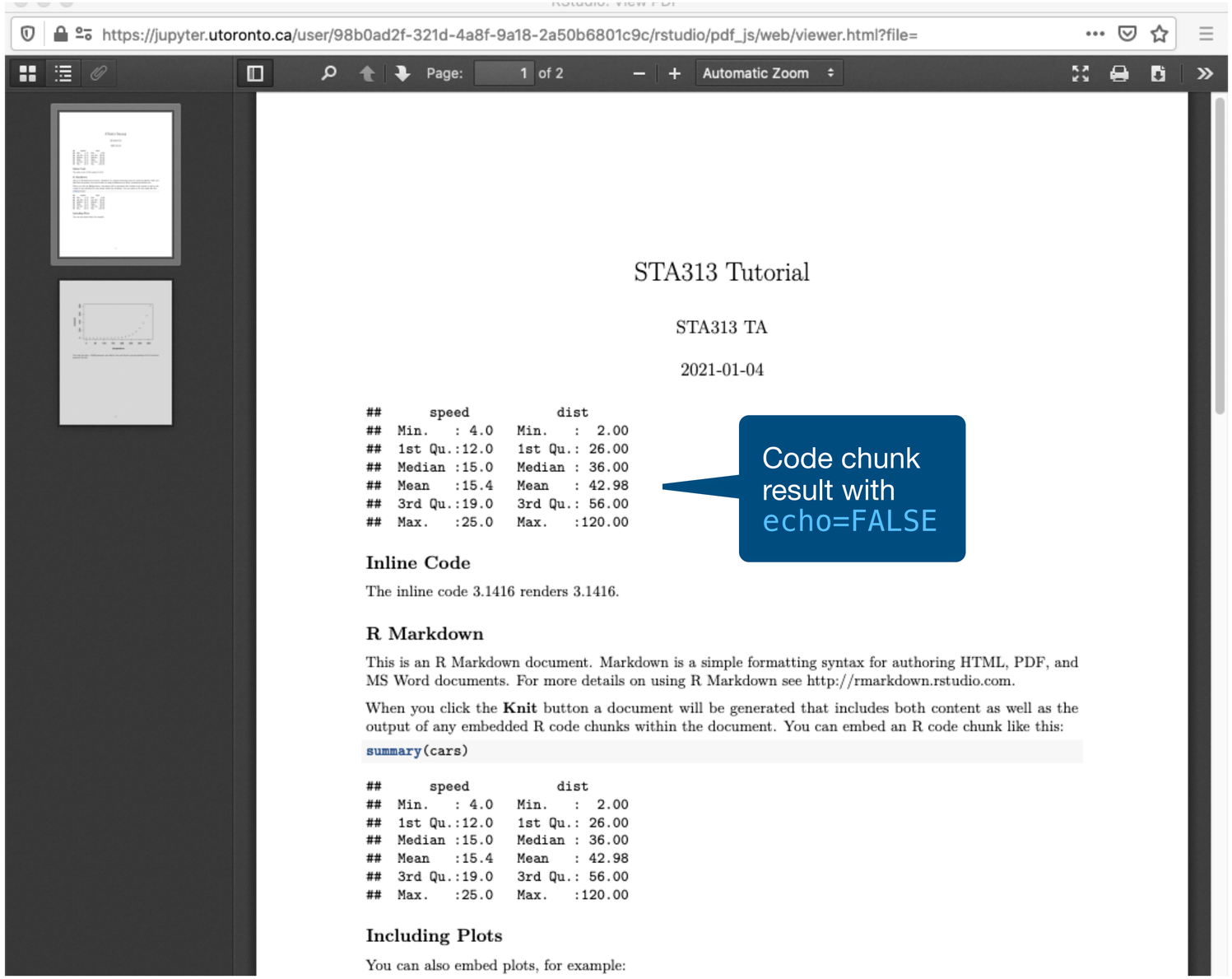
