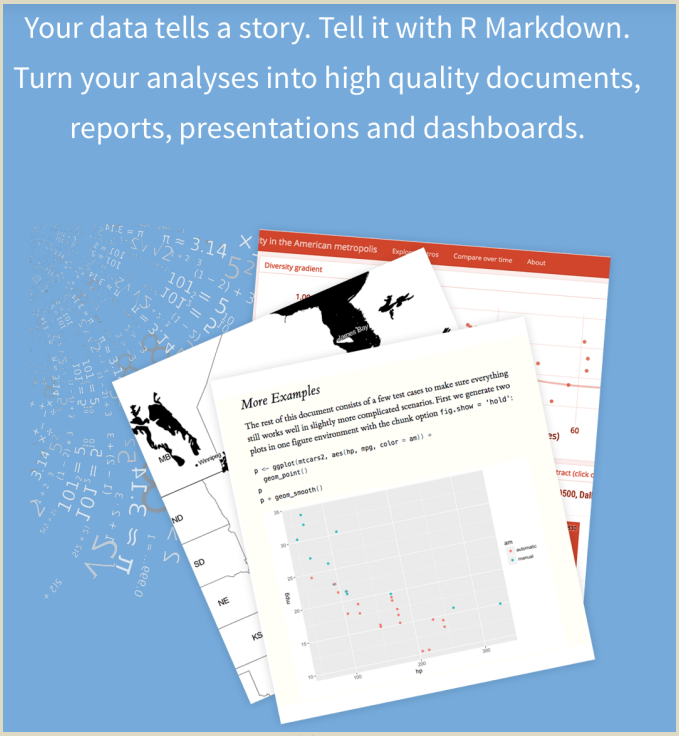
BIOSTATS 540 – Introductory Biostatistics
Fall 2022
Introduction to R
05 – Introduction to R Markdown



Source: https://rmarkdown.rstudio.com

1. Console *versus* R Script *versus* R Markdown

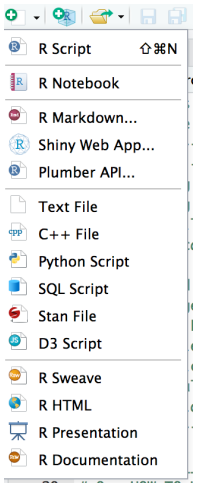
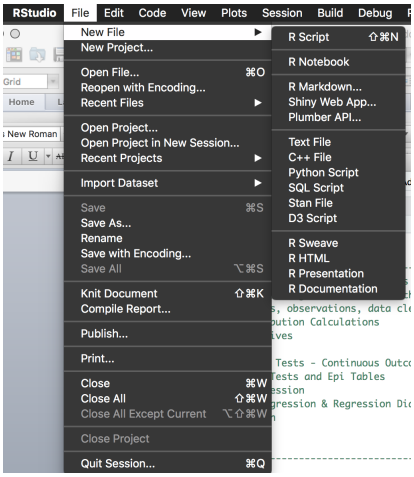
	Console	R Script	R Markdown
At a Glance	**Execute**	**Execute** + **Save Code**	**Execute** + **Save Code** + **Produce Output**
What is it	**R Studio interface.** Here, commands written and executed immediately.	**Text editor** Here, commands are written. + **Utility** This utility sends commands to the console for execution.	**Chunks** R commands are written inside shaded gray chunks. + **Utility** This utility sends commands to the console for execution. + **Text Markup** Instead of MS Word, the R Markdown markup language is used to format your narrative (italics, bold, lists, tables, etc.) + **Additional Utilities** Additional utilities render/knit your work to produce a product in any of several formats (e.g., html, PDF, Word).
Where to find it	**Console Pane** Usually at lower left. How to change the location: `tools > global options > tab BASIC > pane layout`	**Source/Editor Pane** Usually at upper left How to change the location: `tools > global options > tab BASIC > pane layout`	**Source/Editor Pane** Usually at upper left Location can be changed `tools > global options > tab BASIC > pane layout`

	Console	R Script	R Markdown
Suggested use	As a calculator When learning an R command	To save code fragments as boilers for future work	To archive a full report of text, code, results, graphs, etc. *ie, for pretty much everything*
Good to know	Work cannot be saved The command prompt is **>** Retrieve command ↑ **+** means your command is incomplete; R is waiting for you to type the rest of it. If you don't know the rest, hit **<esc>** How to cancel a command (it might take a while) **<control> - c**	- Work can be saved as an **".R"** file	- Work can be saved as an **".Rmd"** file - File must be "self contained" Commands that require external objects or utilities cannot be rendered; e.g., - ~~`View( )`~~ - ~~`install.packages( )`~~

