

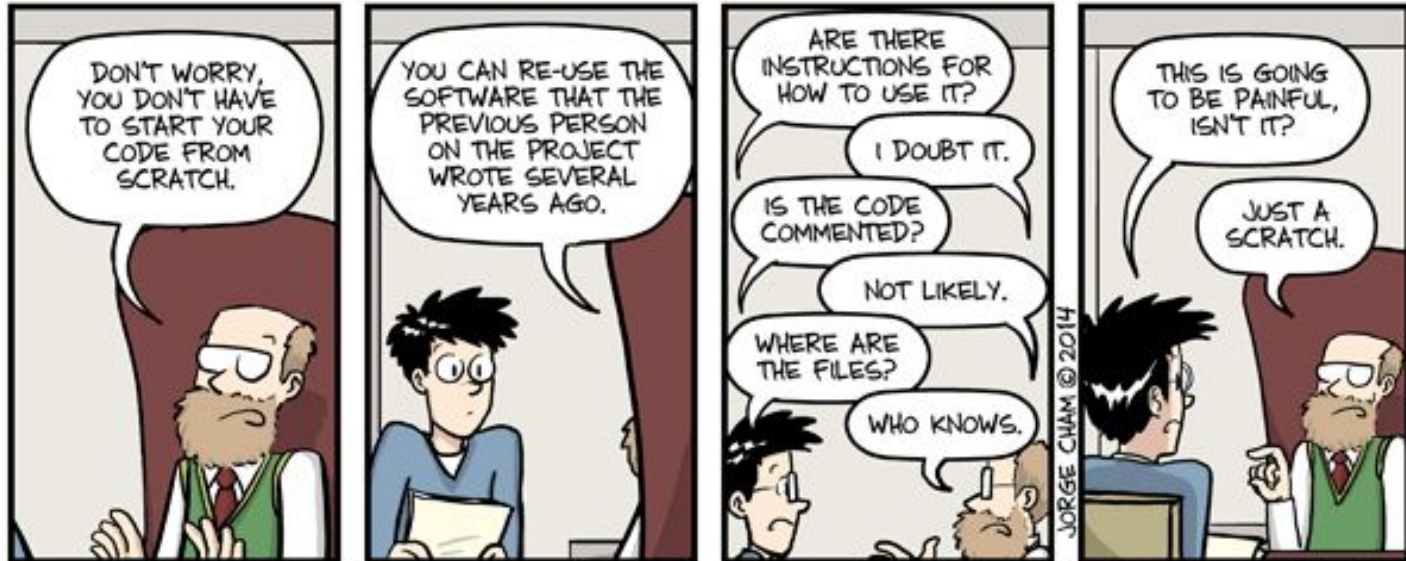


Introduction to R, RStudio, and RStudio Server

The Data Lab

Powered by Alex's Lemonade Stand Foundation

Who's been here before?



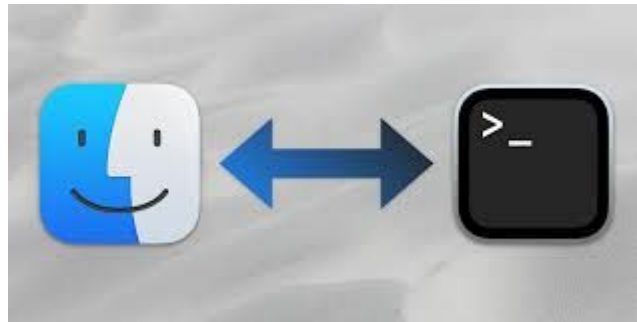
One of our goals is to help you write code that makes this process much, much less painful!

GUI (graphical user interface) vs command line

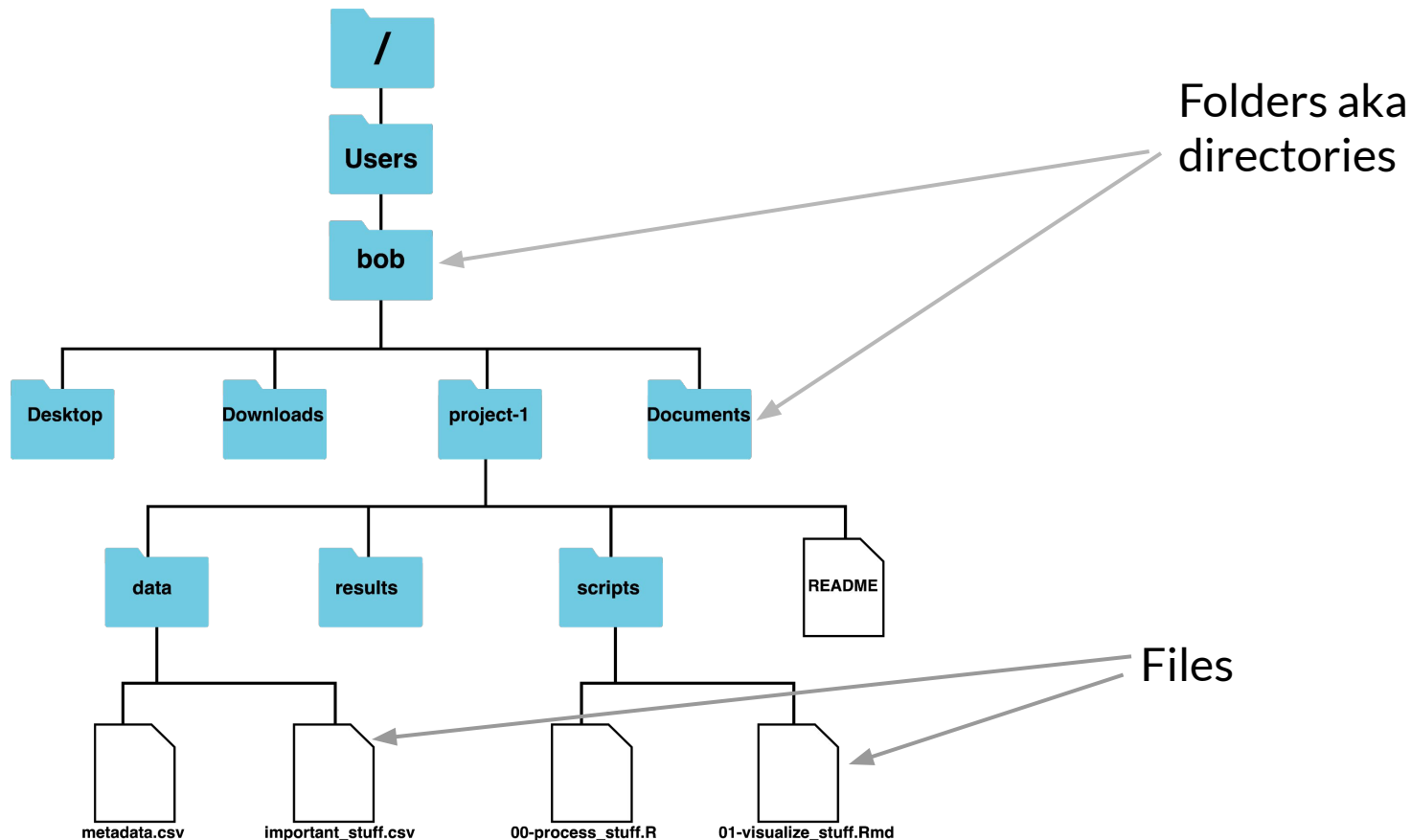
An interface is how you interact with a program