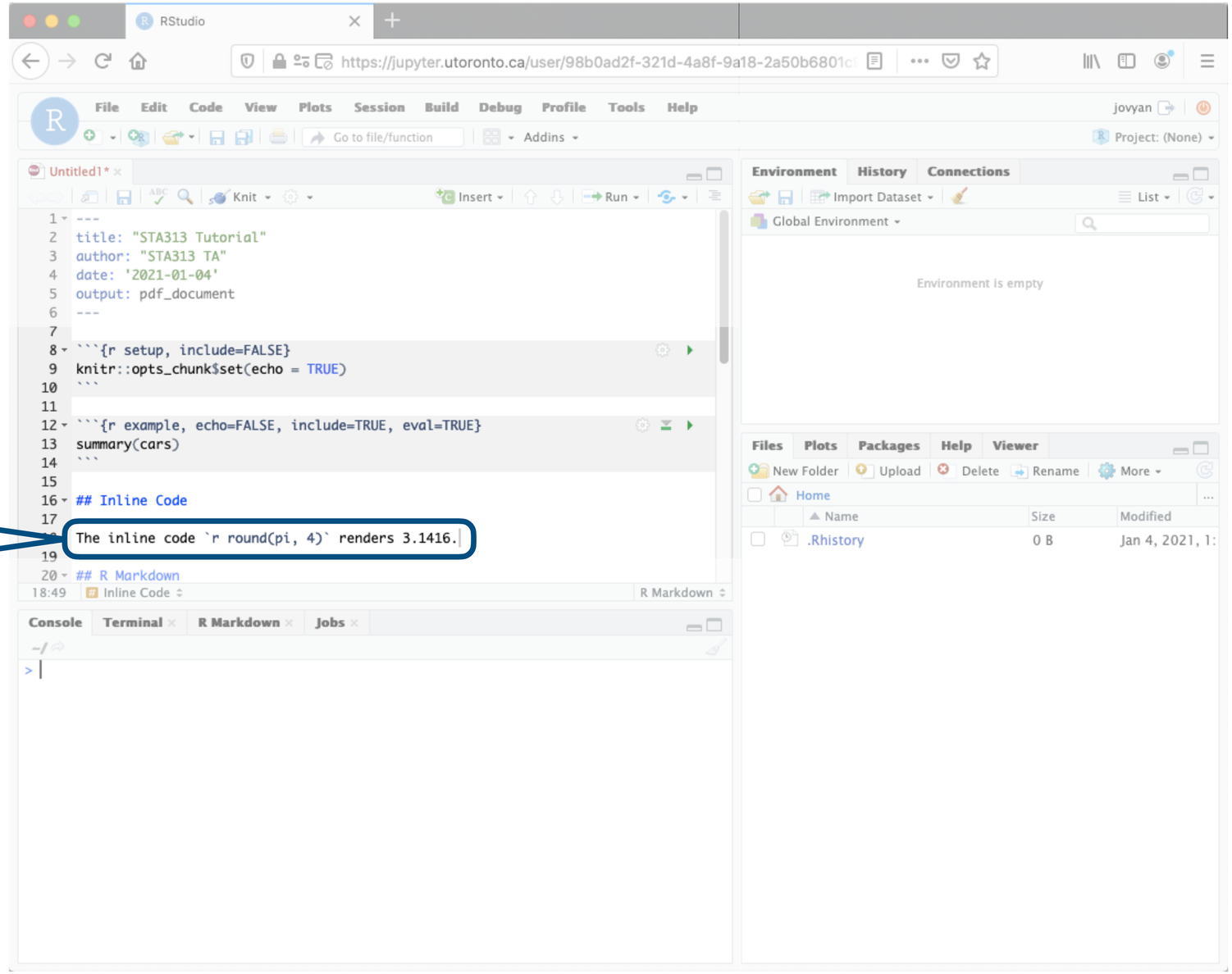