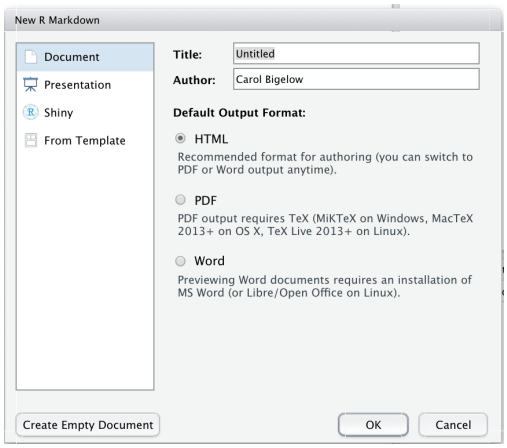
2. How to Work with Chunks

How to Create an R Markdown file:

From the Source/Editor pane, click on either (+) or, from the toolbar, do File > New File > R Markdown

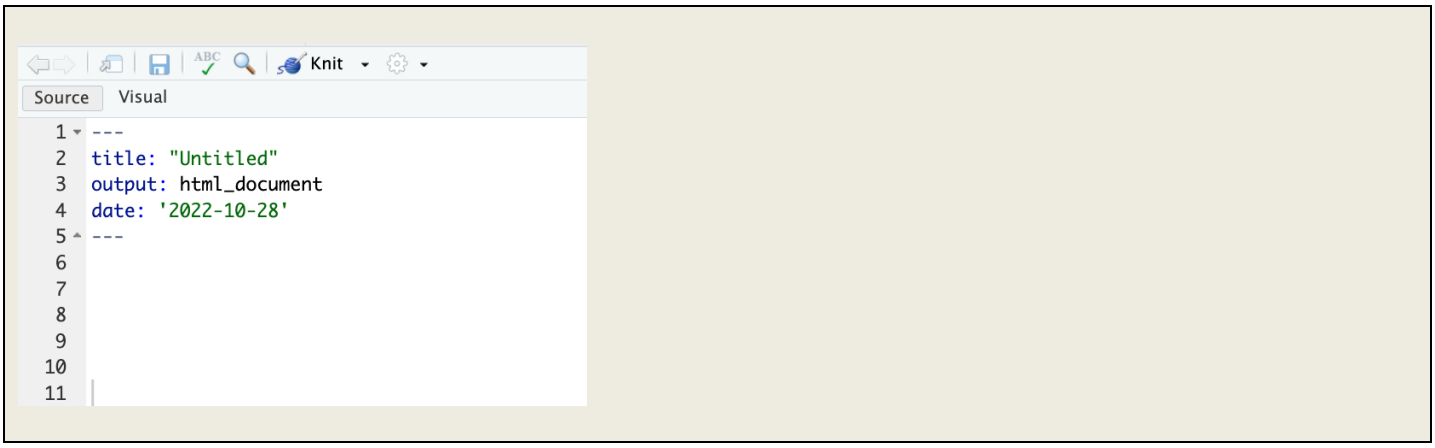
The "+" symbol > R Markdown	**FILE > NEW FILE > R Markdown**
	

Make your choices

	**In the box Title**: Enter a title of your choice **In the box Author**: Edit (or not) as you like **Under Default Output Format**: Leave as is **At left, "Document" is highlighted**: Leave as is **Click OK**

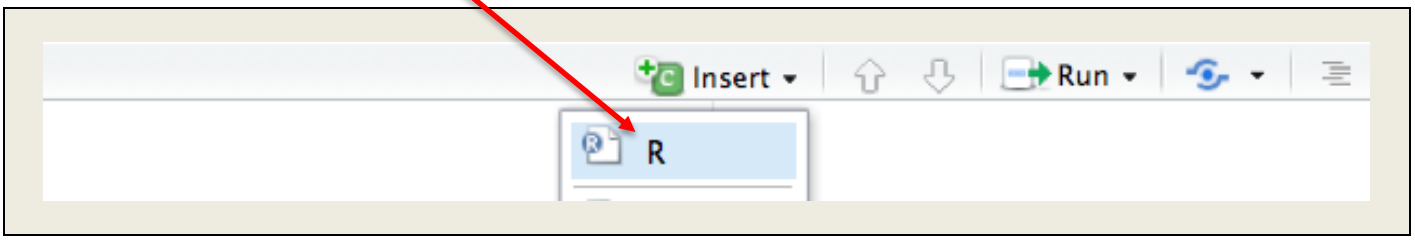
Delete the pre-supplied R code chunks and text

R returns a new R Markdown with some pre-supplied chunks and texts. These are here to help you understand chunks. In practice, you will delete the unwanted chunks and text.