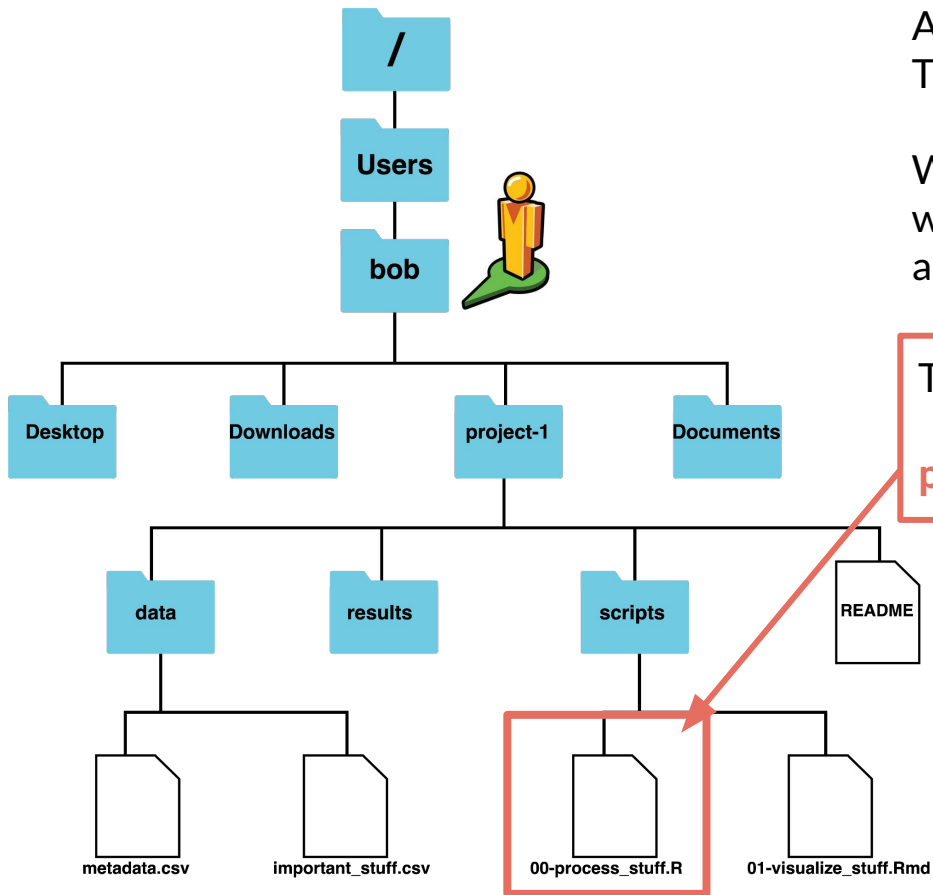
Most of the time, you're using a GUI (graphical user interface) where you point and click to issue commands.

We're moving to a CLI (command line interface) where you *type* to issue commands.



You're always working from somewhere in the filesystem





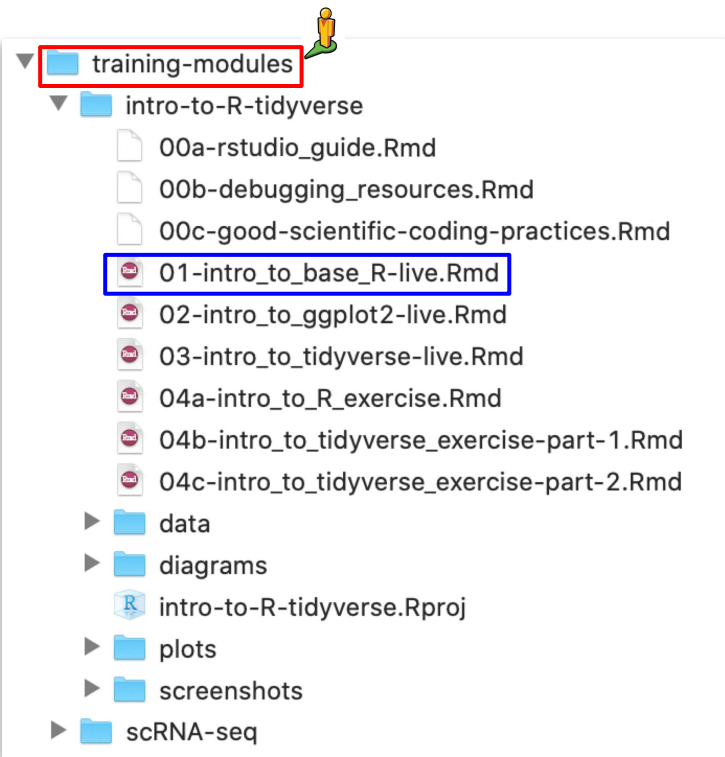
Assume we are working “from” the **bob** directory.
This means **bob** is the *current (working) directory*

We also need to know the **paths** to files we are working with, relative to our working directory, to be able to use those files in our code.