Inline Code

- You can directly include r outputs in markdown texts by enclosing codes with `` `r `` and `` ` ``
- For example, `` `r round(pi,4)` `` renders 3.1416 in the output document
- This is useful when you want to include results from your analysis in your report text body



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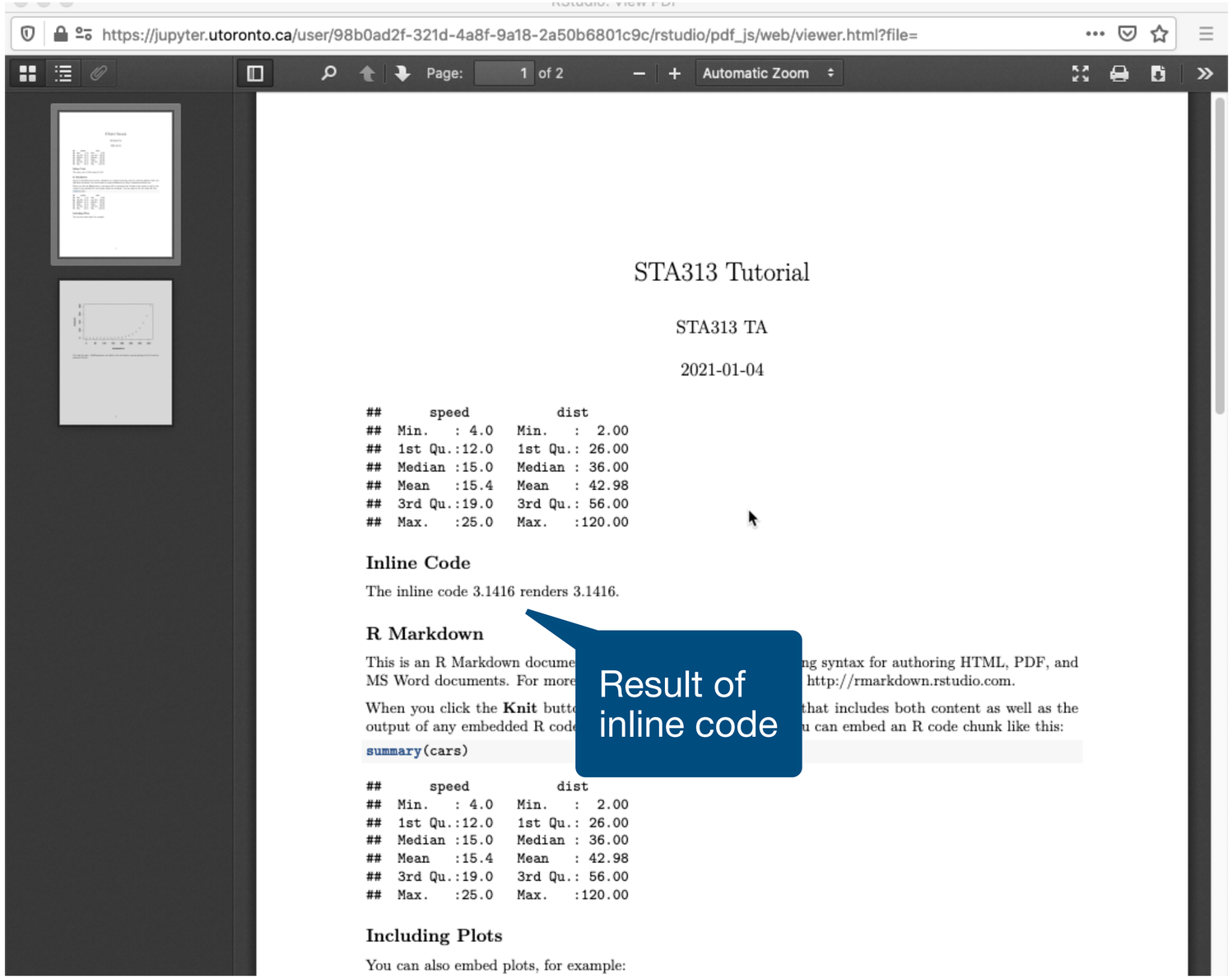


Markdown and LaTeX

Markdown

R Markdown uses markdown to format text.