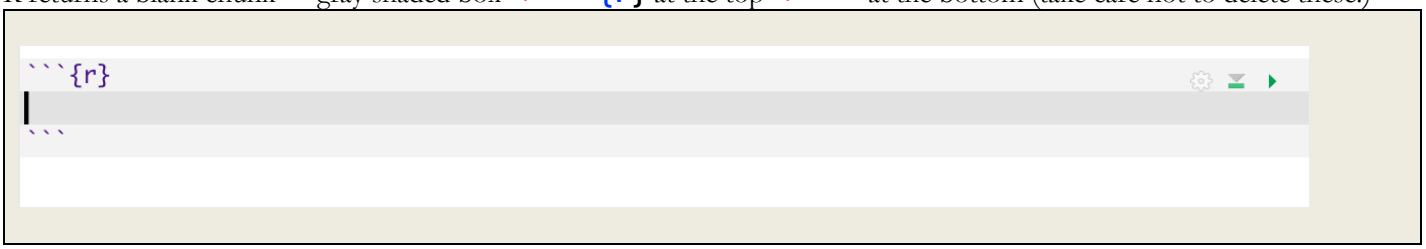


How to Create a New Chunk

Click on the little green "insert a chunk" icon at top (on the right).
From the drop down menu, choose R



R returns a blank chunk = gray shaded box + ```{r} at the top + ``` at the bottom (take care not to delete these!)



Give your chunk a name (*optional*) and supply the options you want (*also optional*). Separate with commas. If you are new to working with chunks in R Markdown, the following options may be all you need.

Chunk Option	Description
`echo=FALSE`	Report will show output R code will NOT be shown
`include=FALSE`	Report will NOT show output and R code will NOT be shown So why do this!. Sometimes, you want to run a chunk as a preliminary to a later chunk and you do NOT want the results of this preliminary chunk to appear in the final report
`message=FALSE`	Nice. This will prevent messages from appearing in the final report. Tip - This is handy when you call a package and you don't want messages to appear in your final report.
`warning=FALSE`	Also nice. This will prevent warnings from appearing in the final report.

Example

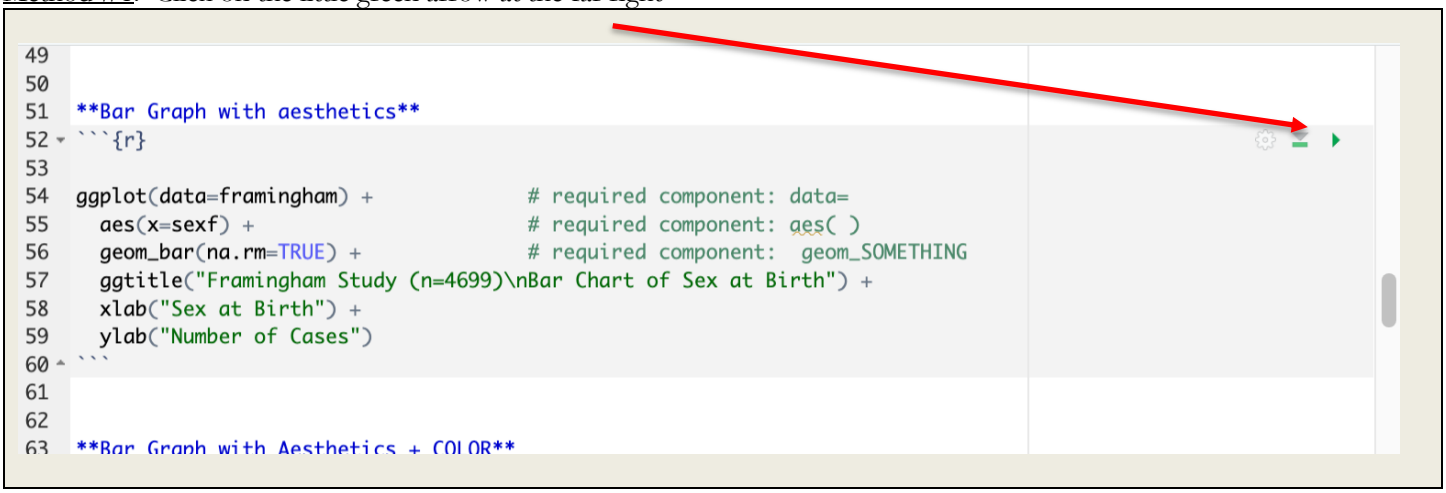
````
```{r descriptives, message=FALSE, warning=FALSE}
library(summarytools)


```
````