The *relative path* to the file we are working with is:

project-1/scripts/00-process_stuff.R

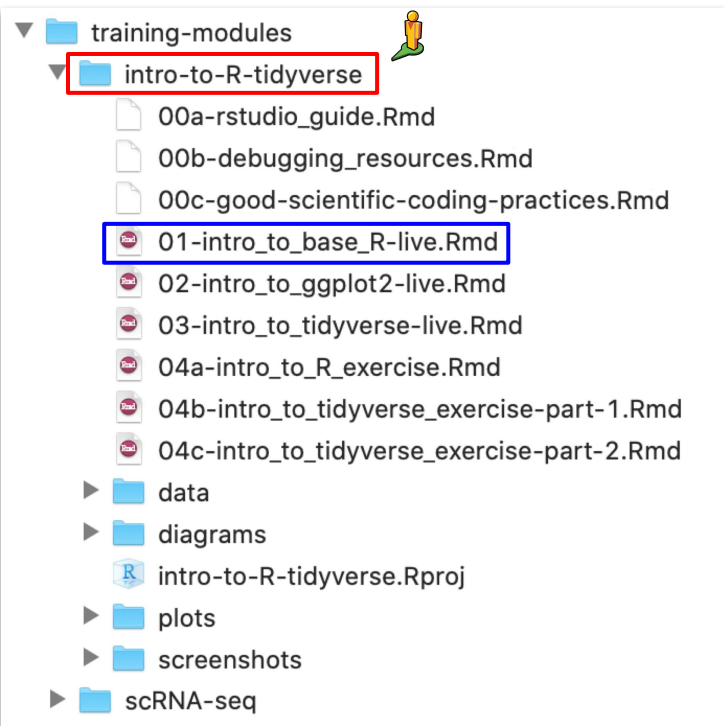
Let's look at our workshop files



Let's say we want access to `01-intro_to_base_R-live.Rmd`

From the current/working directory `training-modules`, the relative path is: `intro-to-R-tidyverse/01-intro_to_base_R-live.Rmd`

Relative paths depend on your working directory



If the working directory is instead `intro-to-R-tidyverse`, the relative path is: `01-intro_to_base_R-live.Rmd`



Introduction to R and RStudio

The Data Lab

R programming

Programming: making executable scripts for accomplishing a task
(in this case, data analysis is our task)

Scripts allow others to see, step-by-step, what you did.

Why we use R:

- It's free and open-source
- People make cool packages that do stuff for us
- Many researchers in genomics use it (as well as Python)



R, RStudio, and RStudio Server

R is a statistical programming language.



RStudio is an IDE for working in R

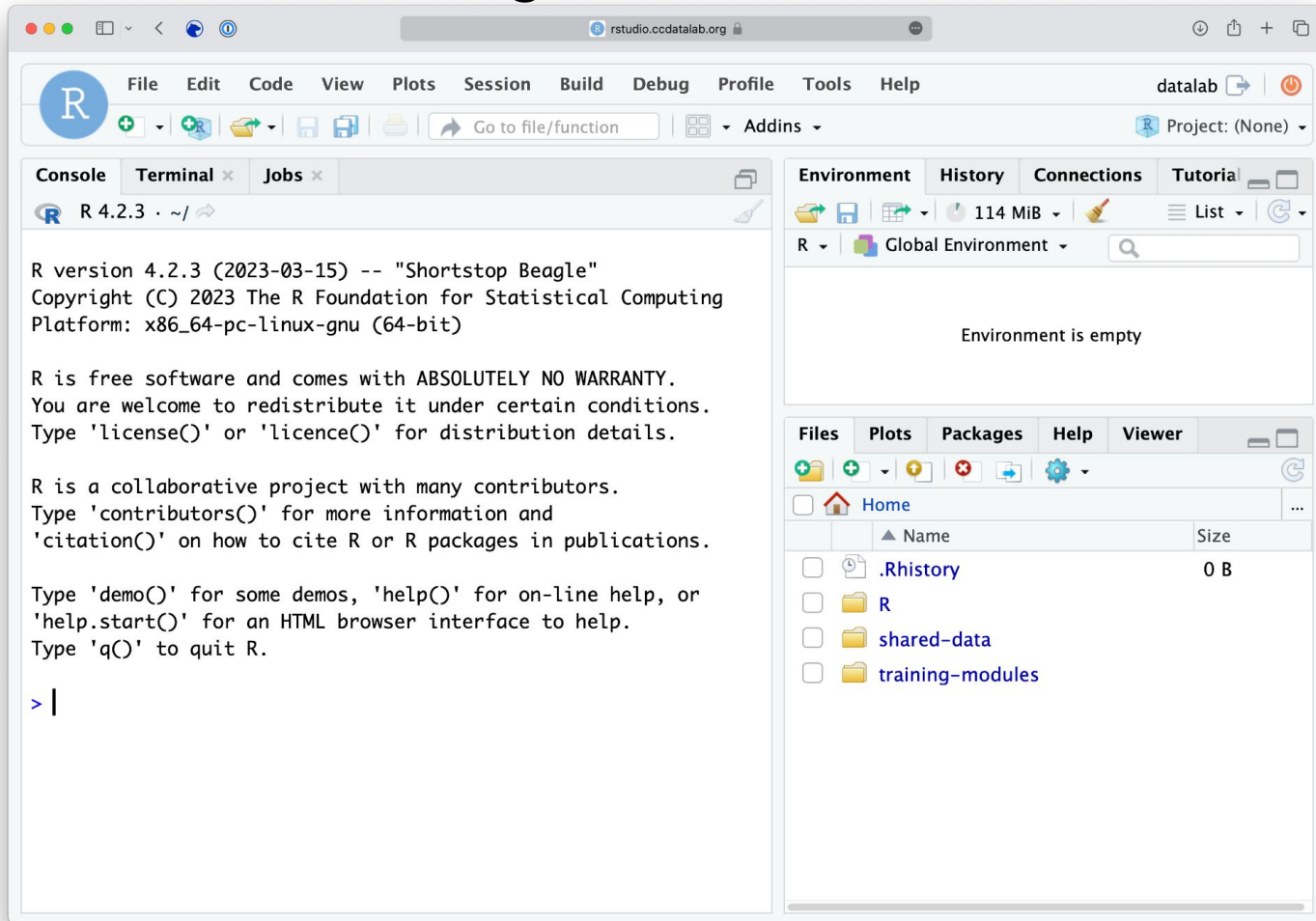
- IDE: Integrated Development Environment
- We write R code using the (free!) RStudio IDE