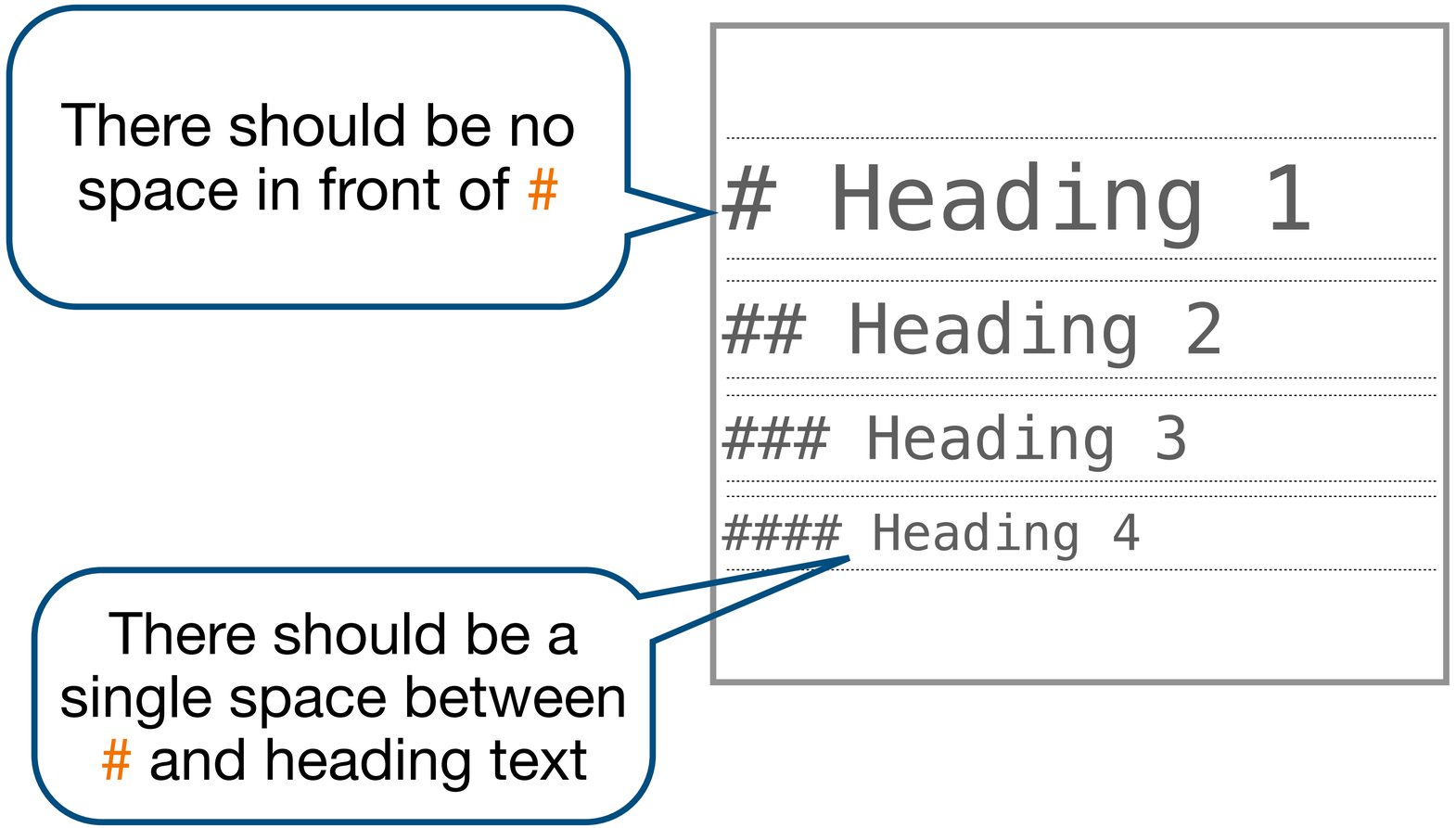
Markdown is a mark-up language for formatting texts.

You can think of HTML but with simpler, typing-friendly syntax.

What it is **NOT** :
a WYSIWYG word processor like MS Word.

Headings

Organise your document using appropriate headings. # indicates the line of text is a heading.



Paragraphs

In markdown, you need to explicitly mark where to start a new line or a new paragraph.

- An empty line separate two paragraphs
- Two empty spaces followed by a new line inserts a line break without creating a new paragraph
- Alternatively, you can use LaTeX syntax \\ to mark a new line

```
This
sentence
renders in a single
line.

This is a new
paragraph.
```

Lists

Lists can be easily typed in markdown - ordered or unordered.

- You can use +, -, or * to create unordered lists
- You can create ordered (numbered) lists with numbers followed by . or)
- There are no spaces before the symbols and at least one space between the symbol and item text

```
+   This is
+   an unordered
+   list rendered
+   with bullet points


1.  This is an item
2.  in a numbered list
```

Math Equations

You can include math expressions using LaTeX syntax.