Key. The name of this chunk is `descriptives`. This is followed by a comma and two options, also separated by a comma

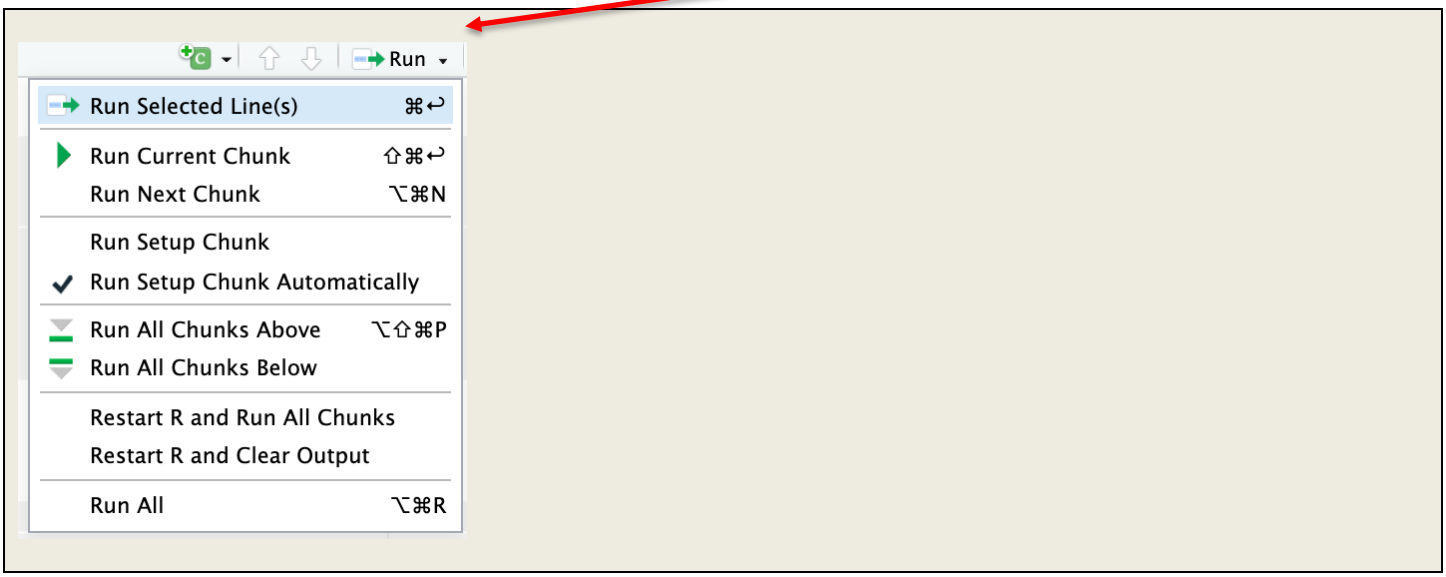
How to Execute a Chunk

There are 2 ways to execute the current chunk:

Method #1. Click on the little green arrow at the far right



Method #2. Alternatively, you can use the drop down options under RUN at upper right



How to Render/Knit/Execute/Produce Your Report
Before you render, be sure to do a final save!
At upper left, click on the icon that looks like a ball of yarn with a knitting needle!