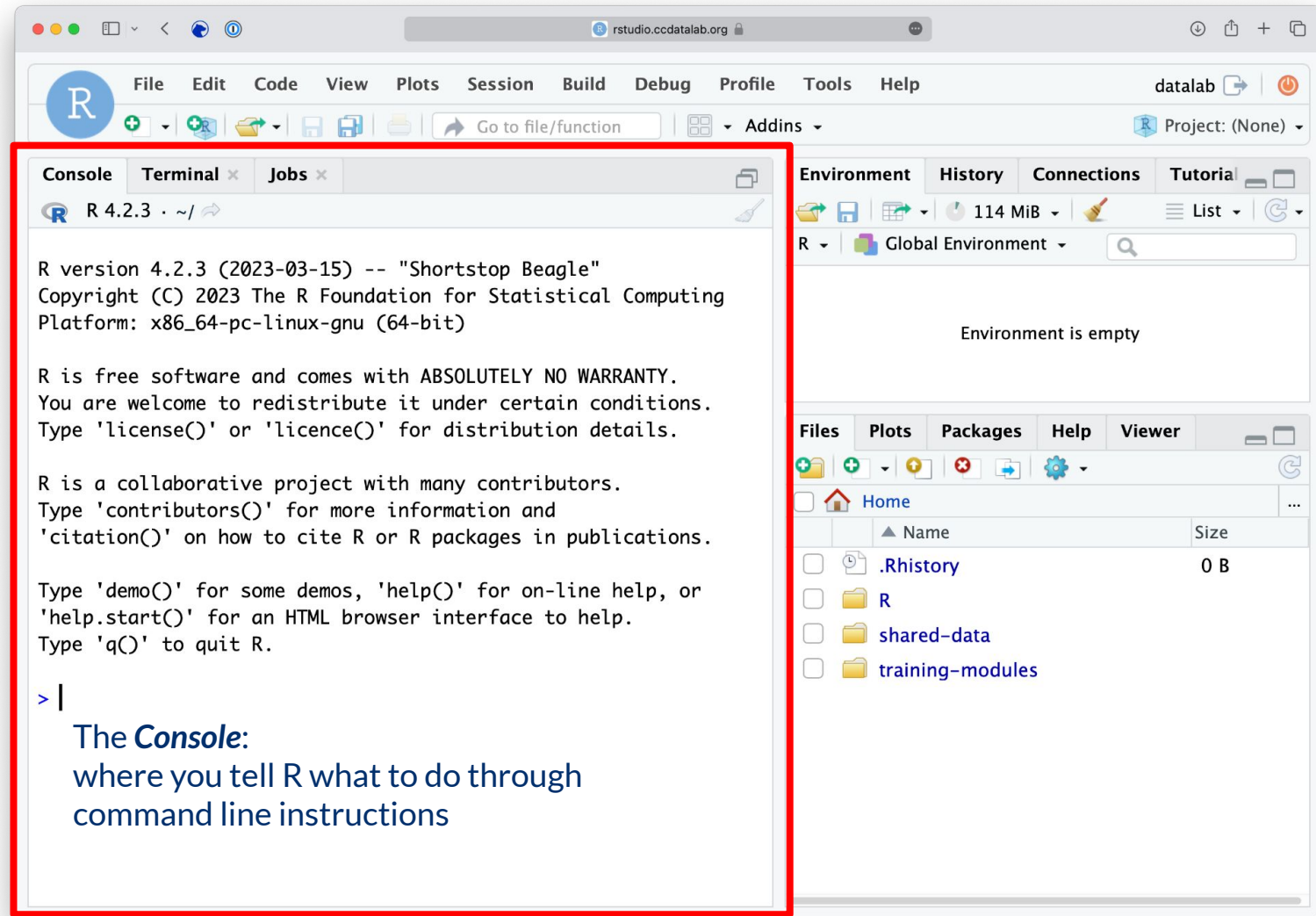


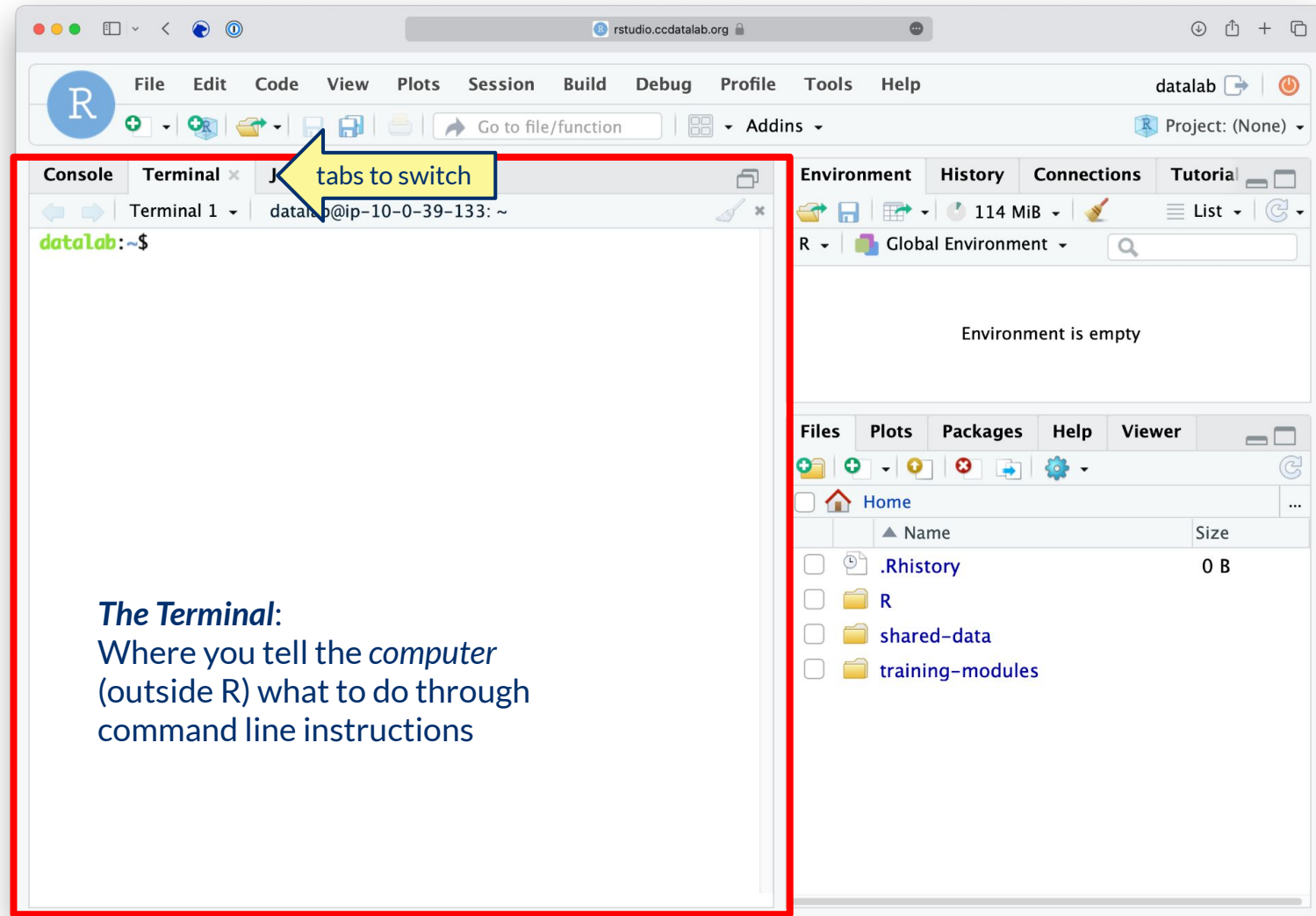
RStudio Server allows us to run the **RStudio IDE** from a browser