- `$...$` renders mathematical expressions inline
- `$$...$$` renders mathematical expressions in display mode in a separate paragraph and centred
- See https://en.wikibooks.org/wiki/LaTeX and http://ctan.mirror.colo-serv.net/info/lshort/english/lshort.pdf if you need resources on LaTeX

```
This $\alpha^1$
renders inline.

$$\beta_2$$ renders
in a separate
paragraph.
```

Tables

You can use `knit::kable` inside a code chunk to display data in a nicely formatted tables.

````
Below code chunk creates a table
with a caption.

```{r sometable}
library(knitr)
tbl <- data.frame(…)
kable(tbl,
    format='latex',
    booktabs=TRUE,
    caption='Caption for table',
    digits=2)
```
````

Indicates the table is for a PDF document.

booktabs is a LaTeX package that creates clean-looking tables.

You need to include `\usepackage{booktabs}` in the YAML under `header-includes`.

The code renders a formatted table with a caption in PDF.

Table: Caption for table

Labels	Numbers	Decimals
Label 1	1000	1.00
Label 2	200	3.14
Label 3	-35	2.72

Figures

You can include plots by generating plots in code chunks with rendering options specified using code chunk parameters.

````
Below code chunk renders a plot

fitted to 50% of the line width.

```{r someplot, fig.width=4, fig.height=3,
out.width=".5\\linewidth", fig.cap="Figure
Caption", fig.align="center"}
plot(...
# plotting code here
)
```
````

- `fig.width` and `fig.height` specify width and height of the figure in inches before placing on the document
- `out.width` specifies the width of the rendered image on the document; you can specify relative to the document width
- Try different values for the figure sizes to render your figure in the desired size and resolution.
- `fig.cap` specifies the figure caption
- `fig.align` specifies figure alignment

A sample R Markdown document is available at Quercus for you to try rendering different components on your own.

Application Exercise

- Download the sample Rmd script from Quercus
- “Upload" the script to your Jupyter R, through the File System
- Edit the script to append the following content to this document, in a new page

STA313 - Meet the R Markdown toolkit

Application exercise

- First, we want a summary of the *anscombe* dataset, but we don’t want to show the code

```
##        x1              x2              x3              x4            y1
##  Min.   : 4.0   Min.   : 4.0   Min.   : 4.0   Min.   : 8   Min.   : 4.260
##  1st Qu.: 6.5   1st Qu.: 6.5   1st Qu.: 6.5   1st Qu.: 8   1st Qu.: 6.315
##  Median : 9.0   Median : 9.0   Median : 9.0   Median : 8   Median : 7.580
##  Mean   : 9.0   Mean   : 9.0   Mean   : 9.0   Mean   : 9   Mean   : 7.501
##  3rd Qu.:11.5   3rd Qu.:11.5   3rd Qu.:11.5   3rd Qu.: 8   3rd Qu.: 8.570
##  Max.   :14.0   Max.   :14.0   Max.   :14.0   Max.   :19   Max.   :10.840
##        y2              y3              y4
##  Min.   :3.100   Min.   : 5.39   Min.   : 5.250
##  1st Qu.:6.695   1st Qu.: 6.25   1st Qu.: 6.170
##  Median :8.140   Median : 7.11   Median : 7.040
##  Mean   :7.501   Mean   : 7.50   Mean   : 7.501
##  3rd Qu.:8.950   3rd Qu.: 7.98   3rd Qu.: 8.190
##  Max.   :9.260   Max.   :12.74   Max.   :12.500
```

Application Exercise

- Continue to edit the script to append the following content to the document

- Then, we want to plot the `x1` and `y1` dimensions of this dataset, as a scatterplot. Again, we don't want to show the code in the knitted document.