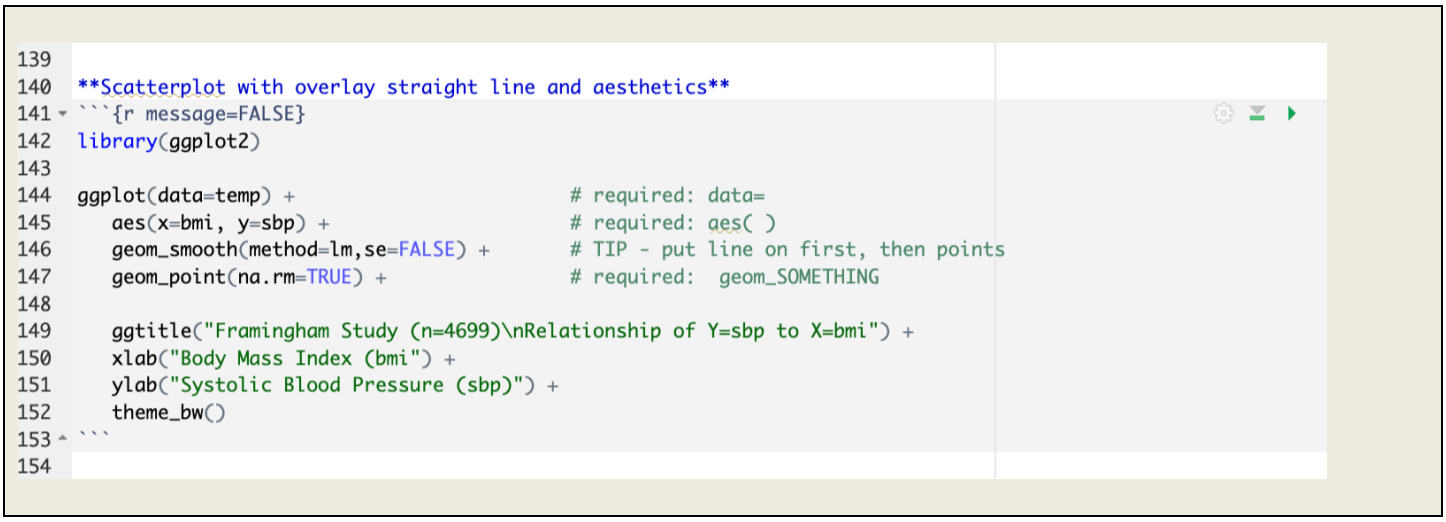
Tips!!

- **Work chunk by chunk.** Focus on each chunk one at a time. Create it, execute, examine the output, fix your mistakes, tweak to your liking, wash, rinse repeat.

- **Focus each chunk on just one thing** (e.g., producing a plot, producing table, creating factors, and so on). This will make your program more readable and much easier to troubleshoot.

- **Preview the looks of your report as you go along.** To do this, in the **`Environment pane`**, click on the tab **`Viewer.`** Now you can periodically knit to HTML; this will produce the output in your viewer for you to review.

Example



3. How to Work with R Markdown Markup Language

How to Markup Your Text Narrative (don't even think of MS Word!)
Tip - Preview your work as you go along! In R Studio, in the environment pane, click on the tab **Viewer**. As you go along you can check your work by knitting to HTML and looking at a preview in the viewer.

Markup	Syntax
`italics`	*** text*** **_ text_** **Tip –** There must be NO SPACE before your text begins
`bold`	**** text**** **__ text__**
`italics and bold`	*****text***** ***__ text__ ***
`subscript`	**~ text ~**
`superscript`	**^ text ^**
`quote`	**<RETURN>** **>** **> body of quote** **>**
`hyperlink`	**[text name of link] (URL)**
`image`	**![text name of image] (path to image)**
`inline R code`	**` r YOUR R COMMAND `**

Markup	Syntax ** My personal preference
`force a line break`	**** Just add \ at the end of the line** **Or, put *two* trailing blank spaces. Then click RETURN**
`to add 2 blank lines after a sentence (and so on...)`	**** Just add \ at the end of the line. Then do 2 more!** \ \
`inline equation`	**$equation$**
`equation on its own line`	**$$equation$$**

`first level header`
`second level header`
`third level header`
 	
Tip - if you want your headers unnumbered
`first level header`
`second level header`
`third level header`
	# text
	## text
	### text
	
	Tip – There MUST be a space before your text begins
	
	# text{-}
	## text{-}
	### text-}

`NUMBERED list`
`1. etc is level 1`
`<tab> a. etc is level 2`
`<tab><tab> i.is level 3`
 	
Tip – This relies on use of the tab key
	1. titleoflist
	a. subitem 1
	i. subsub item 1
	ii. subsub item 2
	b. subitem 2
	i. subsub item 1
	ii. subsub item 2

`UN-numbered list`
`* is level 1`
`+ is level 2`
`- is level 3`
 	
Tips –
(1) Each *, +, - must be followed by a space
(2) Use the tab key to get to next sublevel
	*** titleoflist**
	+ subitem 1
	- subsub item 1
	- subsub item 2
	+ subitem 2
	- subsub item 1
	- subsub item 2