RStudio Server: A basic guide

(FYI, we're now
at R 4.4.0)







The image shows a screenshot of the RStudio web interface. The top menu bar includes File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, and Help. The top right shows 'datalab' and a power icon. Below the menu bar is a toolbar with icons for adding files, saving, and navigating. The main interface is divided into several panes. On the left, the 'Console' pane is active, showing a terminal window with the prompt 'datalab:~\$'. Two arrows point from the text below to the '~' and '\$' in the prompt. To the right of the terminal is the 'Environment' pane, which is currently empty. Below the environment pane is the 'Files' pane, showing a file explorer view of the 'Home' directory with files like '.Rhistory', 'R', 'shared-data', and 'training-modules'. The bottom right pane is labeled 'Viewer'.

These indicate what **directory** you are **currently** carrying out a command in

This is called your "**current directory**"

"~" is a shortcut for your "**Home**" directory, so these mean the same thing.

The screenshot displays the RStudio IDE interface. The top menu bar includes File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, and Help. The top toolbar contains icons for creating a new file, opening a file, saving, and navigating. The main workspace is divided into four panes: Console, Terminal, Jobs, and Environment. The Console pane shows the following commands and output:

```
datalab:~$ ls
R shared-data training-modules
datalab:~$ cd training-modules/
```

Below the Console pane, the text "Some common **Terminal** commands:" is displayed, followed by two examples:

- ls** - list the files and folders in a directory (files that start with a '.' are not shown by default)
- cd** - change directories

The Environment pane shows the Global Environment, which is currently empty. The bottom pane shows the Files view, displaying the directory structure:

	Name	Size	Modified
<input type="checkbox"/>	.Rhistory	0 B	Jan 31, 2023
<input type="checkbox"/>	R		
<input type="checkbox"/>	shared-data		
<input type="checkbox"/>	training-modules		

The screenshot displays the RStudio application window. The top menu bar includes File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, and Help. The toolbar below the menu contains various icons for file operations and navigation. The main workspace is divided into four panes: Console, Terminal, Jobs, and Environment. The Console pane shows a terminal session with the following commands and output:

```
datalab:~$ ls
R shared-data training-modules
datalab:~$ cd training-modules/
datalab:~/training-modules$ ls
LICENSE.md README.md intro-to-R-tidyverse
module-cheatsheets scrna-seq
datalab:~/training-modules$
```

The words "training-modules" in the last command are highlighted with a red box. Below the terminal output, a text box contains the following explanation:

The words in front of our cursor have changed because we are now "in" the `training-modules` directory

The Environment pane on the right shows the current environment is empty. Below it, the Files pane displays the file structure of the current directory:

	Name	Size	Modified
<input type="checkbox"/>	.Rhistory	0 B	Jan 31, 2023
<input type="checkbox"/>	R		
<input type="checkbox"/>	shared-data		
<input type="checkbox"/>	training-modules		

The screenshot displays the RStudio application window. The top menu bar includes File, Edit, Code, View, Plots, Session, Build, Debug, Profile, Tools, and Help. The toolbar below the menu contains various icons for file operations and navigation. The main workspace is divided into four panes: Console, Terminal, Jobs, and Environment. The Console pane shows a terminal session where the user has navigated to the `training-modules` directory. The Environment pane is empty, indicating no objects are loaded in the current environment. The Files pane at the bottom right shows the file structure of the current project, which is the `training-modules` directory. The Files pane lists the following files and directories: `.Rhistory`, `R`, `shared-data`, and `training-modules`. The `training-modules` directory is highlighted, indicating it is the current working directory.

```
datalab:~$ ls
R shared-data training-modules
datalab:~$ cd training-modules/
datalab:~/training-modules$ ls
LICENSE.md README.md intro-to-R-tidyverse
module-cheatsheets scrna-seq
datalab:~/training-modules$
```

The words in front of our cursor have changed because we are now “in” the `training-modules` directory

The files tab over here does **NOT** reflect your current directory or any changes within it

The screenshot displays the RStudio IDE interface. The main editor window shows a notebook titled "01-intro_to_base_R-live.Rmd". The code in the notebook includes instructions on how to use the console and a simple R expression to calculate 5 * 6. The console output shows the result [1] 30. The right sidebar contains the Environment pane (empty), the Files pane (showing a file explorer view of the project directory), and the Plots pane. A red box highlights the "Console" icon in the bottom right corner of the sidebar, with a red arrow pointing to it and a text box that says "Click here to show the Console".