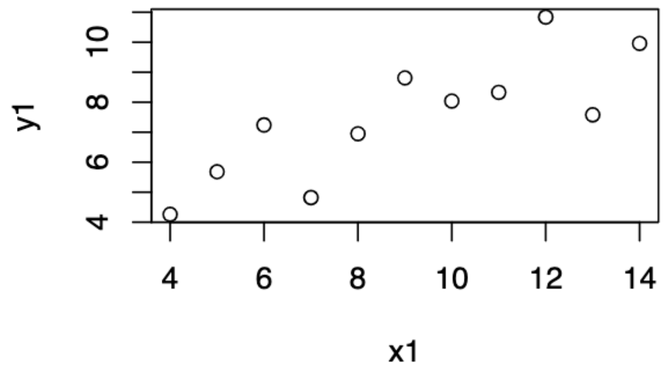


Figure 2: Scatterplot I of the Anscombe's dataset

Application Exercise

- Continue to edit the script to append the following content to the document

- Now, create the same plot, and include a linear regression line

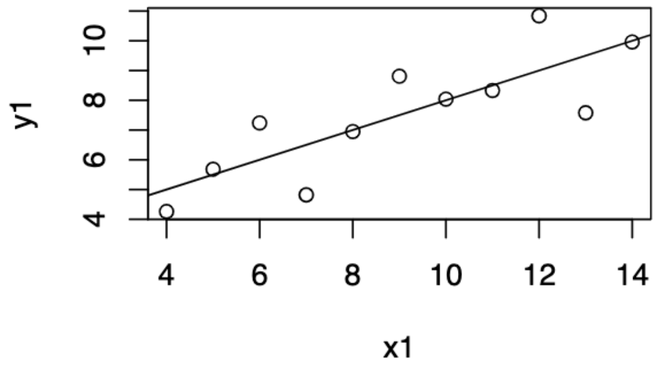


Figure 3: Scatterplot I of the Anscombe's dataset, showing the linear regression line

Application Exercise

- Continue to edit the script to append the following content to the document

- Using inline code, indicate that the max value along the `x1` dimension of the dataset is 14

Application Exercise

- Continue to edit the script to append the following content to the document

Table 2: Min and max

Dimension	Min	Max
x1	4	14
y1	4	11

- Finally, create a table using to show the min, max and mean values for the `x1` and `y1` data dimensions of the `anscombe` dataset

Final Tips and References

Final Tips

- RStudio will explicitly point out errors found in R codes
- `output file: <filename>.knit.md` followed by error messages in the error log likely indicates that there is a LaTeX syntax error
- Characters with special functions in LaTeX may cause unintended behaviours when used outside markdown text - e.g., `fig.cap`. Often, you can fix errors with these characters by placing \\ in front of the character. e.g., `fig.cap="…50\\%…"` instead of `fig.cap="…50%…"`
- `Knit` your document often, especially after complex LaTeX commands to identify errors early

Resources

- A quick markdown introduction.
  https://commonmark.org/help/tutorial/index.html
- Another markdown reference.
  https://daringfireball.net/projects/markdown/
- A simple R Markdown tutorial.
  https://rmarkdown.rstudio.com/lesson-1.html
- A comprehensive documentation.
  https://bookdown.org/yihui/rmarkdown
- Reference for kable and kableExtra for formatting tables.
  https://haozhu233.github.io/kableExtra/awesome_table_in_pdf.pdf

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Local Installation

(self-guided instructions)

Local Installation

Follow the steps to set up R & R Studio locally, on your machine

1. Download and install R

- Download available at https://cran.rstudio.com/
- Select your OS and download the latest release
- If you are using a Windows machine, download the base package
- If you are using a Mac, download the latest binary (R-4.#.#.pkg) the library is pre-installed.

Local Installation

Follow the steps to set up R & R Studio locally, on your machine

1. Download and install R
2. Download and install R Studio

- Download available at https://www.rstudio.com/products/rstudio/download/#download
- Download the free **RStudio Desktop** (not RStudio Server or the Pro versions)

Local Installation

Follow the steps to set up R & R Studio locally, on your machine

1. Download and install R
2. Download and install R Studio
3. Install rmarkdown

- Open RStudio
- In the RStudio **Console** type

```
install.packages('rmarkdown')
```

Local Installation

Follow the steps to set up R & R Studio locally, on your machine

1. Download and install R
2. Download and install R Studio
3. Install rmarkdown
4. Install tinytex

- In the RStudio **Console** type

```
install.packages('tinytex')
tinytex::install_tinytex()
```

- It enables PDF document rendering from RMarkdown

Local Installation

You will now have a local R and RStudio installed with rmarkdown set up for PDF rendering.

You can access your local files from RStudio.