How to Format Mathematics

Preliminary: Install the package `{tinytex}`. `No need to issue a library( ) however.`

`To insert an equation in-line` `$YOURMATH$`	Example: `$\sum_{n=1}^{10} n^2$` is rendered as $\sum_{n=1}^{10} n^2$.
`To insert an equation display form` `$$YOURMATH$$`	Example: `$$\sum_{n=1}^{10} n^2$$` is rendered as $$\sum_{n=1}^{10} n^2$$.
`Greek Letters`	αA `$\alpha A$` νN `$\nu N$` βB `$\beta B$` $\xi \Xi$ `$\xi\Xi$` $\gamma \Gamma$ `$\gamma \Gamma$` oO `$o O$` (omicron) $\delta \Delta$ `$\delta \Delta$` $\pi \Pi$ `$\pi \Pi$` $\epsilon \varepsilon E$ `$\epsilon \varepsilon E$` $\rho \varrho P$ `$\rho\varrho P$` ζZ `$\zeta Z \sigma \,\!$` Σ `$\sigma \Sigma$` ηH `$\eta H$` τT `$\tau T$` $\theta \vartheta \Theta$ `$\theta \vartheta \Theta$` $\upsilon \Upsilon$ `$\upsilon \Upsilon$` ιI `$\iota I$` $\phi \varphi \Phi$ `$\phi \varphi \Phi$` κK `$\kappa K$` χX `$\chi X$` $\lambda \Lambda$ `$\lambda \Lambda$` $\psi \Psi$ `$\psi \Psi$` μM `$\mu M$` $\omega \Omega$ `$\omega \Omega$`

Formatting Mathematics - continued

Mathematical Notation

$x = y$	`$x = y $`
$x < y$	`$x < y $`
$x > y$	`$x > y $`
$x \le y$	`$x \le y $`
$x \ge y$	`$x \ge y $`
x^n	`$x^{n}$`
x_n	`$x_{n}$`
$\overline{x}$	`$\overline{x}$`
$\hat{x}$	`$\hat{x}$`
$\tilde{x}$	`$\tilde{x}$`
$\frac{a}{b}$	`$\frac{a}{b}$`

Fractions

$$\frac{1}{2}$$

```
$$
\frac{1}{2}
$$
```

Subscripts and Superscripts

$$Y = X_1 + X_2$$

$$a^2 + b^2 = c^2$$

```
$$
Y = X_1 + X_2
$$

$$
a^2 + b^2 = c^2
$$
```

Square Root

$$\sqrt{p}$$

```
$$
\sqrt{p}
$$
```

Example

Step 1: In R Markdown, markup your narrative (I added the **blue** to make this easy to read).

```
### Some Plain Text
This is some plain text with no markup.  Here comes a return.\
And here I am on the next line.  And I am still happily typing away, not giving a care about anything.  Here comes a
return followed by a blank line.\
\
### Some Text that has been marked up using R Markdown.\
\
Example of italics.  *sunshine in italics*.
\
Example of bold.  **Friday in bold**.
\
Example of bold italics.  ***really important***
\
Example of superscript (the R-squared in regression).  R^2^.
\
Example of subscript (first observation of X). X~1~.
\
Example of quote.\

>
> Our greatest glory is not in never falling, but in rising up every time we fall
>
> Ralph Waldo Emerson
>


* UNNumbered List - Results of Sampling Cities
    + Massachusetts
        - Boston
        - Worcester
     + Washington
        - Seattle
        - Olympia

 1. NUMBERED LIST - Results of Sampling Cities
    a. Massachusetts
        i. Boston
        ii. Worcester
    b. Washington
        i. Seattle
        ii. Olympia
```

Step 2: All done? Knit/Render (Here, I knit to HTML)

Some Plain Text

This is some plain text with no markup. Here comes a return. And here I am on the next line. And I am still happily typing away, not giving a care about anything. Here comes a return followed by a blank line.

Some Text that has been marked up using R Markdown.

Example of italics. *sunshine in italics*.

Example of bold. **Friday in bold**.

Example of bold italics. ***really important***

Example of superscript (the R-squared in regression). R^2.

Example of subscript (first observation of X). X_1.

Example of quote.

> Our greatest glory is not in never falling, but in rising up every time we fall
>
> Ralph Waldo Emerson

- UNNumbered List - Results of Sampling Cities
  - Massachusetts
    - Boston
    - Worcester
  - Washington
    - Seattle
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1. NUMBERED LIST - Results of Sampling Cities
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   b. Washington
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