Source Visual Outline

```
84 | Divide | \ / |
85 | Exponentiate | ^ or ** |
86
87 For example, we can do some simple multiplication like this.
88 When you execute code within the notebook, the results appear beneath
89 the code.
90 Try executing this chunk by clicking the *Run* button within the chunk
91 or by
92 placing your cursor inside it and pressing *Cmd+Shift+Enter*.
93
94 ```{r calculator}
95 5 * 6
96 ```
```

[1] 30

```
97
98 Use the console to calculate other expressions. Standard order of
99 operations applies (mostly), and you can use parentheses `()` as you
100 might expect (but not brackets `[]` or braces `{}`, which have special
101 meanings). Note however, that you must **always** specify multiplication
102 with `*`; implicit multiplication such as `10(3 + 4)` or `10x` will not
103 work and will generate an error, or worse.
104
105 ```{r expressions, live = TRUE}
106
107 ```
```

105:193 Defining and using variables R Markdown

Environment History Connections Tutorial

R Global Environment

Environment is empty

Files Plots Packages Help Viewer

Home > training-modules > intro-to-R-tidyverse

Name	Size	Modified
00a-intro_to_base_R-live.Rmd	19 KB	Apr 7, 2023
00b-debugging_resources.md	13.6 KB	Apr 7, 2023
00c-good-scientific-coding-pr...	3.9 KB	Apr 7, 2023
01-intro_to_base_R-live.Rmd	19 KB	Apr 7, 2023
02-intro_to_ggplot2-live.Rmd	11.5 KB	Apr 7, 2023
03-intro_to_tidyverse-live.Rmd	21.3 KB	Apr 7, 2023
04a-exercise_01a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04b-exercise_02a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04c-exercise_03a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04d-exercise_04a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04e-exercise_05a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
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04fr-exercise_174a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04fs-exercise_175a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04ft-exercise_176a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04fu-exercise_177a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
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04fw-exercise_179a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04fx-exercise_180a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04fy-exercise_181a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
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04gj-exercise_192a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04gk-exercise_193a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04gl-exercise_194a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04gm-exercise_195a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04gn-exercise_196a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04go-exercise_197a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04gp-exercise_198a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
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04gt-exercise_202a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
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04gv-exercise_204a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04gw-exercise_205a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
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04hi-exercise_217a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04hj-exercise_218a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
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04hl-exercise_220a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
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04hn-exercise_222a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04ho-exercise_223a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
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04hq-exercise_225a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04hr-exercise_226a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04hs-exercise_227a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04ht-exercise_228a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04hu-exercise_229a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04hv-exercise_230a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04hw-exercise_231a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04hx-exercise_232a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04hy-exercise_233a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04hz-exercise_234a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04ia-exercise_235a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04ib-exercise_236a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04ic-exercise_237a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04id-exercise_238a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04ie-exercise_239a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
04if-exercise_240a-intro_to_tidyverse...	1.7 KB	Apr 7, 2023
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04ih-exercise_242a-intro_to_tidyverse...	1.7 KB	Apr 7, 20

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File Edit Code View Plots Session Build Debug Profile Tools Help

01-intro_to_base_R-live.Rmd

Source Visual [1] 30 Outline

```
95
96 Use the console to calculate other expressions. Standard order of
    operations applies (mostly), and you can use parentheses `()` as you
    might expect (but not brackets `[]` or braces `{}`, which have special
    meanings). Note however, that you must **always** specify multiplication
    with `*`; implicit multiplication such as `10(3 + 4)` or `10x` will not
    work and will generate an error, or worse.
97
98 ```{r expressions, live = TRUE}
99 x <- 5.5
100
101 x
102 ```
```

[1] 5.5

103
104

118:91 # Defining and using variables R Markdown

Environment History Connections Tutorial

Import Dataset 172 MiB

R Global Environment

Values

x	5.5
---	-----

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Home > training-modules > intro-to-R-tidyverse

	Name	Size	Modified
	00a-reading_guide.md	3.1 KB	Apr 7, 2023
	00b-debugging_resources.md	13.6 KB	Apr 7, 2023
	00c-good-scientific-coding-pr...	3.9 KB	Apr 7, 2023
	01-intro_to_base_R-live.Rmd	19 KB	Apr 7, 2023
	02-intro_to_ggplot2-live.Rmd	11.5 KB	Apr 7, 2023
	03-intro_to_tidyverse-live.Rmd	21.3 KB	Apr 7, 2023
	data		
	diagrams		
	exercise_01-intro_to_base_R.R...	4.8 KB	Apr 7, 2023
	exercise_02-intro_to_R.Rmd	4.7 KB	Apr 7, 2023
	exercise_03a-intro_to_tidyvers...	7.7 KB	Apr 7, 2023
	exercise_03b-intro_to_tidyvers...	6.2 KB	Apr 7, 2023
	README.md	1.8 KB	Apr 7, 2023

Console Terminal Jobs

R 4.2.3 ~ /

```
> x <- 5.5
>
> x
[1] 5.5
> |
```

R Console:
What you are actually telling R to do

The screenshot shows the RStudio IDE interface. A red rectangular box highlights the Source editor area, which contains R code and a preview of the output. Overlaid on this box is the text: "R Script or Notebook: Where you are writing and editing what you will tell R or Terminal".

Source Editor Content:

```
01-intro_to_base_R-live.Rmd* x
[1] 30

95
96 Use the console to calculate other expressions. Standard order of
    operations applies (mostly), and you can use parentheses `()` as you
    might expect (but not brackets `[]` or braces `{}`, which have special
    meanings). Note however, that you must **always** specify multiplication
    with `*`; implicit multiplication such as `10(3 + 4)` or `10x` will not
    work and will generate an error, or worse.
97
98 ```{r expressions, live = TRUE}
99 x <- 5.5
100
101 x
102 ~```

[1] 5.5

103
104
```

Console Content:

```
118:91 # Defining and using variables
R 4.2.3 ~ /
> x <- 5.5
>
> x
[1] 5.5
> |
```

Environment Panel:

Environment History Connections Tutorial

R Global Environment

Values

Variable	Value
x	5.5

Files Panel:

Files Plots Packages Help Viewer

Home > training-modules > intro-to-R-tidyverse

Name	Size	Modified
00a-creating_a_github_repo	3.1 KB	Apr 7, 2023
00b-debugging_resources.md	13.6 KB	Apr 7, 2023
00c-good-scientific-coding-pr...	3.9 KB	Apr 7, 2023
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exercise_03b-intro_to_tidyvers...	6.2 KB	Apr 7, 2023
README.md	1.8 KB	Apr 7, 2023

The screenshot displays the RStudio IDE interface. The main editor window shows an R script file named `01-intro_to_base_R-live.Rmd`. The script contains a comment explaining the order of operations and a code chunk that defines a variable `x` with the value `5.5`. The console at the bottom shows the execution of `x <- 5.5`, resulting in `[1] 5.5`. The Environment pane on the right, highlighted with a red box, shows the `Global Environment` with a variable `x` having the value `5.5`. The Files pane at the bottom right shows a directory structure with various R Markdown files and folders.

Environment

R ▾ Global Environment ▾

Values

x	5.5
---	-----

R environment:
What R knows and remembers for you

Files | **Plots** | **Packages** | **Help** | **Viewer**

Home > training-modules > intro-to-R-tidyverse

Name	Size	Modified
00a-creating_a_github_repo	1.8 KB	Apr 7, 2023
00b-debugging_resources.md	13.6 KB	Apr 7, 2023
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01-intro_to_base_R-live.Rmd	19 KB	Apr 7, 2023
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datalab Project: (None)

01-intro_to_base_R-live.Rmd*

Source Visual [1] 30 Outline

```
95
96 Use the console to calculate other expressions. Standard order of
    operations applies (mostly), and you can use parentheses `()` as you
    might expect (but not brackets `[]` or braces `{}`, which have special
    meanings). Note however, that you must **always** specify multiplication
    with `*`; implicit multiplication such as `10(3 + 4)` or `10x` will not
    work and will generate an error, or worse.
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98 ```{r expressions, live = TRUE}
99 x <- 5.5
100
101 x
102 ```
```

[1] 5.5

103
104

118:91 # Defining and using variables R Markdown

Console Terminal Jobs

```
R 4.2.3 ~/>
> x <- 5.5
>
> x
[1] 5.5
> |
```

Environment History Connections Tutorial

Import Dataset 172 MiB

R Global Environment

Values

x	5.5
---	-----

Other Assistance Tabs:
Things that help you in your coding

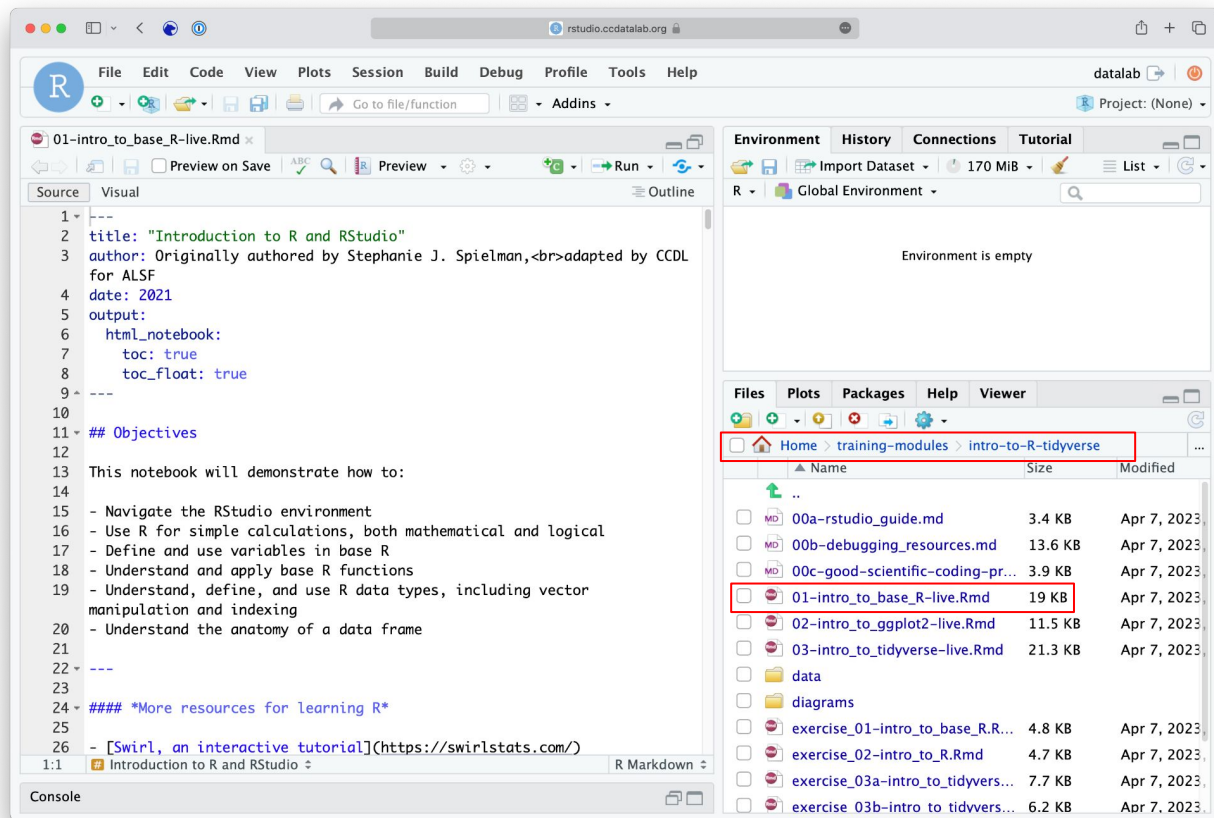
Files Plots Packages Help Viewer

Home > training-modules > intro-to-R-tidyverse

	Name	Size	Modified
	00a-tidyverse_gardenma		
	00b-debugging_resources.md	13.6 KB	Apr 7, 2023
	00c-good-scientific-coding-pr...	3.9 KB	Apr 7, 2023
	01-intro_to_base_R-live.Rmd	19 KB	Apr 7, 2023
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	exercise_03b-intro_to_tidyvers...	6.2 KB	Apr 7, 2023
	README.md	1.8 KB	Apr 7, 2023

R Notebooks

Use the "Files" tab to open: `training-modules/intro-to-R-tidyverse/01-intro_to_base_R-live.Rmd`

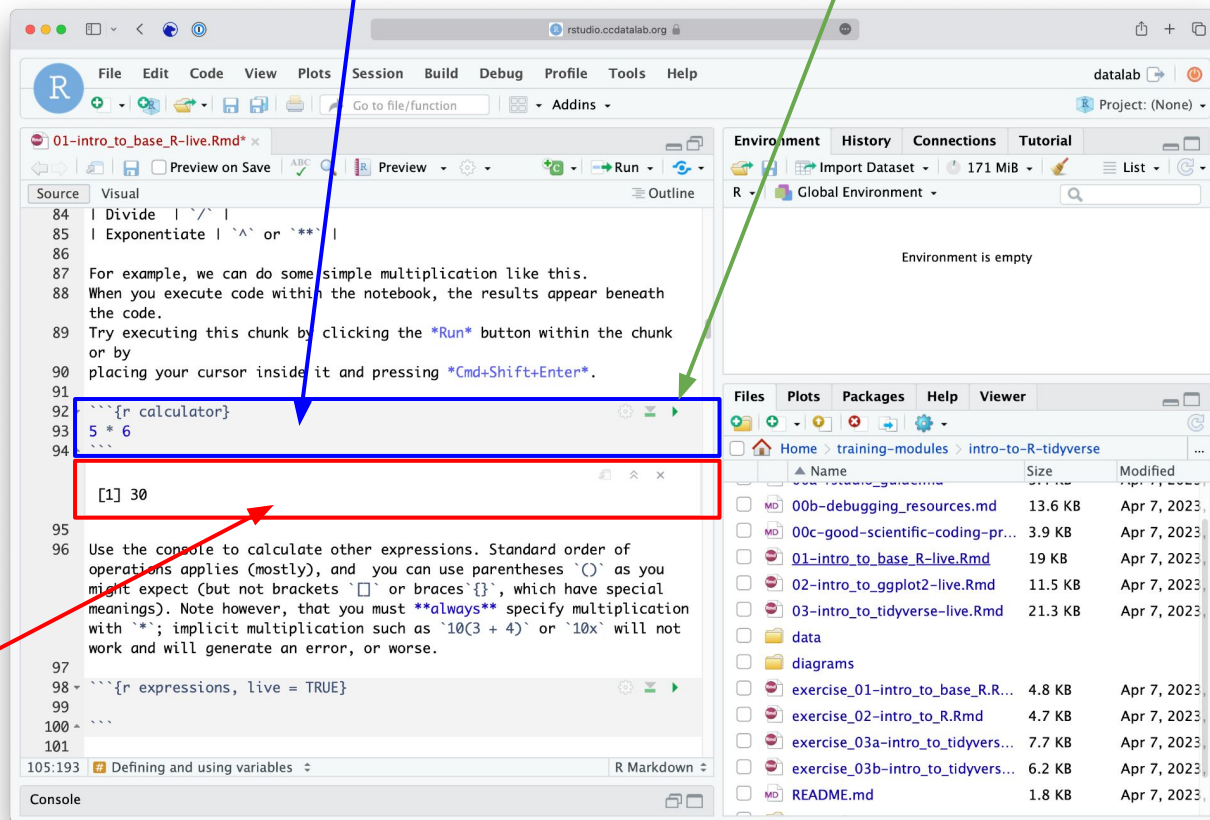


R Notebooks

R Notebooks allow you to have files that show both your code and results

Executable code chunk

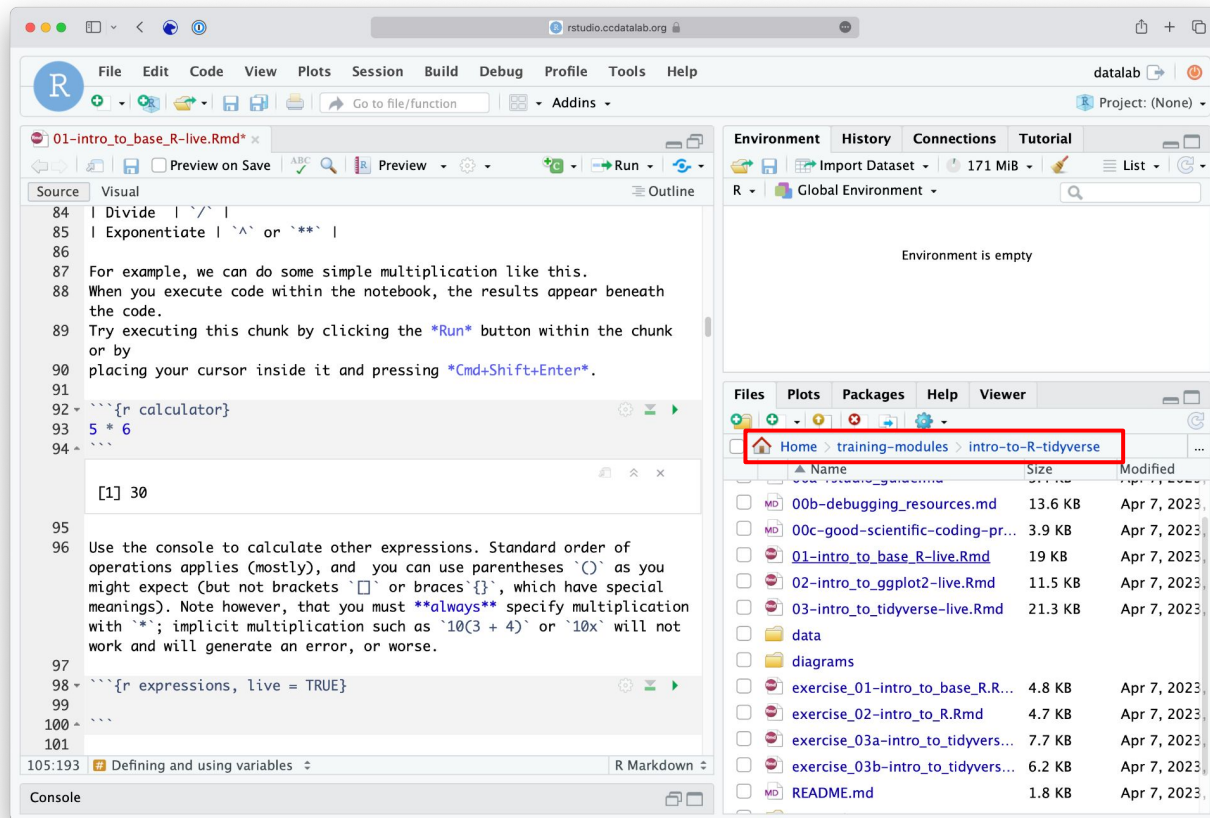
Can click here to run a code chunk



Output from above code chunk

R Notebooks

- Code that runs in R Notebooks uses wherever the file is saved as its *current directory*
- Warning!** That may not be the directory shown in the files pane or the console!



RStudio Sessions

- On the server, R is running many times at once
 - Each user has their own “**Session**” running, with its own memory and processes
- We will usually want to start new sessions between notebooks to keep the environment clean

